Opportunities for a Sustainable Informal Economy: The Case of Mexico

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Abstract

The impact of the informal economy on the environment is largely unknown. Estimates of the size of the Mexican informal economy vary between 27 to 49% of GDP depending on the method of measurement. Given the size of its share of the economy, it is expected that the informal economy will have an impact of the environment. This paper models pollution demand of the informal economy in 2454 Mexican municipalities and tests whether output generated by the shadow economy produces a significant environmental impact. We test the effectiveness of regulation to reduce the size of the informal economy in order to reduce its environmental impact. Our findings suggest that the impact of informal economies on the environment is significant, and that developing a sustainable informal economy may be possible through the combined efforts of government, society, and organizational / managerial alternatives.

Introduction

Informal economies comprise a large part of the developing world's economy. Conservative estimates of the informal economy in developing economies is between 40 to 60% of GDP; in

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transition economies, the estimate is 30 to 40% of GDP; and in OECD countries, estimates vary from 10% in the most developed economies up to 40% (Schneider & Enste, 2000). By definition, informal economies are unregistered, and thus their impact on the environment is largely unknown. Policies, regulation, and voluntary efforts aimed to diminish industry impact on the environment are concentrated solely on the formal economy and, therefore, are incomplete. In developing countries where the size of the informal economy is large and regulation and enforcement efficiency are inadequate, the impact of the informal sector on the environment is of particular concern. This paper models pollution demand of the informal economy in 2454 Mexican municipalities and tests whether output generated by the shadow economy produces a significant environmental impact. We test the effectiveness of regulation to reduce the size of the informal economy in order to reduce its environmental impact. Our findings suggest that the impact of informal economies on the environment is significant, and that developing a sustainable informal economy may be possible through the combined efforts of government, society, and organizational / managerial alternatives.

The informal economy is traditionally defined as all economic activities that contribute to the officially calculated (or observed) gross national product but are currently unregistered.
It is also understood as "market based production of goods and services, whether legal or illegal, that escapes detection in the official estimates of GDP." And yet these definitions are narrow in scope. Schneider & Enste, 2000 use a broader definition by dividing the informal sector into types of transactions, monetary or non-monetary, and into legal and illegal activities. The illegal activities that involve monetary transactions include: trade in stolen goods, drug dealing and manufacturing, prostitution, gambling, smuggling, and fraud. Legal activities with monetary transactions include: unreported income from self employment in addition to wages, salaries, and

assets from unreported work related to legal services and goods. Illegal activities that involve non-monetary transactions include bartering drugs and stolen goods, smuggling, production or theft of drugs for personal use, etc. Finally, legal activities that involve non-monetary transactions include the barter of legal services and goods, small-scale tax evasion, or do-it-yourself work (Mirus and Smith 1997 on Schneider and Enste, 2000). Mexico's informal economy encompasses all these dimensions. These legal and illegal activities are embedded in the economy, create goods and services, produce economic wealth (Brambila Macias, 2008) and, as a by product, produce pollution (Blackman, 1999; Kathuria, 2007; Sterner, 2002)

The informal economy includes many pollution intensive activities such as leather tanning, brick and tile making, and metalworking that have significant environmental impact. Controlling pollution created by informal firms is complicated for a number of reasons. First, by definition, informal economies are largely unregistered and have few ties to the state: they are difficult to monitor because of their size, number and geographical dispersion, or because they have very low safety standards (Biswas, Farzanegan, & Thum, 2011; Blackman, 1999; Chattopadhyay, Banerjee, & Millock, 2011).

In contrast, the firms that belong to the formal economy—those registered in formal schemes, that pay taxes and participate in a very competitive dynamic—are expected to adopt environmental standards and sustainability processes. The regulator enforces compliance of these firms with command and control policies or through voluntary and self-regulatory schemes. These measures, however, particularly in developing economies, can be inadequate: society in itself demands action towards a more responsible environmental management (Darnall &

Carmin, 2005; Delmas & Toffel, 2004; Delmas & Toffel, 2007; González-Lara, 2008; Harrison & Freeman, 1999).

Given the aforementioned situation, it is possible to ask whether the informal sector has any incentive to become formalized. In fact, the difference in the stringency of regulation may induce the formal sector to escape pollution control by shifting the pollution-intensive part of the production process to the informal sector through subcontracting; these measures would have a direct effect on the environment. (Chattopadhyay et al., 2011)

Can the informal sector become sustainable? What are the determinants that may induce informal workers to comply with current legislation? And if so, what are the organizational and managerial schemes necessary to transform the informal economy into a sustainable economy? This paper address such questions empirically by showing the impact of the informal economy on the environment and suggesting organizational and institutional actions to revert such impact. Section 1 lays out the hypotheses and theoretical background; section 2 discusses the research and methodological procedure; section 3 address the econometric specification and description of data; section 4 discusses the results; and section 5 concludes and poses questions for further research. The contribution of this paper to the literature is that it addresses the issue of the informal economy and its impact on the environment by showing empirically the effect that the regulator and society have in the informal economy to reduce pollution. Further, this paper suggests organizational schemes the informal sector may adopt with a managerial approach to build a more sustainable informal economy.

Hypotheses and propositions.

H1. The Informal Economy has significant impact on the environment.

The informal economy includes many pollution-intensive activities. These activities are difficult to monitor because of their size, number, and geographical dispersion or because they have very low safety standards. Blackman, 1999: suggests that informal sources are more pollution-intensive than larger sources since they use inputs relatively inefficiently, lack pollution control equipment, lack access to basic sanitation services such as sewers and waste disposal, and are operated by persons with little awareness of the health and environmental impacts of pollution. Kent, 1991 in (Blackman, 1999). For instance, informal transportation in most developing countries is one of the main causes of local air pollution (SO2 emission). Vehicles in the informal transportation sector are usually old, poorly maintained, and do not meet environmental quality standards. Other informal activities with significant environmental impact include artesanal jewelry-making, metal working, bleaching, dyeing, and tanning (Biswas et al., 2011; Blackman, 1999; Chattopadhyay et al., 2011).

H2. The regulator has public policy options to reduce the size of the informal economy and therefore the impact on the environment.

Under the assumption that the regulator has more efficient control mechanisms and enforcement schemes to impose environmental restrictions on firms, it makes sense to think that formalization indirectly reduces the environmental impact of the informal economy on the environment. This hypothesis flows naturally from the traditional approach of the transition of the informal

economy into the formal economy. Less cumbersome bureaucratic procedures, uniform tax schemes, and access to capital are activities the municipalities and state and federal governments may use to reduce the size of the informal economy. (Becker, 2004; Loayza, 1997). Another factor is the great effect corruption has on the informal economy: informal economies are larger in countries with pervasive corruption or where the rule of law is weak, and high levels of corruption can explain the high level of informal activities in some Latin American countries (Gërxhani, 2004). According to Chattopadhyay et al., 2011, fighting corruption may help to reduce the detrimental effects of the shadow economy on the environment.

H3. Society has means to revert the impact of the informal economy on the environment.

Society may revert the impact that the informal economy has on the environment by informally enforcing better environmental practices. Pargal & Wheeler, 1996, have shown that community income and education are strongly consistent with non-formal[2] regulation: that is, marginalized minority groups may have little ability to use available regulatory channels, and therefore as income and education increase, pollution intensity declines. Also, informal firms are usually a significant source of local employment and are often situated in poor residential areas. Emissions from these firms therefore directly affect a considerable population within the neighborhoods (Blackman, 1999). Local societies that denounce environmental hazards may be able to reduce the impact of the informal economy on the environment.

[2] The authors use the term "informal regulation" which we change to "non-formal regulation" to avoid confusion with the informal economy discussion.

Proposition I. Organizational schemes may reduce the size of the informal economy and, indirectly, the impact in the environment.

The informal sector lacks many inputs for larger scale production. The sector is not well organized and lacks the funds and technology of formal firms. Inefficient access to raw materials and to financial and human capital limits their chances for value creation and growth (Kathuria & Haripriya, 2003). Should the informal sector have access to valuable resources and capability, chances are it would engage value chains with formal firms and other registered ventures that currently are limited or unaccounted for. Informal firms require thinking about the nature of the production system through which they are linked with the formal system. Many informal enterprises produce and exchange goods and services with formal firms. We expect that in the future, large established firms engage in self-regulatory processes that may use production from informal economies. This trend may result in firms' engaging in sustainable practices and permeating the supply chain with better environmental practices. Informal economies willing to grow have the incentive first to formalize and second to incorporate better environmental practices. Additionally, the benefits that employees receive from a formalized health system or other government program benefits also create incentives and better employment relationships that currently are not legally regulated or protected (Chen, 2007).

Research Setting and Methodology

In order to describe the relation between pollution and the informal sector and then evaluate feasible sustainability and environmental performance by the informal sector, we use a simple

yet tractable model similar to the one used by (Pargal & Wheeler, 1996) to measure informal regulation in Indonesia. The model that describes the relation between pollution and the informal sector aims to understand the impact the shadow economy has on the environment. We follow the conventional KLEM framework where pollution is viewed as a commodity and has a negative price. Another way of looking at it is as if society must be compensated to consume pollution, which involves an implicit positive price for compensation. (Kolstad, 2000; Pargal & Wheeler, 1996)

As it is not common to think of negative prices, the model can be viewed instead as a pollution abatement effort: the demand for pollution abatement is downward sloping, and as the price of abatement effort increases, the demand for pollution abatement is less. In such a model, the consumer of pollution is the producer of pollution abatement and the producer of pollution is a consumer of pollution abatement.

Mexico is a Federal Republic divided into 32 states[3]. Each state is divided into municipalities that are the minimum geopolitical scheme. Municipalities have mostly administrative power and depend largely on state and federal budgets to operate, yet each municipality has some enforcement attributes depending on the state legislature. There are a total of 2454 municipalities, which are the administrative units closest to society. Data from these municipalities point to some of the problems of developing a sustainable informal economy. According to Blackman (1999), in Mexico efforts to control pollution from traditional kilns in Mexico have not been coordinated at the national level. Rather, individual municipalities have implemented a variety of strategies that have met with decidedly mixed success.

[3] Formally it is 31 states and one Federal District: Mexico City. For the purpose of this study, I consider 32 states.

As the environmental quality of a municipality deteriorates, society along with the regulator will try to enforce pollution abatement, either by means of traditional command and control policies or by enforcing non-traditional policies such as voluntary policies with established firms and individuals. These policies will work with the formalized firm or people engaged in formal activities that are regulated by environmental restrictions. In the case of the informal sector, this may not be necessarily the case: informal businesses are mobile and thus regulations may lack specificity or simply be difficult to enforce given their fluid nature. Efforts to impose formal regulation on the informal sector may be inefficient or costly. Informal economies are characteristically of a small scale (inclusive of some illegal activities) operated mostly by self-employed producers. The rather small scale creates increasing costs for the regulator, and the degree of compliance with traditional regulation is generally very low. Informal economies are characterized by low capital intensity, lack of modern technology, a largely unskilled labor force and low productivity. (Chattopadhyay et al., 2011)

Under the assumption that formal economic activities face a specific pollution abatement scheme enforced by the regulator, the municipalities will have then an environmental supply schedule that is based in both formal and informal economies as well as in municipalities' characteristics. The environmental demand schedule faced by polluters, both formal and informal, includes factors such as output and price for inputs, labor and capital.

The quantity and implicit price of pollution in equilibrium

The implicit price of pollution is specific for each state given the characteristics of each municipality, the level of federal and state enforcement and in particular the price accrued by some communities may tolerate polluting economies more than others when they provide informal jobs. Also since the price is an expectation, both formal and informal economies learn about expected penalties or abatement restrictions based on municipal, state and federal enforcement activities.

The following equations summarize environmental demand and supply relations under informal economies per municipality using the concept of equilibrium pollution in an implicit market for environmental services.

Demand. The demand for environmental services from both the formal and the informal sector in each municipality is given by:

$$P_i = f(IPP_i, VP_i, W_i, M_i, K_i, E_i, NE_i, S_{ij}) \quad \textbf{(1)}$$

Where P_i is the total release of pollution emissions in municipality i; IPP_i is the expected pollution price for municipality i, VP_i is the value added of production from the informal sector in municipality i; W_i is the manufacturing wage of the informal economy in municipality i; M_i is the material input price index in municipality I; K_i is the capital price index in municipality i; E_i

is the energy price index in municipality *I*; NE_i is the number of economic units in the formal economy and S_{ij} is the number of firms in municipality *i* in sector *j*.

Supply: The environmental supply schedule faced by the formal and informal sector in each municipality reflects the expected price they will pay for pollution given the characteristics of the municipality as well as the state of enforcement. This is modeled as:

$$IPP_i = f(P_i, U_i, ED_i, RL_i, IPC_i) \quad \textbf{(2)}$$

Where P_i is the total release of pollution emissions in municipality *i*, U_i is the level of urbanization in municipality *i;* ED_i is the level of education in municipality *i;*RL_i is the rule of law, or enforcement proxy in municipality *i*; and IPC_i is the income per capita in municipality *i*.

Given the demand and the supply functions, we can solve for the municipalities' partial equilibrium pollution as:

$$P_i = f(VP_i, W_i, M_i, K_i, E_i, NE_i, S_{ij}, U_i, ED_i, RL_i, IPC_i) \quad \textbf{(3)}$$

The demand schedule and the pollution function treats both the formal and the informal economy as exogenous to the municipality characteristics, a strong assumption given that certain municipalities are more urbanized, where the existence of more informal activities are expected. In order to control for such factors, we include the level of urbanization, education, enforcement and income under the assumption that informal activities that establish themselves in any

municipality will consider the possible price for polluting that the regulator and society may impose in them, however difficult to implement. Nevertheless, to account for endogeneity in the location choice by the informal sector (or formal sector, for that matter) in the municipality, we use proxies for the variables under discussion that are correlated with the variables but not necessarily with the error term in the econometric specification.

Data and econometric specification

We estimate eight slightly different models with two types of pollution and, in addition, derive a model to account for the size of the informal sector defined as the number of informal workers. We do so in order to understand the effect of municipality characteristics in the level of informality.

The econometric model we use is based on the pollution demand equation used by the informal and formal sectors assuming that both sectors have a cost minimization production schedule. The demand equation of pollution is $P_i = f(IPP_i, VP_i, W_i, M_i, K_i, E_i, NE_i, S_{ij})$. To account for problems in the regression model, we transform our variables to logarithms, and perform tests for multicollinearity and heteroskedasticity and report studentized coefficients.

Data:

The analysis combines information of municipalities and production characteristics of the informal sector.

Dependent Variables

We used two dependent variables, SO2 emissions and CO2 emissions. These are calculated by the Ministry of the Environment and reported for each municipality.

SO2, Sulfur dioxide: SO2 is a poisonous gas that is released by volcanoes and in various industrial processes. Sulfur dioxide is typically produced in significant amounts by the burning of common sulfur-rich materials including wool, hair, rubber, and foam rubber such as are found in mattresses, couch cushions, seat cushions, carpet pads, and vehicle tires. It is a by-product of combustion of coal and petroleum and is largely a source of pollution in urban areas. (NIST, 2011) SO2 per capita is a widely used indicator of local air pollution. SO2 is the major cause of acid rain, which degrades trees, crops, water and soil. It also causes breathing problems, exacerbating asthma, chronic bronchitis and respiratory and cardiovascular disease (Biswas et al., 2011)

CO2 Carbon dioxide is a naturally occurring chemical compound composed of two oxygen atoms and one single carbon atom. Natural sources of atmospheric carbon dioxide include volcanic outgassing and the combustion of organic matter and the respiration of aerobic organisms. Man made sources of carbon dioxide include the burning of fossil fules for heating, power generation and transport, as well as some industrial processes such as cement making. CO2 emissions, which are a well-known cause of global warming. are calculated primarily with the amount of energy consumption (Biswas et al., 2011)

Independent Variables

The data sources are the Statistics Bureau of Mexico that reports census data for municipalities, the Ministry of Economics that reports the economic activities though the Sistema de Informacion Empresarial de Mexico (SIEM), the Ministry of Health that reports the number of workers enrolled in the formalized health system as well as those that belong to the popular health system called "Seguro Popular" which is a basic health system subsidized by the government only for those families that are not covered by the official health system and that likely belong to the informal sector.

The informal sector pollution demand function accounts for the level of output and price of labor, capital, energy and materials. The size of the informal sector in each municipality was calculated through the Ministry of Labor and Bureau of Statistics which is reported for states alone and not for municipalities. Since the size of the informal sector is an estimate, the bureau does not calculate size of the sector for each of the 2454 municipalities but rather calculates the size of the sector in each of the 32 states in Mexico. The percentage of informality per state was applied to the number of occupied (both formal and informal) people as reported by the bureau and then found the value added per capita of each municipality and multiply by the size of the informal sector. I used that proxy as the size of the informal economy. (Schneider & Enste, 2000) have reported that the informal economy in Mexico using the physical input method, the currency demand approach and the MIMIC approach was 49%, 33% and 27.1% of GDP respectively thus the estimate of value added per capita by the number of informal workers seems appropriate as a proxy of the level of production from such sector.

The informal sector is made up of a largely unskilled labor force with low productivity. The wage for the informal sector is practically impossible to estimate. To get an estimate, however, we used as a proxy the popular health system representing an incentive for the informal

economy. The minimum wage used in the formal economy is fixed in three categories varying very little across states. The popular health system is provided by the federal government and requires enrollees to pay a minimum amount to enroll based on their socio-economic level as determined by the Ministry of Health. However, given that the system only covers basic illness and emergencies, the informal worker will nevertheless expend more on health relative to the formal worker that has a broader health system[4]. The popular health system may as well represent then a minimum wage the informal worker receives by the government but in order to face larger health expenses, the worker with demand a higher wage from the informal activity she performs.

The materials, capital price for production was considered constant across municipalities as informal economies are characterized by low capital intensity and lack of modern technology (Chattopadhyay et al., 2011) It has been reported that informal economies often use cheap sources of inputs for production such as old transportation systems (Biswas et al., 2011)

The informal sector uses various energy sources such as a variety of cheap, highly polluting fuels including plastic refuse, used tires, manure, wood scrap, and used motor oil (Blackman, 1999). These sources are not always priced but electricity is. We used the value of the electricity generated in each municipality and divided it by the amount of energy generated and used the estimate the price of electricity per municipality that was then used in the demand function for pollution of the informal sector.

[4] The formal employee receives additional benefits trough the formal health service such as recreation and retirement; in addition, the employer spends a large amount of money per worker that is consider as a benefit.

Finally the municipalities' characteristics included information on the average level of education and a proxy of education based on the amount invested on education by the municipality. The urban sprawl and the main polluting sectors operating in the municipality as well as the total of registered economic units serve as proxies of the formal sector. We did not use the demand function of the formal economy as we are only interested in understanding the informal sector pollution activities.

Results

Based on the hypotheses discussed earlier, we have found statistical significance to show that the informal economy has an environmental impact, that the regulator has means to reduce environmental degradation directly through reducing the size of the informal economy, and that society may engage in some informal regulation to reduce the impact of the informal sector on the environment.

[Insert table 2 and table 3 about here]

H1: The Informal Economy has significant impact on the environment.

In models I to VIII from tables 1 and 2, we used the value of production of the informal sector (model I, II, V, VI) regressed to emissions per capita of SO2 and CO2. In all cases, accounting for the formal economy and for municipal characteristics, we found statistical significance that the informal sector has a negative impact on the environment. This is also the case for the emissions of SO2 regressed with the size of the informal economy as measured by the number of

informal workers. In the best of cases, a 1% increase in the value of the informal economy, results in a 0.17% increase in the per capita SO2 emissions.

However, for the case of CO2 regressed with the number of informal workers in the economy, we found a significant and negative effect suggesting that the informal economy has a positive impact on CO2 emissions. This result contradicts our hypothesis for the case of Carbon Dioxide. However, we believe that the underlying mechanism explaining such results deals with energy consumption rather than with the size of the informal economy. Given that the informal economy at large lacks technical skills and has low levels of education, their access to energy consumption such as technology and energy intensive instruments is lower than for that of the formal economy.

H2. The regulator has public policy options to reduce the size of the informal economy and therefore the impact on the environment.

The environmental demand model does not estimate enforcement stringency or the impact of the rule of law on pollution emissions directly, since the model considers the implicit price of pollution that pollution producers face given their expectations on regulatory stringency and societal demands. So, we developed a model that estimates the impact of the rule of law on the size of the informal economy. We proxied the rule of law based on crime statistics reported by the statistics bureau for each municipality. This procedure intends to capture the effect that a municipality with a higher detention rate has a higher level of rule of law. In table 4, model IX, we regress the rule of law and income per capita to estimate the size of the informal economy and found that as the rule of law increases the size of the informal economy declines. The same

effect happens with income per capita. The result suggests and supports the evidence that as the regulator uses enforcement activities, the size of the informal sector may be impacted negatively thus with a positive indirect effect in pollution demand.

H3. Society has means to revert the impact of the informal economy on the environment.

Society may revert the impact that the informal economy has on the environment by informally enforcing better environmental practices. Our results support the hypotheses of the non-formal regulation forwarded by Pargal & Wheeler, 1996. We found that for models I to IV in table 2 for SO2 emissions, education is strongly significant and negatively related to pollution emissions. For the size of the informal sector, in model IX table 4, we found also evidence that the size of the informal sector decreases as income per capita increases. However, for CO2 emissions in table 3, models VII and VIII, education has the opposite effect on emissions of CO2 when accounted for informal economy production and a negative effect when consider the size of the informal economy. We believe that education as measured by the average years of education is correlated with the size of the informal economy. In table 4 model IX we instead consider income per capita as a proxy of education and found that the size of the informal economy decreases as per capita income increases. The latter results imply that richer communities may indirectly informally regulate the size of the shadow economy to reduce environmental pollution.

PI. Organizational schemes may reduce the size of the informal economy and indirectly the impact in the economy.

Data on informal economies is not at all easy to get, as informal economic activities pass largely unreported. However, given that we have found that the informal economy has a negative impact on the environment and that the rule of law by the government and informal regulation by society reduces directly or indirectly the level of pollution accrued by the informal economy, we propose that the informal sector may be able to reduce its environmental impact by formalizing its activities, taking advantage of better organization, access to capital, technology, financial and human capital as a result of a broader interaction with the formal economys. As the informal economy engages in supply chain and value chains and other possible formal ventures that are currently limited, chances are that the incentive to grow will be attractive enough to use managerial capabilities and organizational schemes that formal economies give to the companies.

Conclusions

Informal economies comprise a large part of the developing world's economy. By definition, informal economies are unregistered, and thus their impact on the environment is largely unaccounted for. Policies, regulation, and voluntary efforts aimed to diminish industry impact on the environment are concentrated solely on the formal economy and, therefore, are incomplete. In developing countries where the size of the informal economy is large and regulation and enforcement efficiency are inadequate, the impact of the informal sector on the environment is of particular concern. In this paper, we model the pollution demand of the informal economy in 2454 Mexican municipalities and test whether output generated by the shadow economy produces a significant environmental impact. We find that the informal economy has significant impact on the environment and that in the best of cases, a 1% increase in the value of the informal economy results in a 0.17% increase in per capita SO2 emissions. We find too that the

regulator indirectly can reduce the impact the informal economy has on the environment by enforcing the rule of law. Additionally, we find that society may informally regulate the informal economy and indirectly reduce pollution emissions. Communities that have a greater education level and income per capita are more likely to have an impact on informal regulation, reducing then the negative impact on the environment. Finally, we proposed that organizational schemes and managerial activities become incentives for the informal economy to engage in supply chain and value chains and other possible formal ventures .

Tables

Table 1. Summary Statistics of data

Descriptive statistics

	N	Min	Max	Media	Std error
SO2 Emissions	2454	.01	12,456.4	106.2	532.7
CO2 Emissions	2454	5.89	1,582,718.4	16,661.9	70,631.3
Crime	1754	1.00	75,408.0	863.6	3,722.0
Informal value of production (miles of Mx pesos)	2447	71.41	504,983,190.9	5,803,315.4	27,510,387.4
Informal workers	2454	11.59	223,141.4	5,003.8	15,450.4
Popular health system people (Informal wage)	2450	1.00	274,958.0	10,699.7	18,487.8
Workers in formal Health System	2454	5.00	1,096,323.0	29,539.6	87,436.9
Energy Price	1916	2.42	82,476.3	176.6	1,888.2
Urban area	1697	.20	28,233.3	744.5	1,946.3
Investement in education	1376	4.00	2,551,140.0	13,722.3	97,887.6
Average years of education	2454	2.03	13.5	6.7	1.5
Economic Units	2437	4.00	123,223.0	1,994.2	7,015.0
Primary sector	2454	.00	26.0	0.3	1.5
Mining sector	2454	.00	44.0	0.1	1.2
Energy sector	2454	.00	12.0	0.1	0.7
Construction sector	2454	.00	1,236.0	8.2	53.1
Manufacturing sector	2454	.00	2,402.0	12.7	86.5
Population density	2430	1.00	17,978.0	253.5	1,148.5
Population	2454	93.00	1,815,786.0	45,758.2	132,854.7
N	640				

Table 2. Regression Results for pollution of SO2

Dependent variable	Log SO2							
	Model I		Model II		Model III		Model IV	
Independent Variable	Studentized coefficients	t-statistic	Studentized coefficients	t-statistic	Studentized coefficients	t-statistic	Studentized coefficients	t-statistic
(Constant)		-14.954***		-17.531		-12.324***		-13.773***
Ln (Inf. Value of production)	0.299	9.921***	0.549	18.045***				
Ln (Informal workers)					0.103	2.614***	0.308	8.416***
Ln (Wage of informals)	0.036	1.389	0.165	5.721***				
Ln (Health system)					0.06	1.64	0.019	0.498
ln (Output of municipality)					0.482	19.601***	0.591	25.139***
ln (Price of energy)	-0.02	-1.419	-0.004	-0.255	-0.02	-1.954*	-0.014	-1.327
ln (Urban size)	0.107	4.685***	0.239	′′9.55***	0.029	1.86*	0.064	3.964***
ln (Education investment)	-0.009	-0.522	-0.014	-0.648				
Ln (Years of education)					-0.041	-2.895***	-0.03	-2.048**
Ln (Formal economic units)	0.542	16.578***			0.33	11.147***		
Primary Sector			0.039	1.99**			0.021	1.591
Minning Sector			0	-0.019			0.001	0.065
Energy Sector			0.019	0.961			0.002	0.112
Construction Sector			-0.042	-1.923*			-0.041	-2.57***
Manufacturing Sector			0.058	2.611***			0.052	3.274***
R(2)	0.848		0.796		0.863		0.852	
N	748		749		1268		1270	

** Ho: B=0 rejected with 90 percent confidence (two-tail)*

*** Ho: B=0 rejected with 95 percent confidence (two-tail)*

**** Ho: B=0 rejected with 99 percent confidence (two-tail)*

Table 3. Regression Results for pollution of CO2

Dependent variable	Log CO2							
	Model V		Model VI		Model VII		Model VIII	
Independent Variable	Studentized coefficients	t-statistic	Studentized coefficients	t-statistic	Studentized coefficients	t-statistic	Studentized coefficients	t-statistic
(Constante)		0.852		-1.057		2.236**		1.287
Ln (Inf. Value of production)	0.17	4.013***	0.277	7.432***				
Ln (Informal workers)					-.255	-4.26***	-.147	-2.762***
Ln (Wage of informals)	0.255	6.987***	0.302	8.557***				
Ln (Health system)					.613	11.159***	.593	10.747***
ln (Output of municipality)					0.237	6.382***	0.295	8.598***
ln (Price of energy)	-0.036	-1.764*	-0.027	-1.345	-0.018	-1.139	-0.014	-0.874
ln (Urban size)	0.242	7.589***	0.3	9.817***	0.161	6.771***	0.182	7.709***
ln (Education investment)	0.078	3.175***	0.085	3.285***				
Ln (Years of education)					-0.53	-2.505**	-0.47	-2.219**
Ln (Formal economic units)	0.209	4.552***			0.166	3.725***		
Primary Sector			0.019	0.783			0.017	0.848
Minning Sector			0.005	0.238			0.003	0.169
Energy Sector			-0.016	-0.673			0.005	0.24
Construction Sector			-0.07	-2.643***			-0.054	-2.349**
Manufacturing Sector			0.053	1.932*			0.028	1.192
R(2)	0.70		0.695		0.687		0.686	
N	748		749		1268		1270	

** Ho: B=0 rejected with 90 percent confidence (two-tail)*

*** Ho: B=0 rejected with 95 percent confidence (two-tail)*

**** Ho: B=0 rejected with 99 percent confidence (two-tail)*

Table 4. Regression results for the size of the informal economy

Dependent variable	Ln (Informal workers)	
	Model IX	
Independent Variable	Studentized coefficients	t-statistic
(Constant)		1.177
Ln (Wage of informals)	0.68	44.629***
Ln (Price of energy)	0.014	1.074
Ln (Rule of Law)	-0.033	-2.208**
Ln (Pop. Density)	0.341	20.849***
Ln (Income per capita)	-0.047	-3.064***
R(2)	0.836	
N	935	

** Ho: B=0 rejected with 90 percent confidence (two-tail)*

*** Ho: B=0 rejected with 95 percent confidence (two-tail)*

**** Ho: B=0 rejected with 99 percent confidence (two-tail)*

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