Research Paper 59 **| 2019**

ENVIRONMENTAL REGULATION IN A TRANSITIONAL POLITICAL SYSTEM: DELEGATION OF REGULATION AND PERCEIVED CORRUPTION IN SOUTH AFRICA

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Environmental Regulation in a Transitional Political System: Delegation of Regulation and Perceived Corruption in South Africa

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17 JUNE 2019

Abstract

I study the economic motivations behind a reduction in the discretionary power of environmental regulators, and the impact that such reduction has on perceived corruption in South Africa. I examine the transition from the Air Pollution Protection Act of 1965 to the Air Quality Act of 2005, a change from full to partial delegation of regulation. By constructing a principal-agent model, I argue that this transition might have occurred because of an increase in the dispersion of rent-seeking motivations of public agents. This happens because, from the principal's perspective, the possible harm—loose pollution control and misappropriation of environmental fines—generated by corrupt agents is greater than the potential benefits brought by diligent agents. In my empirical analysis, I use diff-in-diffs models for a two-period panel with 191 South African firms to show that the regulatory change decreased treated firms' perceived corruption, but did not improve other institutional quality measures.

Keywords: Delegation of Regulation, Perceived Corruption, South Africa.
JEL: D22, D73, Q53, P48.

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[1]The research leading to these results was funded by the Swiss National Science Foundation under the Project Environmental Regulation and Economic Competitiveness No 100010_159375. I would like to thank Tony Leiman, Mare Sarr, Tim Swanson and Martina Viarengo for helpful comments. I would also like to thank seminar participants at the Department of Economics in the University of Cape Town and at the Gerzensee Study Center.

1 Introduction

Environmental quality appears to be increasingly important for individuals in developing countries. However, at the same time that pollution levels and demand for environmental quality are constantly increasing in these countries, national governments are struggling to reduce emissions (Greenstone and Hanna (2014), Oliva (2015), Hanna and Oliva (2015) and Jalan and Somanathan (2008)). There are several reasons for this. One possible reason is that governments of developing countries usually prefer to invest in economic development than in environmental protection. Another potential reason is the design of poor environmental regulation, that is, regulation that does not create adequate incentives for firms to reduce emissions. A third—and less studied—reason appertain to the interaction between environmental regulation and the characteristics of the agents in charge of enforcing it.

It is particularly difficult for legislators to implement regulation that provides inspectors with an optimal level of discretionary power. Too much regulatory discretion, combined with inefficient governmental incentives, might generate costs for society, such as corruption[1] (Banerjee et al. (2012)); whereas zero discretionary power generates abusive costs of monitoring and might lead to inefficient environmental outcomes.[2] There are two main reasons for this difficulty. First, inspectors and legislators usually have misaligned preferences—that is, they give different relative weights to society's welfare. Second, it is impossible for legislators to perfectly monitor the behaviour of inspectors (Dhaliwal and Hanna (2017) and Olken and Pande (2012)).

In this paper, I study how the preferences of public servants affect the type of delegation of environmental regulation that is implemented by legislators.[3] I show that an increase in the heterogeneity of the public service—that is, more state agents with more dispersed preferences—favours partial delegation of regulation over full delegation. I also ex-

[1] I define corruption as "an act in which the power of public office is used for personal gain in a manner that contravenes the rules of the game" (following Jain (2001) and Aidt (2003)).

[2] There is a debate on whether regulatory discretion helps or hinders the enforcement of environmental regulation. The most common view is that too much discretion might generate inefficient outcomes (Leaver (2009), Burgess et al. (2012), Jia (2017) and Damania (2002)). For example, Zhang et al. (2018) make the case the direct centralised supervision improves local enforcement. However, recent work has showed that discretion might be valuable (Duflo et al. (2014)). Inspectors and local authorities might use their discretionary power to target polluting firms more efficiently, reducing overall emissions.

[3] I examine two types of delegation of regulation. The first one is full delegation, when inspectors and environmental regulators have complete discretionary power to enforce and punish polluting firms. The second type is partial delegation, when the discretionary power of regulators is constrained by guidelines or laws.

amine the impact of a change in the delegation regime—a reduction in the discretionary power of regulators—on perceived corruption of South African firms.

During the Apartheid regime, air quality regulation in South Africa followed the Atmospheric Pollution Prevention Act (APPA), which gave considerable power of monitoring and punishment to inspectors, and failed to provide legally robust guidelines. In 2005, the democratic government substituted the APPA with the Air Quality Act (AQA), a more stringent regulation that considerably restricted the discretionary power of inspectors. This regulatory change—from APPA to AQA—can be interpreted as a transition from a system of full delegation of regulation to a system of partial delegation.[4]

By employing a theoretical model, I argue that the expansion and restructuring of the South African bureaucracy might have triggered this regulatory change. The incorporation of political groups that were once excluded from the government terminated a corrupt bureaucracy that was ethnically and ideologically homogeneous (Hyslop (2005)).[5] The new socioeconomic profile of the public service increased the uncertainty associated to rent-seeking behaviour[6] (but did not necessarily increase corruption levels). Because the possible harm to society—in terms of loose pollution control and misappropriation of environmental fines—caused by a bad inspector might have a greater impact than the potential benefits generated by a diligent inspector, the government decided to restrict inspectors' discretionary power.

I construct a principal-agent model in which a bureaucracy has to be used to regulate a polluting firm. Building upon previous work (Nilssen and Kundu (2018), Duflo et al. (2014) and Laffont and Tirole (1991)), I assume bureaucrat's interest—which is a random variable—is partly aligned with society's interests and partly self-motivated.[7] The degree of misalignment between the preferences of the bureaucrat and of society is defined as the bureaucrat's *rent-seeking motivation*, which is a random variable. Producers have to compensate society for pollution through a transfer that is handled by the bureaucratic class (agent). A fraction of this transfer is appropriated by this class, and the remainder is sent to the consumers (principal).

[4]Delegation of regulation has been extensively studied in the literature of Administrative Law (Cooter (1996), Rose-Ackerman (1975), Boyer and Laffont (1999) and Epstein and O'halloran (1994)).

[5]Historians do not see great variation in corruption levels during and after the Apartheid (Posel (1999), Lodge (1998) and Hyslop (2005)). For an investigation on the influence of political stability on corruption, see Damania et al. (2004).

[6]By "rent-seeking behavior", I mean the behaviour associated to petty corruption: bribery, misappropriation of funds, etc.

[7]Previous work has mostly assumed that bureaucrats are only self-motivated (see e.g. Banerjee et al. (2012)).

My model shows that the characteristics of the bureaucracy (rent-seeking motivations and capacity of appropriation) determine the delegation regime that is implemented—that is, the amount of discretionary power legislators give to bureaucrats. If there is a substantial increase in the dispersion of bureaucrat's rent-seeking motivations, the principal prefers to implement a partial delegation regime. This happens because the expected disutility associated with an increase in average rent-seeking motivation is greater than the expected utility of a reduction in the same variable. Finally, because appropriation under partial delegation is always lower than under full delegation, expected corruption levels then decrease. Unfortunately, I do not have the required microdata to test all the propositions of my model.

I show empirically that the introduction of the AQA reduces regulated firms' perceived corruption.[8] I measure the impact of the AQA on perceived corruption by examining a panel of 191 South African firms and two periods, 2003 and 2007.[9] I use a diff-in-diffs in a linear probability model with time and firm fixed effects, and several controls. The results show that the AQA decreased treated firms' probability of listing corruption as an obstacle for their business by 56% when compared to other firms not affected by regulation. Decreased discretionary power of inspectors affected their capacity to accept bribes and misappropriate funds. I do not find, however, improvements in other institutional measures, such as in the perception on the fairness of the judicial system. This supports my claim that the AQA had an impact specifically on the discretionary power of regulators, and not on other institutional dimensions.[10] Therefore, a direct result of the change in regulation appears to be a reduction in the expected corruption firms face.

This papers contributes to the literature that investigates the effect of environmental regulation on corruption (Damania (2002), Duflo et al. (2013), Duflo et al. (2014), Oliva (2015) and Zhang et al. (2018)), and to the one that examines the economic consequences of regulation (Greenstone and Hanna (2014) and Hansman et al. (2018)). It is also related to recent work that has examined the impact of environmental regulation in developing countries (Ravetti et al. (2014) and Hanna and Oliva (2015)) and, more specifically, in South Africa (Sundström (2013) and Sundström (2015)).

This paper is divided as follows. The next section relates this work to the existing literature. Section 3 outlines the main characteristics of air quality regulation in South Africa. In section 4, I present my theoretical

[8]"Perceived corruption" is the probability of listing corruption as an obstacle to a firm's operation (see e.g. Olken (2009)).

[9]The data come from the World Bank Enterprise survey and provide information on firm's operation and general perception of the business environment.

[10]This auxiliary result also reduces concerns related to potential omitted variable bias.

model. Section 5 presents my empirical analysis, with main results and robustness checks. I conclude this paper in section 6.

2 Related Literature

This work is closely related to the literature that investigates the relationship between environmental regulation, discretionary power and corruption levels (Damania (2002), Duflo et al. (2013), Duflo et al. (2014), Oliva (2015) and Zhang et al. (2018)).

As in Damania (2002), I investigate the effect that the possibility of—or expected—corruption has on the design of environmental regulation. Unlike his study, however, I do not focus on pollution control, but on the amount of rents appropriated by environmental agents. I am more interested in the question of why a change in the discretionary power of agents might occur, and whether such a change affects outcome variables, such as expected corruption. In this sense, this paper is also related to Duflo et al. (2014) and Zhang et al. (2018).

Duflo et al. (2014) examines how changes in the discretionary power of regulators affect enforcement in India. They find that discretionary power allows regulators to target firms more accurately.[11] This result is in line with one of my theoretical predictions; although full delegation enables agents to appropriate a greater fraction of the transfer for pollution, it also enables them to punish more severely highly polluting firms. Zhang et al. (2018), on the other hand, study the impact of multiple levels of governance on environmental enforcement. They find that central supervision improves local enforcement and, in turn, decreases emissions. This goes in line with my theoretical prediction that partial delegation—that is, less local autonomy to regulators—reduces rent appropriation.

My theoretical framework builds upon the classic literature that studies the principal-agent problem (see e.g. Laffont and Tirole (1991) and Boyer and Laffont (1999)). My model is an extension of the one developed by Nilssen and Kundu (2018), which studies delegation of regulation for environmental control. Their model allows the principal to implement different types of regulation regimes—in terms of the discretionary power of agents—depending on the characteristics of the agents and the expected amount of rents appropriated. I add a further element: agents' heterogeneity in terms of rent-seeking motivations. In my model, the agent has a stochastic rent-seeking motivation and the simple increase in the variance of this variable might change the type of

[11] The most common view in the economic literature is that too much discretionary power might generate inefficient outcomes (Leaver (2009), Burgess et al. (2012) and Jia (2017)).

delegation (ceteris paribus). Overall, my model contributes to the theoretical literature of Administrate Law that studies the problem of delegation of regulation (Cooter (1996), Rose-Ackerman (1975) and Epstein and O'halloran (1994)) by focusing on environmental regulation.

This paper is also related to the literature that examines the relationship between corruption, efficiency and the composition of the public service in South Africa (Lodge (1998), Posel (1999) and Hyslop (2005)).[12] Posel (1999) studies the reasons behind the "Afrikanerization" of the public service during Apartheid, and argues against the idea that the old bureaucracy was efficient. Both Hyslop (2005) and Lodge (1998) examine how corruption varies during and after the Apartheid. They conclude that, although ethnically and ideologically very homogeneous, the old Afrikaner bureaucracy was not less or more corrupt than the democratic one. In line with these results, I argue that it was an increase in the dispersion of motivations for bureaucratic rent-seeking (variance) that triggered the regulatory regime change and not an increase in (average) rent-seeking motivation.

To a lesser extent, this study is also related to the economic literature that examines the economic consequences of environmental regulation (Greenstone et al. (2012) and Hansman et al. (2018)); and to recent work that has examined the interaction between regulation and imperfect institutions in developing countries (Ravetti et al. (2014) and Hanna and Oliva (2015)). My inquiry is also part of the growing literature studying environmental corruption in South Africa (see e.g. Sundström (2013) and Sundström (2015)).

3 Air Quality Regulation in South Africa

Air quality became a concern in South Africa in the fifties and sixties (Republic of South Africa (2014)). The rapid development of heavy industries deteriorated air quality in urban centres and industrial areas. There was a general consensus that some regulation was needed and, in 1965, the Atmospheric Pollution Prevention Act (APPA) was introduced. The APPA focused mainly on industrial pollution and employed a traditional command-and-control method (Republic of South Africa (1965) and Republic of South Africa (2014)). Industries identified as significant polluters were required to have registration certificates and were regulated by the national government.

As Naiker et al. (2012) point out, the APPA was criticized for three

[12]The level of decentralisation of a government also affects the behaviour of the bureaucracy and corruption levels (see e.g. Albornoz and Cabrales (2013) and Fan et al. (2009)). In the case of South Africa, decentralisation levels have remained the same for most of the period that goes from the Apartheid to the beginning of the democratic government.

main reasons. First, there seemed to be a lack of proactive management of air pollution control. In most cases, local authorities only inspected and charged industries after excessive emissions had become a major local problem. Second, inspectors and local authorities used guidelines that could not be legally enforced—that is, there was no legal provision for them in the legislation. Third, the APPA was poorly enforced—and that can be confirmed by civil society's complaints regarding ambient air quality (Republic of South Africa (2014)).

The root of these problems is the way in which the regulation was drafted. The APPA gave considerable power of monitoring and punishment to local authorities, such as inspectors and the chief officer (Republic of South Africa (1965)), guidelines and registration certificates were not legally robust, and several minimum standards for ambient air pollution were not part of the regulation (Shabala (2008) and Naiker et al. (2012)). This left inspectors to exercise their own judgment when evaluating and punishing industries for excessive emissions.

By the nineties, pressures from the civil society and the new Constitution paved the way for an environmental law reform. This reform began in 1998 with the promulgation of the National Environmental Management Act (NEMA). The NEMA provided principles for environmental management and implementation (Naiker et al. (2012) and Republic of South Africa (1998)). Following the NEMA, and after a participatory process that took three years, in September 2005, the Air Quality Act (AQA) was brought into effect (Republic of South Africa (2014)). The AQA reforms all the existing laws regulating air quality, provides measures for the prevention of pollution and ecological degradation, and set national standards for air quality (Republic of South Africa (2005)). It does not, however, state provisions related to atmospheric emission licensing (AEL)—that is, licenses for special activities that require further regulation.[13] The 2010 amendment to the AQA established this list of activities and the required minimum standards for them (Republic of South Africa (2010)).

In this paper, I study the economic motivation behind the regulation change from the APPA to the AQA, and I test whether the introduction of the AQA affects perceived corruption. Before I outline my theoretical framework, there are two important features of the AQA that are worth mentioning here.

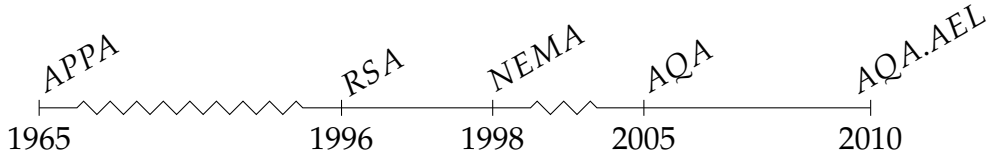
First, the AQA changes the power structure of environmental regulation and implementation in the country. It makes the three tiers of government—national, provincial and municipal—to work cooperatively by delegating different responsibilities to all government levels.[14]

[13]Besides granting the right to emit, AEL also stipulates monitoring procedures, review periods, and penalties for non-compliance (Republic of South Africa (2010)).

[14]For example, municipalities, provinces, and the national government are all in-

By adopting this shared responsibility approach, the AQA reduces local officials and inspectors' decision power over penalties and fines.

Figure 1: Environmental Legislation in South Africa.



APPA: The Atmospheric Pollution Prevention Act;
RSA: The Constitution of the Republic of South Africa;
NEMA: The National Environmental Management Act;
AQA: Air Quality Act;
AQA.AEL: Atmospheric Emission Licences.

Note that I study the period that goes from 1995 to 2010. My empirical findings stem from survey responses provided in 2003 and 2007.

Second, the AQA is more stringent than previous air pollution regulation. Unlike the APPA, it establishes measures not previously legislated in pollution control, such as ambient air quality standards; and, with these, provide a clear indication of the environmental quality aimed by the national government. Compared to previous regulation, the AQA constraints inspectors and public officials' behaviour by setting minimum standards for industrial activities. Geographic differences in standards might arise, but only if local and provincial governments decide to set stricter standards (Naiker et al. (2012)).[15]

The change in environmental regulation described here—from the APPA to the AQA—is a change from full to partial delegation of regulation (see Cooter (1996)). During the APPA period, inspectors, local authorities and public officials had considerable autonomy to regulate firms, to control pollution and to charge fines. After the introduction of the AQA, however, this autonomy was reduced. Inspectors received clearer guidelines and standards—also known by the firms—and their work was monitored by other spheres of the government. In other words,

volved in drafting an annual report, in choosing an air quality officer, and in preparing an air quality plan.

[15]The South African government is structured in three autonomous spheres, the national government, the provincial government and the local government (Naiker et al. (2012) and Republic of South Africa (1996)). Local government can be further divided into metropolitan, district and local municipalities. The structure of environmental legislation can be outlined as follows. It begins with a national minimum level of emissions. It then allows the provincial government the option of accepting the national minimum or imposing a more stringent provincial level of emissions. Lastly, it allows municipal authorities to set an even more stringent set of regulations.

their discretionary power was constrained. As I show in the remainder of this paper, this change might have reduced expected corruption levels.[16]

4 Theoretical Model

In this section, I develop a principal-agent model to understand why there might be a change in the type of delegation of regulation and how such institutional change impacts expected corruption levels.[17]

I show that the type of delegation implemented by the consumer (principal) is a function of the characteristics of the bureaucrat (agent). The bureaucrat has a rent-seeking motivation, which is a random variable that measures the degree of misalignment between the preferences of the principal and hers. I demonstrate that an increase in the variance of the distribution of rent-seeking motivations—that is, a more heterogeneous bureaucratic class in terms of rent-seeking behaviour—favours partial instead of full delegation of regulation.

Expected corruption levels under full delegation are always greater than under partial delegation. Hence, a change in the regulatory regime will decrease the fraction of the transfer (for pollution) appropriated by the bureaucrat.

4.1 Agents

Consider an economy composed of three types of agents, a consumer C (principal), a producer P, and a bureaucrat B (agent).[18] P produces a good that generates utility $G > 0$ to C. P can increase her revenue by increasing emissions, d. However, as a compensation for excessive emissions, P has to make a transfer $t > 0$ to C.

[16]Note that the change in delegation of regulation mainly involved the creation of new guidelines and norms, and not so much the creation of new environmental regulation. In some contexts (see e.g. Holcombe and Boudreaux (2015)), higher levels of regulation might increase corruption (or expected corruption), but I believe this was not the case here.

[17]I build on the model developed by Nilssen and Kundu (2018), which was inspired by Laffont and Tirole (1991). For a more complete treatment on the problem of delegation of regulation, see Nilssen and Kundu (2018). Appendix B of their paper is specially important. For seminal work on this topic, see Laffont and Tirole (1991) and Boyer and Laffont (1999).

[18]Unlike Nilssen and Kundu (2018), I do not consider the situation in which there is no bureaucracy. I assume that it is always more efficient for the consumer to employ a bureaucrat to inspect polluting firms. Interested readers may look at section 3.1 of Nilssen and Kundu (2018) for a discussion on that issue. For an analysis on the opportunities for strategic behaviour that can be created by environmental regulation, see Mason and Swanson (2002).

The problem I present here investigates how to optimally choose a contract $\alpha = (t, d)$, and how this affects rents appropriated by B.

P's net revenue function is given by,

$$R(\theta, d, t) = \pi + \theta d - t, \tag{1}$$

where $\pi > 0$ is a constant, $d > 0$ is the emissions amount chosen by P, and θ is a coefficient that converts emissions into extra revenue or reduced costs (that is, it can be interpreted as the ability to reduce costs by increasing emission).[19] I assume that θ is a random variable that can take two values, $\theta \in \{\underline{\theta}, \bar{\theta}\}$, with probability v and $1 - v$, respectively. The consumer C knows θ's probabilities, but not the realised θ—that is, she does not know P's specific type. θ is P's private information. I assume that P's choice of emissions intensity is observable and verifiable by B.[20]

C derives disutility from emissions, $\frac{d^2}{2}$. She receives t from P as a compensation for emissions arising from production. C wishes to implement a regulation contract $\alpha = (t, d)$ that determines this transfer and an emissions level. To implement such a regulatory policy, C has to make use of a bureaucrat B.

The bureaucrat is able to appropriate and consumes a fraction $\frac{\lambda}{1+\lambda} \in (0, 1)$ of this transfer t—which means that C only receives the remainder. The coefficient λ is understood here as B's capacity of appropriation, which can be seen as a function of the monitoring and control systems in place in this economy, and it is independent of B. C observes the value of λ, but it is not able to change it.[21]

C's utility for a contract α is given by,

$$U_c(t, d) = G - \frac{d^2}{2} + \frac{t}{1+\lambda}, \tag{2}$$

where G is the utility gain from consuming the good produced by P.[22] Because B knows θ, she can implement a type-contingent regulatory policy. However, she has vested interests on the transfer t. She offers

[19] P's revenue function is the result of a fixed revenue component and a cost function: $cost = K - \theta d + t$ and $revenue = s$; $R(\theta, d, t) = s - K + \theta d - t = \pi + \theta d - t$. The coefficient K is the cost that comes from usual sources of production (labour, physical capital, etc); and the coefficient s is P's revenue. I assume that P's costs decrease with emissions intensity; firms that have higher θ benefit more from emissions. I assume that π is constant for the sake of simplicity.

[20] I assume that B is able to measure d. Note that P's participation constraint is given by $\pi + \theta d - t \geq 0$.

[21] For the sake of simplicity, I do not endogeneize λ in my model. The idea here is that this coefficient is not a function of B's willingness of appropriation; she receives $\frac{\lambda t}{1+\lambda}$, no matter how she feels about it. The coefficient represents a feature of the economy we are in, and not a specific trait of the bureaucrat. This is why I posit that this capacity depends the level of control and monitoring of B's behaviour.

[22] This term is not relevant for the analysis conducted here.

contracts to P having the amount she can obtain in mind. I define this amount as the appropriation level, $b = \frac{\lambda t}{1+\lambda}$.

B's payoff is given by,

$$U_b(\theta, t, d) = \beta \frac{\lambda t}{1+\lambda} + (1-\beta) U_c(t, d), \tag{3}$$

where $0 < \beta < 1$ measures the bureaucrat's rent-seeking motivation. That is, β can be interpreted as the degree of misalignment between the preferences of C and B. If β were equal to 0, then B and C would have perfectly aligned preferences. I assume that β is a random variable that can take two values, $\beta \in \{\underline{\beta}, \bar{\beta}\}$, with probability γ and $1-\gamma$, respectively. C knows β's distribution, but not the actual realisation of β.

As $U_c(t, d)$, $U_b(\theta, t, d)$ also increases with the size of the transfer t. Note that B also dislikes emissions; her payoff is a weighed average of the amount appropriated, b, and the consumer's utility.

If C knew θ's realisation, she would not need to use the bureaucrat B, and the type of contract implemented would be the following.

Complete Information Under complete information (CI), C implements a type-contingent contract,

$$d^{CI}(\theta) = \frac{\theta}{1+\lambda} \quad t^{CI}(\theta) = \pi + \theta d^{CI}(\theta). \tag{4}$$

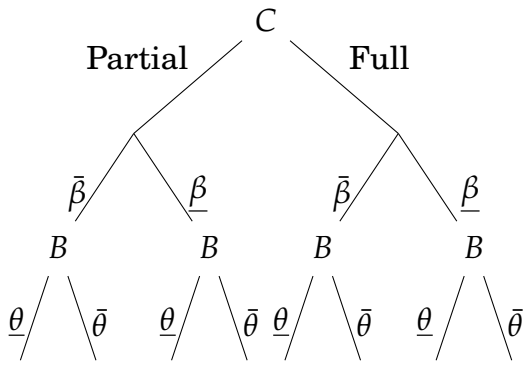
Proof. See Appendix A.

That is, C would force P to make a transfer that is a function of P's true type. Note that both emissions amount and transfer increase with θ. P's capacity of converting emissions into extra revenue determines pollution levels and the size of the transfer in the equilibrium.

4.2 The Delegation Problem

Let's set a four-period game now. In the first period, C decides whether to delegate full or partial powers to the bureaucrat B. In the second period, nature draws B's type ($\beta \in \{\underline{\beta}, \bar{\beta}\}$). In the third period, B learns θ. In the fourth period, the contract is implemented and payoffs are realised. This proposed setting illustrates a possible way in which the consumer C decides whether to implement partial or full delegation of regulation.

Figure 2: Game Tree



C chooses between full and partial delegation of regulation. Nature draws B's type. B learns θ and offers a contract to P. The contract is implemented and payoffs are realised.

I solve this game by backward induction. I compare C's expected utility in both regimes, full and partial delegation, and characterise the optimal outcome as a function of the expected value and variance of β and θ. I begin by analysing the full delegation regime.

Full Delegation Under full delegation (FD), C delegates decision-making authority to B without any restriction on B's behaviour. This implies that B solves the following optimisation problem:

$$\begin{aligned} \max_{\alpha=(t,d)} \quad & \beta\frac{\lambda t}{1+\lambda} + (1-\beta)U_c(t,d) \\ \text{subject to} \quad & \pi + \theta d - t \geq 0 \end{aligned} \tag{5}$$

Note that B's utility function increases in t. This means that the individual rationality constraint for P is always binding. The optimal contract in the full delegation regime is then given by:

$$d^{FD}(\theta) = \frac{\theta}{1+\lambda}H(\beta,\lambda) \quad t^{FD}(\theta) = \pi + \theta d^{FD}(\theta), \tag{6}$$

where $H(\beta,\lambda) = \frac{1-\beta(1-\lambda)}{1-\beta} > 1$ can be interpreted as the environmental cost of not having perfect information.

Proof. See Appendix A.

Equation 3.6 describes the level of pollution (d^{FD}) and the transfer (t^{FD}) made by the producer under full delegation of regulation. It is straightforward to verify that $d^{FD}(\theta) > d^{CI}(\theta)$, for the same θ and for

any value of (β, λ). This means that B always prefer an equilibrium with more emissions than C.[23]

Partial Delegation Under partial delegation (PD), C imposes an interval for pollution, $d \in [d_1, d_2]$.[24] The problem that B solves is the same as before, with this extra constraint. The optimal amount of emissions chosen by B is given by the following:

$$d^{PD}(\theta) = \begin{cases} d_1 & \text{if} \quad d^{FD}(\theta) < d_1; \\ d^{FD}(\theta) & \text{if} \quad d_1 < d^{FD}(\theta) < d_2; \\ d_2 & \text{if} \quad d^{FD}(\theta) > d_2. \end{cases}$$

Proof. See Appendix A.

That is, if P's pollution level in inside the interval $[d_1, d_2]$, B implements the full delegation contract (see equation (3.6)). Otherwise, B restricts pollution levels to be equal to d_1 (when pollution is too low) and d_2 (when pollution is too high), and implements contracts that are a function of these boundaries.[25]

I now have to determine the values of d_1 and d_2.

Lower bound The optimal lower bound for C is equal to $d^{CI}(\underline{\theta})$, that is, emissions level under complete information for a low-type P. However, C knows that B always delivers a higher emissions level than under complete information, $d^{CI}(\underline{\theta}) < d^{FD}(\underline{\theta})$ (for any value of (β, λ)). Hence, setting a lower bound d_1 becomes irrelevant.

Upper bound Let's assume that the lowest pollution level under full delegation is higher than the highest pollution level under complete information (for any value of (β, λ)):

$$d^{FD}(\underline{\theta}) = \frac{\underline{\theta}}{1+\lambda} H(\beta, \lambda) > \frac{\bar{\theta}}{1+\lambda} = d^{CI}(\bar{\theta}) \tag{7}$$

This implies that $H(\beta, \lambda) > \frac{\bar{\theta}}{\underline{\theta}}$. That is, the environmental cost of delegation is greater than the ratio between possible types of P. This assumption enables us to focus on bureaucratic appropriation—that is,

[23] This makes sense, since the transfer t increases with emission levels and B's utility increases with t.

[24] I do not prove that this is the optimal way to implement partial delegation of regulation. Following Nilssen and Kundu (2018), Alonso and Matouschek (2008), and Amador and Bagwell (2013), I take this as a given; this considerably simplifies my model.

[25] That is, $d^{PD} = d_1$ and $t^{PD} = \pi + \theta d_1$; and $d^{PD} = d_2$ and $t^{PD} = \pi + \theta d_2$.

on the effect of β and λ on the contract implemented—and abstract from the component that comes from differences between $\bar{\theta}$ and $\underline{\theta}$.[26]

Then, I have that,

$$d^{PD}(\theta) = d_2 = \frac{E(\theta)}{1+\lambda}$$

Proof. See Appendix A.

C forces B to implement a contract in which the emissions amount is always equal to d_2. When the difference between $\bar{\theta}$ and $\underline{\theta}$ is not too big, it is optimal for C to restricts B's behaviour such that there is only one allowed value for the emissions amount.

4.3 Equilibrium Outcome

I now wish to obtain the optimal regime of delegation implemented in equilibrium. To do that, I need to compare C's expected utility under full and partial delegation of regulation. I do that by solving the game in Figure 2 by backward induction.

I then have that full delegation is implemented every time the following inequality holds:

$$\frac{1}{2} - \lambda^2 \left(VAR(\beta) + E(\beta)^2 \right) > \frac{E(\theta)^2}{2\left(VAR(\theta) + E(\theta)^2\right)} \tag{8}$$

This inequality describes how changes in the distributions of β and θ, together with changes in the bureaucrat's capacity of appropriation λ, affect the optimal regime of delegation in equilibrium. The following proposition describes how changes in the terms of this inequality affect the choice of C.

Proposition 1 *C favours partial delegation over full delegation whenever:*

- *the motivation for bureaucratic rent-seeking increases (on average);*
- *the profitability of pollution increases (on average);*
- *the dispersion of profitability from pollution decreases; or*
- *the dispersion of motivations for bureaucratic rent-seeking increases.*

[26] I do not analyse the other case here, that is, $H(\beta,\lambda) < \frac{\bar{\theta}}{\underline{\theta}}$. In Appendix A, I show that, under this second case, it is never optimal to have full delegation.

Proof. From equation (3.8).

Hence, overall, C favours full delegation (ceteris paribus) if: B is homogeneous (in terms of motivations); B has low average rent-seeking motivation; there is low capacity of appropriation; P is heterogeneous (in θ); and P has low average θ.

I focus on the variance of β, that is, how spread out from the average value rent-seeking motivations are. From Proposition 1, it is clear that an increase in $VAR(\beta)$ (ceteris paribus) favours stricter regulation. The key driver of this result is my assumption on C's utility. The principal's preferences towards pollution are concave: greater pollution risk makes more attractive for C to impose a specific level of emissions. And a greater dispersion in the preferences of B increase pollution risk. Therefore, any exogenous change that makes the bureaucrat more heterogeneous will favour partial delegation of regulation

4.4 Expected Appropriation Levels

I now turn to the question of how different delegation regimes affect expected appropriation levels at the equilibrium. As I mentioned earlier, the appropriation level in this economy is defined as the amount b that B is able to appropriate from the transfer t. This amount includes both B's compensation for her expertise and potential bribes (I do not differentiate between the two in this model).

Proposition 2 Expected appropriation levels under full delegation are always higher than under partial delegation.

$$E(b^{FD}) > E(b^{PD}), \tag{9}$$

is always true.

Proof. See Appendix A.

Partial delegation not only restricts the amount of emissions that there is in equilibrium, but also reduces potential appropriation levels. If I assume that the appropriation level is an increasing function of the amount of bribes, this result implies that a change from full to partial delegation of regulation will also decrease expected corruption in this economy.

4.5 Discussion – Possible Drivers of a Regulation Change in South Africa

According to my model, a relation between three key variables determines whether partial delegation will be optimal: (i) the bureaucrat's capacity of appropriation, (ii) the rent-seeking motivation, and (iii) the profitability of pollution. In this last part of my theoretical section, I use this relation—expressed in equation (3.8)—to discuss the economic reasons behind the implementation of the AQA in South Africa. I focus on the first two variables, and assume that the distribution of the capacity of firms to transform excessive pollution into extra revenue has remained constant over time.[27]

The key political event in South Africa in the period from 1965 (APPA) to 2005 (AQA) is the end of the Apartheid (1995). Together with the reform in the political structure of the country, a series of smaller reforms began in 1995 with the objective of expanding and restructuring the national government by incorporating social and ethnic groups that were not part of the public service during the autocratic regime. This process changed the profile of the public service. My argument here is that such transformation towards a more representative public service increased the heterogeneity of public employees (with respect to their preferences towards the public good) and might have triggered the air quality regulation change—a change from full delegation of regulation (APPA) to partial delegation (AQA).

The historical literature describes the South African public service in 1995, when democracy was finally established, as a body that was "ethnically and ideologically homogeneous, tightly linked by a network of cultural, social and political organizations" (Hyslop (2005)). The public service was controlled by male Afrikaners, employed in all levels of the government, with particular presence at higher levels and positions of command.[28]

This scenario changed after the end of Apartheid. The government of democratic South Africa has put in place a series of structural reforms since its beginning. It expanded government's reach both socially and geographically, decentralised operations and responsibilities, increased government's transparency, and, most importantly for my purposes, established a policy of affirmative actions to make the public service more

[27] I do not have data to test Proposition 1 using econometric tools. Hence, this discussion serves only as an illustration of what I think the drivers of the regulation change (from APPA to AQA) might have been.

[28] As Posel (1999) points out, during the Apartheid, the National Party introduced a tacit policy of affirmative action for white Afrikaners. They were given preferential access to jobs in the civil service and were protected from competition. The National Party's objective was to change the ethnic composition and political leanings of the government, and to encourage a political culture of Afrikaner nationalism.

representative of the South African population (Lodge (1998)).

From 1995 to 2005, the proportion of non-white employees in the public service increased by almost 20%. The increase was even more striking at higher levels of the public sector. From 1995 to 2001, the increase in the proportion of non-white senior managers was equal to roughly 50%. And the proportion of high skilled positions increased from 2% of total employment in 1995 to 14% in 2008. There was also a substantial increase in the percentage of women in positions of command. In 1995, 8% of all senior managers were women, while in 2001 this number increased to roughly 20%.[29]

The implications of this process are many—and I do not intend to analyse all of them here. My focus is on the consequences of these changes to what I call "bureaucratic rent-seeking motivation" and "capacity of appropriation", the key variables of Proposition 1 in my model.

Overall, it appears that the South African public service has been transformed into a much more heterogeneous group as compared to the once ethnically and ideologically dominated Afrikaner government. This increase in heterogeneity is expressed in terms of different political, economic and cultural backgrounds inside the government at almost all levels. In the language of my model, this seems to imply that there was a change in the distribution of the bureaucratic rent-seeking motivation (β).

On the one hand, as the population of public servants became more heterogeneous, their preferences towards the public good also widened; that is, the variance in the alignment between bureaucrat and consumer ($VAR(\beta)$) increased. On the other hand, historical evidence does not suggest that the new public service was more misaligned with preferences of society than the old, Afrikaner public service (Posel (1999) and Lodge (1998)). As the population of public services became more representative of the South African population, their preferences towards the public good also became more representative of society's, on average. This means that the average bureaucratic rent-seeking motivation ($E(\beta)$) probably did not increase—and, it may be argued, even decreased.

As proposition 1 tells us, an increase in the variance of the bureaucratic rent-seeking motivation, together with no significant change in the average value, favours the implementation of partial delegation of regulation. This happens because the possible harm——in terms of pollution—caused by a bad environmental regulator has a greater potential negative impact than the benefits generated by a diligent regulator.[30] To finish this discussion, I need to analyse what happened to the bureaucratic capacity of rent appropriation (λ).

[29]All these figures are presented in Hassen and Altman (2010) and Bhorat et al. (2015). See Appendix C for graphs.

[30]As in my model, I am assuming that society (C) is risk averse, that is, has concave preferences towards pollution.

As Posel (1999), Lodge (1998) and Hyslop (2005) point out, there is no significant variation in corruption levels in the period that goes from the 1990s to 2005.[31] That is, there is no no evidence to make us believe that the new public service is more prone to appropriate rents or is more capable of doing so.[32] This suggests that the capacity of rent appropriation remained more or less constant over the political transition, and did not influence the change in the delegation of regulation.[33]

It is important to mention that, to develop this argument, I assume that society's preferences towards air pollution do not change over time. This means that, with the transition from the Apartheid to democracy, the change in the electorate did not translate into a change in air quality preferences. A possibility that would go against my reasoning here is that, over the last decades, the awareness of the harm associated to pollution in South Africa increased, and this has changed society's preferences. Unfortunately, I cannot test this alternative explanation.

5 Empirical Analysis

In this section, I examine the impact of a regulatory change on perceived corruption levels. I do that by measuring the impact of the introduction of the AQA on perceived corruption of South African firms. I begin by describing the data, I then outline my identification strategy, and I finish this section with the presentation of my main results.

5.1 Data

Firms I use data from the World Bank Enterprise Survey (WBES), conducted in South Africa in 2003 and 2007.[34] The WBES surveyed approximately 600 firms in 2003, and 1,000 firms in 2007, but only a

[31] As Fernandez and Lee (2016), Lodge (1998) and Hyslop (2005) point out, the changes in the post-Apartheid government have been effective in controlling corruption in some fronts, but also have generated possibilities for new forms of abuse.

[32] Although actual corruption levels have not increased significantly, corruption awareness increased dramatically in South Africa in recent years. This is portrayed, for example, in the numbers of the self-reported surveys conducted by Transparency International. TI's index goes from 0 (highly corrupt) to 10 (very clean). Over 16 years, South Africa has seen this index to go from 5.62 to 4.10.

[33] Recall that the capacity of appropriation is a variable that depends on the system bureaucrats are embedded in and not on their specific characteristics.

[34] For more information on the data, see Appendix B. The data are publicly available at http://www.enterprisesurveys.org/data/exploreeconomies/2007/south-africa. The WBES is a firm-level survey of a representative sample of South Africa's private sector. The objective of the survey is to present a detailed picture of the business environment in the country. It interviews top managers and business owners in small, medium and large non-agricultural firms, and has information that ranges from legal status to sales' revenue. I focus here on variables that are related to perceived corruption.

fraction of these firms is present in both years. I work with this fraction, which gives me a balanced panel of 191 firms. The main industrial sectors in my sample are: food products, textiles, papers products, chemicals, metals, electrical machinery, transport equipment, and services.

Air Quality Act The AQA was promulgated in September 2005, and, besides setting minimum air emissions standards for all industries, it has put in place a new institutional framework for monitoring, controlling and punishing polluting firms. The AQA made provision for a list of selected activities that would be subject to more stringent regulation after some years of its introduction. This list was only published in the AQA.AEL of 2010.

5.2 Descriptive Statistics

In 2007, roughly 25% of the firms in my sample mentioned corruption as one of the three most serious obstacles for their businesses. This figure is in line with the high levels of perceived corruption in the general population of South Africa. However, if I compare averages of variables related to corruption over time—from 2003 to 2007—it seems that there was an overall institutional improvement in at least three fronts.

First, the number of firms declaring that corruption was an obstacle decreased by 10%, from 53% in 2003 to 49% in 2007. Second, the number of firms that reported that licensing and/or permits are an obstacle decreased by 44%.[35] Although this seems to suggest that the procedure for obtaining these documents became easier for most firms, there was a decrease in the number of firms applying for these documents and an increase in average waiting time.[36] Finally, approximately 45% of firms in the sample declared that courts were an obstacle in 2003, while only 16% did so in 2007. This improvement in the perception of the judicial system is corroborated by the fact that 65% of firms agreed that courts are fair and uncorrupted in 2007 (I do not have this figure for 2003).[37]

[35]These are licenses and permits for all sorts of procedures, and not only environmental certificates.

[36]In 2003, 37 firms applied for a permit, and, in 2007, 21 firms; whereas 49 firms applied for an operating license and/or permit in 2003, and just 1 firm in 2007. The average number of days to get a permit and an operating license increased substantially: from 9 to 143 for permits (two were still in process during the time of the survey), and from 6 to 10 for operating license.

[37]In my dataset, there are also variables related to the amount of bribes firms gave to public officials. In general, I observe a slight increase in the number of firms that declared to have bribed a public official or local authority. Given that the number of firms declaring bribes is small as compared to the total number of firms in my sample, I do not think that this increase indicates any upward trend in the amount or frequency of bribery.

Table 1: Descriptive statistics of Main Variables.

		2003 (all)	2007	2003 (treated)	2007
Corruption is an obstacle?					
	No obstacle	47%	51%	53%	68%
	Minor obstacle	19%	21%	29%	8%
	Moderate obstacle	16%	15%	9%	14%
	Major obstacle	10%	12%	7%	6%
	Very severe obstacle	8%	1%	2%	4%
Licensing/permits are obstacles?					
	No obstacle	68%	82%	68%	73%
	Minor obstacle	12%	13%	8%	20%
	Moderate obstacle	14%	3%	14%	5%
	Major obstacle	4%	2%	6%	2%
	Very severe obstacle	2%	0%	4%	0%
Court is an obstacle?					
	No obstacle	55%	84%	64%	82%
	Minor obstacle	19%	9%	16%	11%
	Moderate obstacle	16%	4%	10%	7%
	Major obstacle	5%	2%	6%	0%
	Very severe obstacle	5%	1%	4%	0%
Av. days permit		9	143	4	78
Av. days license		6	10	18	10
Number of firms					
	bribe to officials	2%	5%	2%	5%
	bribe in gov't contract	1%	2%	2%	0%
	bribe for permit	0%	0%	0%	0%
	bribe for license	0%	0%	0%	0%

Table 1 presents the main figures discussed in this section for the whole sample and for my treated group. Treated firms follow the general pattern described for all firms, but improvements in corruption perception, court perception, and licenses and permits seem to be even more intense.

Figure 3 breaks down corruption perceptions for the main sectors in my sample.[38] Corruption perception decreases from 2003 to 2007 in 5 out of the 8 industrial sectors I have. Services, manufacture of trans-

[38]To construct this Figure, I transform the variable "*Corruption is an obstacle?*" into a binary one. The answer "No obstacle" receives value 0, while all other possible answers receive value 1. We present average answers, ranging from 0 to 1, by industrial sector and year.

port equipment, and manufacture of paper products increase their perceived corruption over time. Note that these sectors belong to three different categories of air pollution intensity: high (paper products), low (transport equipment), and virtually zero (services). In absolute terms, in 2007, transport equipment, manufacture of chemicals, and manufacture of textiles were the sectors least likely to consider corruption an obstacle. Again, air pollution intensity ranges from high to low across these three sectors.

Figure 3: Corruption Perception across Industrial Sectors

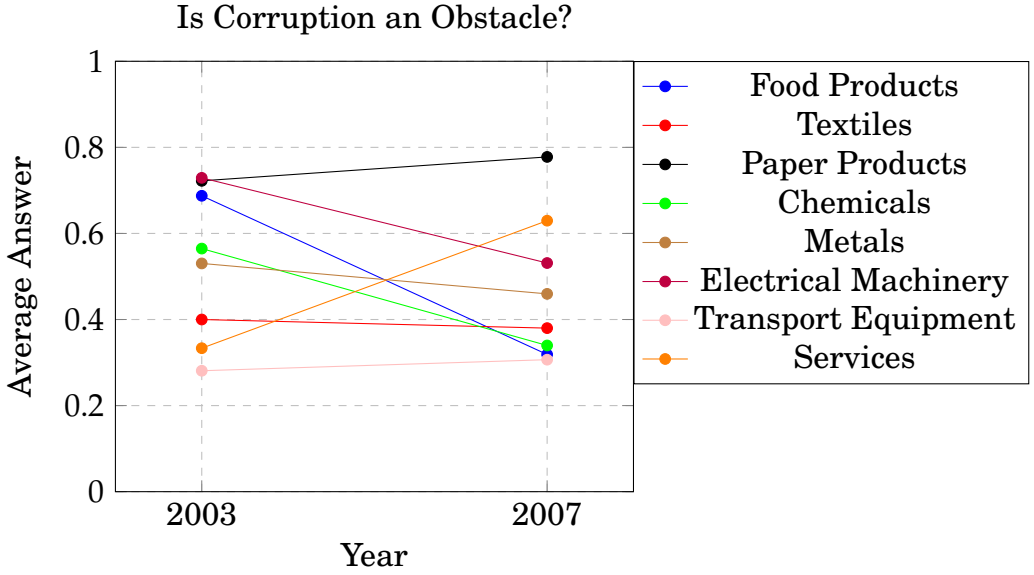


Figure 3 suggests that it is not pollution intensity that is driving corruption perceptions across sectors. It also does not seem that industrial sectors that rely most on state tenders—such as mining, engineering and heavy industries in general—are most likely to believe that corruption is a problem. As a general trend, however, it is plausible to believe that state dependence—that is, the degree of dependence and, more generally, interaction between firm and government—might affect corruption perception. I control for these characteristics—and possible endogeneity that arise from them—by using firm fixed effects.

5.3 Identification

I use the following linear probability model to run my main regressions,

$$corrup_{it} = \gamma_i + \lambda_t + \delta_i \cdot (reg_i \cdot post_t) + X'_{it}\theta + \epsilon_{it}, \tag{10}$$

where $corrup_{it}$ is a binary variable for *is corruption an obstacle?* of firm i at year t (this is the first variable of Table 1). This variable measures perceived corruption; it receives value 0 if the respondent chose

No Obstacle, and one otherwise. reg_i is a dummy that receives 1 if the firm is treated; and $post_t$ is a dummy that is equal to 0 before the AQA (2005) and 1 afterwards. X_{it} is a vector of four controls, covering two important characteristics of firms: size and exports.[39] I include two levels of fixed effects, γ_i and λ_t, respectively firm and year. Standard errors are clustered by firm.[40] [41]

The variable of interest is δ_i, which measures the effect of the introduction of the AQA on what I call perceived corruption. I need two conditions for identification of this effect.[42]

First, the enactment of AQA has to be uncorrelated to the error term in equation (3.10).[43] I assume here that the only driver or determinant of environmental regulation, in this context, is pollution intensity. This means that firms that belong to industries that pollute more, relatively to other firms, have greater chances to be regulated. Hence, this first condition might be invalid if pollution intensity also determines perceived corruption. I use firm fixed effects in my regressions to control for this potential omitted variable bias. The second condition is the parallel trends assumption. This requires that, in the absence of treatment, the difference between the treatment and control group is constant over time.[44] Because I only have two periods in my panel and few observations, it is difficult to select a control group that is not arbitrary. To address this issue, I construct three control groups:

1. 14 firms: non-manufacturers;

2. 25 firms: non-manufacturers plus manufacturers with very low air pollution levels;

3. 46 firms: non-manufacturers plus manufacturers with very low and low air pollution levels.

[39] The controls are: variation in prices 2003-2007, percentage of direct exports, number of employees.

[40] As a conservative measure, I choose the clustering that gives me the greatest standard errors.

[41] From Table 1, we see that my main variable, $corrup_{it}$, is in principle an ordered variable and not a binary one. This structure allows me to employ non-linear diff-in-diffs—as is described in Blundell and Dias (2009), for example, where the imposition of additive separability of the error term is relaxed and an index model is proposed. However, given the complexity of non-linear diff-in-diffs models (see e.g. Athey and Imbens (2006) and Puhani (2012)), I prefer to work with a binary variable and to run a linear probability diff-in-diffs model. Note that one problem that may arise from these models is that the coefficient of interest, δ_i, might be outside the $[0, 1]$ interval.

[42] In reality, I need two additional conditions for identification that I do not discuss in detail here: (i) stable composition of control and treatment groups, and (ii) no spillovers. It is clear that (i) holds for all my regressions, but I am not able to verify the validity of (ii).

[43] In other words, the treatment has to be uncorrelated to the outcome at the baseline.

[44] See e.g. Blundell and Dias (2009)

The first control group is not affected by the AQA due to the nature of its operations. In the second control group, I include industries that traditionally do not generate significant amounts of air pollution; that is, they are most likely not affected by the AQA (this is my preferred specification). Finally, the third group is composed of firms from the two first groups plus manufactures that have low air emissions levels. The idea here is to gradually increase the similarity between control and treatment groups without including industries that are clearly affected by the AQA in my control group.[45] I run four main regressions—a baseline regression with all firms in my sample, plus three regressions for each control group presented above—and eight regressions in total.

5.4 Results

Table 2 presents my results. The first column presents estimates for my baseline regression, with every firm in my sample. The introduction of the AQA decreases the probability of reporting corruption as an obstacle in almost 25%. In the next column, I rerun this same regression including controls. The coefficient of interest is even more negative, 27%.

Columns three and four present estimates for the third control group, columns five and six for the second, and columns seven and eight for the first control group, the one that is only composed of non-manufacturers. The coefficient δ_i gradually increases in magnitude from **(3)** to **(8)**. The probability of reporting corruption as an obstacle decreases by roughly 33% when I use my most flexible control group—the third one—to roughly 67% when I use the most restrictive control group. My favourite specification, **(6)**, shows that the AQA generates a reduction of 56% in the perceived corruption probability. These figures suggest that, in this context, the introduction of the AQA causes a substantial decrease in perceived corruption.

The only control that is statistically significant is number of employees, one of the proxies for firm size. Bigger firms are more likely to believe that corruption is a problem when compared to smaller firms. This might be explained by the fact that inspectors and local authorities have more incentives to try to extract rents from bigger firms—bribes and transfers appropriated by environmental inspectors and local authorities are probably proportional to the size of production, until a certain maximum level. Therefore, it seems that the regulatory regime change, from the APPA to the AQA, decreased perceived corruption of firms affected. As discussed in previous sections, the channel behind this change appears to be a reduction in the discretionary power of agents.

[45] For a detailed list of the industries that compose each control group, see Appendix B. When there is conflicting information on industry category—i.e. the same firm with a different code in each period—I assume that a firm is treated if a code belonging to the list appears at least once.

Table 2: Linear Prob. Model: AQA on perceived corruption

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
AQA x post, δ_i	-0.245**	-0.272***	-0.294**	-0.318**	-0.551***	-0.575***	-0.664***	-0.672***
	(0.098)	(0.010)	(0.127)	(0.133)	(0.141)	(0.141)	(0.159)	(0.157)
# of Employees		$0.22 \cdot 10^{-3}$***		$0.20 \cdot 10^{-3}$***		$0.20 \cdot 10^{-3}$***		$0.23 \cdot 10^{-3}$***
		$(0.41 \cdot 10^{-4})$		$(0.49 \cdot 10^{-4})$		$(0.45 \cdot 10^{-4})$		$(0.38 \cdot 10^{-4})$
% of exports		$-0.13 \cdot 10^{-2}$		$-1.9 \cdot 10^{-3}$		$-2.2 \cdot 10^{-3}$		$-2.3 \cdot 10^{-3}$**
		(0.0023)		(0.0031)		(0.0031)		(0.0040)
Change in prices		-0.104		-0.045		-0.028		0.0036
		(0.079)		(0.100)		(0.106)		(0.114)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs	382	374	236	224	194	188	174	168
R^2_{adj}	0.13	0.15	0.11	0.10	0.17	0.20	0.17	0.21

Dependent variable: perceived corruption. Standard errors are clustered by firm. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

6 Robustness Checks

In this section, I show that my main results are robust to different econometric specifications. I also show that my treatment variable—the introduction of the AQA—has no impact on other subjective outcomes, such as the perceptions managers have on South African courts.

6.1 Alternative Dependent Variables

Table 3: Alternative Dependent Variables: AQA on perceived corruption. Linear Prob. Model and Ordered Logit

	(1)	(2)	(3)
Moderate Obstacle, Major Obstacle or Very Severe Obstacle			
AQA x post, δ_i	-0.242***	-0.224**	-0.690***
	(0.089)	(0.093)	(0.140)
Controls	No	Yes	Yes
Year FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Obs	382	362	188
R^2_{adj}	0.11	0.10	0.25
Major Obstacle or Very Severe Obstacle			
AQA x post, δ_i	-0.025	-0.032	-0.241*
	(0.069)	(0.072)	(0.142)
Controls	No	Yes	Yes
Year FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Obs	382	362	188
R^2_{adj}	0.11	0.11	0.04
Ordered Logit (Average Marginal Effects)			
No Obstacle	0.138**	0.144**	0.260***
	(0.059)	(0.061)	(0.060)
Minor Obstacle	-0.020**	-0.021**	-0.023
	(0.009)	(0.010)	(0.014)
Moderate Obstacle	-0.046**	-0.048**	-0.090***
	(0.020)	(0.021)	(0.025)
Major Obstacle	-0.048**	-0.051**	-0.103***
	(0.022)	(0.023)	(0.031)
Very Severe Obstacle	-0.024**	-0.025**	-0.044**
	(0.012)	(0.012)	(0.019)
Controls	No	Yes	Yes
Obs	382	378	196

Dependent variable: perceived corruption.
Standard errors are clustered by firm.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

My main dependent variable, *is corruption an obstacle?*, is both ordinal and subjective. Respondents chose one of the five possible answers (see Table 1) according to their own assessment of what corruption is and of the scale that was presented to them (going from *No Obstacle* to *Very*

Severe Obstacle). To run my regressions, I transform this ordinal variable into a binary one, assuming that *No Obstacle* meant no corruption ($corrup_{it} = 0$) and every other option meant positive perceived corruption ($corrup_{it} = 1$).

I now change the way I define this variable to accommodate different points of view regarding what corruption is. I rerun my baseline regressions (columns (1) and (2) in Table 2) and my preferred regressions (control group 2, columns (5) and (6) in Table 2) for two different dependent variables. The first one receives value 0 if the respondent chose *No Obstacle* or *Minor Obstacle* and 1 otherwise. The second one receives value 1 only if the respondent chose the options *Major Obstacle* or *Very Severe Obstacle*.

Results are presented in Table 3. We see that they are in line with the ones presented in Section 3.5. Columns (1) and (2) of Table 3 present my results for the baseline specification with and without controls, respectively; and column (3) shows the results for my preferred control group, with regression controls. Coefficients are statistically insignificant for the baseline control group when I restrict $corrup_{it}$ to be equal to one only for *Major Obstacle* or *Very Severe Obstacle*, but become negative and statistically significant as soon as I change the control group. This suggests that my main results are not driven by the way I define my dependent variable.[46]

In Table 3, I also present the results for an ordered logit that I run for my baseline regression (columns (1) and (2)) and for my preferred control group (column (3)). This specification enables me to keep the ordinal structure of my dependent variable, but does not allow for fixed effects. The results are, again, in line with my main results. For example, looking at column (3), I verify that the introduction of the AQA is associated with a 26% increase in the likelihood of a respondent choosing *No Obstacle* and a 10% decrease in the likelihood of choosing *Major Obstacle*.

6.2 A Broader Institutional Change?

Results so far indicate that the introduction of the AQA decreased firms' perceived corruption. However, from the descriptive statistics presented previously, it seems that this phenomenon might not be isolated, but might be part of a broader institutional improvement.

[46] It is important to mention here that perceived corruption always is a subjective measure. Unfortunately, I do not have actual corruption levels to use in my regressions. And even if I had enough variation on the amount of bribes given to inspectors (see Table 1), I would be working with reported bribery and not actual bribery.

Table 4: Linear Prob. Model: AQA on Licensing and Permits, and on Court

	licensing/permits	**court**
AQA x post, δ_i	-0.052	-0.142
	(0.154)	(0.156)
# of Employees	$-1.8 \cdot 10^{-4}$***	$0.24 \cdot 10^{-4}$
	$(0.41 \cdot 10^{-4})$	$(0.74 \cdot 10^{-4})$
% of exports	-0.001	0.004*
	(0.004)	(0.002)
Change in prices	-0.160	0.054
	(0.120)	(0.113)
Year FE	Yes	Yes
Firm FE	Yes	Yes
Obs	188	188
R^2_{adj}	0.02	0.14

Dependent variable: is licensing/permits obstacle?; is court obstacle?.
Standard errors are clustered by firm.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

I now run two additional regressions to investigate whether this change in delegation of regulation is part of a broader change in perceptions of different institutions. I look at the perception that managers have on courts—*are courts an obstacle for your business?*—and their perceptions on obtaining a license or a permit[47]—*are licenses and permits obstacles for your business?*. I use the same specification of the regression in column(6) of Table 2, with two new dependent variables: $license/permit_{it}$ and $court_{it}$. The descriptive statistics for these variables is presented in Table 1.[48]

Results are given in Table 4. There are no signs that the AQA affected in any way the perceptions firms have on courts or on licensing and permits. As the first row in Table 4 shows, the estimates for these variables are statistically insignificant. These results suggest that the AQA does not generate a general institutional improvement. The institutional improvements that I observe in my data appear to be generated

[47]Licenses and permits of all sorts, not the one that are only related to environmental processes.

[48]Note that, again, I transform these into binary variables: 0 means that a firm does not consider licenses or courts an obstacle, 1 means that a firms does consider them to be obstacles for their business. I use the same controls used in my first set of regressions.

by other social, political, and economic factors that are common to all firms in the sample.[49] This supports the claim that the AQA is equivalent to a regulatory regime change, and that it had a specific effect on perceived corruption (as my theoretical model posits).[50]

7 Concluding Remarks

In this paper, I examine the reasons that motivate a change in the delegation of regulation, and how such change affects perceived corruption. Discretionary power of environmental regulators decreases when legislators implement a partial delegation regime as compared to a full delegation one. This reduction in power constraints their behaviour and might inhibit corrupt practices.

My model outlines when it is optimal to have a full delegation regime. When there is a great dispersion of firms, and the bureaucracy is very homogeneous in terms of its rent-seeking motivations, the principal prefers not to constraint agent's behaviour. This is so because the principal will gain more from transfers than she will lose from pollution. Once the dispersion for bureaucratic rent-seeking motivations widens, the principal prefers to implement partial delegation, and restrict agent's discretionary power. My model also shows that full delegation always enables the agent to appropriate more rents.

The empirical analysis illustrates some of my theoretical results. First, the regulatory regime change we observe in South Africa—from the APPA to the AQA—was preceded by a pronounced change in the profile of the public service. What was once an ethnically and ideologically homogeneous group became heterogeneous. I argue that this increase in heterogeneity widened the dispersion motivations—the relative weight bureaucrats give to private and public interests—and triggered the regulatory change. Second, it shows that a reduction in discretionary power of bureaucrats is associated with a decrease in perceived corruption. The introduction of new environmental regulation decreased firms' perceived

[49] I rerun all eight regressions with these two new dependent variables. All the coefficients of interest are statistically insignificant except for the regression with the first control group and $court_{it}$. For this regression, I have that the AQA decreases the probability of reporting courts as an obstacle in approximately 44% (5% significance level).

[50] Another possible explanation for the result of court perception is that there was not enough time to observe prosecutions related to the AQA at the time of the second survey, 2007. The AQA works slowly. First, offenders have to be notified that they are in breach. Second, they are asked to provide a document detailing what they will do to rectify the issue. Finally, if they are found in breach again, then there has to be a decision on whether or not to prosecute. Hence, if this explanation holds, affected firms would not have faced courts at the time of the survey. I believe, however, that there was enough time—two years—for the AQA to be enforced and for firms to be punished.

corruption, but did not change perceptions on courts, and on licensing and permits. This result is robust for different control groups, the inclusion of firm and year fixed effects, and the inclusion of controls.

There are two empirical caveats here. First, because of the reduced number of observations—191 firms in two periods—I am not able to select a control group by observing past trends.[51] Second, I work with a linear diff-in-diffs model, although my dependent variable is, originally, ordered. I decide not to work with a non-linear model because of its complexities—non-additive separability and problems of inference (see e.g. Athey and Imbens (2006)).

[51]It is common in diff-in-diffs regressions to use past data to match similar firms, and then to choose control groups that minimise average differences (see e.g. Blundell and Dias (2009))

Appendix A: Derivations and Proofs

Agents

Producer P's payoff function is given by

$$R(\theta, t, d) = \pi + d\theta - t, \tag{11}$$

where $\pi > 0$ is a constant, $d > 0$ is the emissions level, $\theta \in [\underline{\theta}, \bar{\theta}]$ is the emissions coefficient, and t is the transfer. As we mention in section 3, P transfers t to C to compensate for emissions.

Consumer C's utility function is

$$U_c(t, d) = G - \frac{d^2}{2} + \frac{t}{1+\lambda}, \tag{12}$$

where $G > 0$ is the utility generated by the good produced by P, and $\lambda \in (0, 1)$ is the fraction of the transfer appropriated by B. We assume that both λ and G are fixed.

Bureaucrat B's utility function is

$$U_b(t, d) = \beta \frac{\lambda t}{1+\lambda} + (1-\beta) U_c(t, d), \tag{13}$$

where $\beta \in (0, 1)$ measures the bureaucrat's rent seeking motivation.

Complete Information

C's preferred level of emissions when there is complete information (C knows θ) is given by,

$$\begin{aligned} \max_{\alpha} \quad & G - \frac{d^2}{2} + \frac{t}{1+\lambda} \\ \text{subject to} \quad & \pi + \theta d - t \geq 0 \end{aligned} \tag{14}$$

where $\pi + \theta d - t \geq 0$ is P participation constraint. Because $U_c(t, d)$ increases with t, this constraint will always bind. The equilibrium levels of d and t are:

$$d^{CI}(\theta) = \frac{\theta}{1+\lambda} \quad t^{CI}(\theta) = \pi + \frac{\theta^2}{1+\lambda} \tag{15}$$

The Delegation Problem and Equilibrium Outcome

The timing of the game is:

1. C decides whether to give full or partial delegation power to B;
2. Nature draws B's type ($\beta \in \{\underline{\beta}, \bar{\beta}\}$);
3. B learns θ;
4. B chooses $\alpha = (t, d)$, which is implemented;
5. Payoffs are realized.

We solve this game by backward induction.

Full Delegation The optimization problem under full delegation is:

$$\begin{aligned} \max_{\alpha} \quad & \beta \frac{\lambda t}{1+\lambda} + (1-\beta) U_c(t,d) \\ \text{subject to} \quad & \pi + \theta d - t \geq 0 \end{aligned} \tag{16}$$

In equilibrium, we have that:

$$d^{FD}(\theta) = \frac{\theta}{1+\lambda} H(\beta, \lambda) \quad t^{FD}(\theta) = \pi + \frac{\theta^2}{1+\lambda} H(\beta, \lambda), \tag{17}$$

where $H(\beta, \lambda) = \frac{1-\beta(1-\lambda)}{1-\beta} > 1$ for any $\beta \in \{\underline{\beta}, \bar{\beta}\}$.

Note that d^{FD} is always greater than d^{CI} for the same value of θ. C's expected utility under full delegation is then given by:

$$\begin{aligned} U_c^{FD} = & v\gamma \left(\frac{\pi}{1+\lambda} + \frac{\bar{\theta}^2}{(1+\lambda)^2} \bar{H} - \frac{1}{2} \frac{\bar{\theta}^2}{(1+\lambda)^2} \bar{H}^2 \right) \\ & + v(1-\gamma) \left(\frac{\pi}{1+\lambda} + \frac{\bar{\theta}^2}{(1+\lambda)^2} \underline{H} - \frac{1}{2} \frac{\bar{\theta}^2}{(1+\lambda)^2} \underline{H}^2 \right) \\ & + (1-v)\gamma \left(\frac{\pi}{1+\lambda} + \frac{\underline{\theta}^2}{(1+\lambda)^2} \bar{H} - \frac{1}{2} \frac{\underline{\theta}^2}{(1+\lambda)^2} \bar{H}^2 \right) \\ & + (1-v)(1-\gamma) \left(\frac{\pi}{1+\lambda} + \frac{\underline{\theta}^2}{(1+\lambda)^2} \underline{H} - \frac{1}{2} \frac{\underline{\theta}^2}{(1+\lambda)^2} \underline{H}^2 \right) \\ & = \frac{\pi}{1+\lambda} + \frac{E(\theta^2) E\left(H(1 - \frac{H}{2})\right)}{(1+\lambda)^2} \end{aligned} \tag{18}$$

Partial Delegation The optimization problem under partial delegation is:

$$\begin{aligned} \max_{\alpha} \quad & \beta\frac{\lambda t}{1+\lambda} + (1-\beta)U_c(t,d) \\ \text{subject to} \quad & \pi + \theta d - t \geq 0 \quad d \in [d_1, d_2] \end{aligned} \tag{19}$$

In equilibrium, we have that:

$$d^{PD}(\theta) = \begin{cases} d_1 & \text{if} \quad d^{PD} < d_1; \\ d^{FD}(\theta) & \text{if} \quad d_1 < d^{PD}(\theta) < d_2; \\ d_2 & \text{if} \quad d^{PD}(\theta) > d_2. \end{cases}$$

$$t^{PD} = \pi + \theta d^{PD}(\theta) \tag{20}$$

Now, we need to find the boundary values, $[d_1, d_2]$.

Lower bound The optimal lower bound for C is equal to $d^{CI}(\underline{\theta})$, that is, emissions level under complete information for a low-type P. However, B will always deliver a higher emissions level, $d^{CI}(\underline{\theta}) < d^{FD}(\underline{\theta})$. Hence, setting a lower bound d_1 becomes irrelevant.

Upper bound There are two possible optimal values for d_2.

1) $d^{FD}(\underline{\theta}) = \frac{\underline{\theta}}{1+\lambda}H(\beta,\lambda) > \frac{\bar{\theta}}{1+\lambda} = d^{CI}(\bar{\theta})$ for any value of (β,λ). This implies that $H(\beta,\lambda) > \frac{\bar{\theta}}{\underline{\theta}}$.

Then, we have that:

$$\max_{d_2} \quad v\left(\frac{\pi}{1+\lambda} + \frac{d_2\bar{\theta}}{1+\lambda} - \frac{d_2^2}{2}\right) + (1-v)\left(\frac{\pi}{1+\lambda} + \frac{d_2\underline{\theta}}{1+\lambda} - \frac{d_2^2}{2}\right) \tag{21}$$

And,

$$d_2 = \frac{E(\theta)}{1+\lambda}. \tag{22}$$

Then, C forces B to implement a contract that is always equal to d_2, that is:

$$d^{PD}(\theta) = \frac{E(\theta)}{1+\lambda}$$

Comparing $E(U_c(t,d)^{FD})$ and $E(U_c(t,d)^{PD})$, we reach the following inequality:

$$E\left(H - \frac{1}{2}H^2\right) > \frac{E(\theta)^2}{2E(\theta^2)} \tag{23}$$

We apply a second order Taylor expansion around $\beta = 0$ on the left hand-side of the equation above. We then have:

$$\frac{1}{2} - \lambda^2 \left(VAR(\beta) + E(\beta)^2 \right) > \frac{E(\theta)^2}{2\left(VAR(\theta) + E(\theta)^2 \right)} \tag{24}$$

Note that $VAR(\beta) = \gamma(1-\gamma)(\bar{\beta} - \underline{\beta})^2$.

2) $H(\beta, \lambda) < \frac{\bar{\theta}}{\underline{\theta}}$ for any value of (β, λ).

This means that $d_2 = d^{CI}(\bar{\theta})$.

Comparing $E(U_c(t,d)^{FD})$ and $E(U_c(t,d)^{PD})$, we reach the following inequality:

$$E\left(H - \frac{1}{2}H^2 \right) > \frac{1}{2} \tag{25}$$

This inequality cannot be true. This means that, in this second, full delegation is never optimal.

The intuition here is that the difference between $\bar{\theta}$ and $\underline{\theta}$ is so big as compared to $H(\beta, \lambda)$ that is always better to restrict B's behavior and limit pollution levels in equilibrium.

Expected Appropriation Levels

We define $b = \frac{\lambda t}{1+\lambda}$ as the amount of rents appropriated by B.

By comparing the equilibrium value of b in both outcomes, it is straightforward to show that expected appropriation is always greater when there is full delegation of regulation: $E(b^{FD}) > E(b^{PD})$.

Appendix B: Data

The data used in this paper come from a World Bank Enterprise Survey (WBES) in South Africa (2003 and 2007). The WBES targeted establishments located in Johannesburg, Cape Town, Port Elizabeth and Durban. The sample was stratified according to the following categories of industries:

1. Manufacturing: Food and Beverages, Machinery and Equipment, Electrical Machinery and Equipment, Textiles, Garment, Leather and Footwear, Paper and Paper Products, Printing and Publishing, Non-Metallic Mineral Products, Basic Metals, Fabricated Metal products, Wood and Wood Products, Furniture, Refined Petroleum Products, Chemical Products, Rubber and Plastics, and Other Manufacturing;
2. Retail Trade;
3. Construction;
4. Wholesale trade;
5. Hotels, bars and restaurants;
6. Transportation, storage and communications;
7. Computer related activities.

Firms are identified by their 4-digit ISIC 3.1 code in the panel we have.[52] In total, there are 191 firms surveyed in both periods, belonging to 88 different industries.

The following list shows all industries that are regulated by the AQA.AEL and that are present in our sample (the numbers in parentheses are their ISIC codes):

- Manufacture of other fabricated metal products (2899);
- Treatment and coating of metals; general mechanical engineering (2892);
- Forging, pressing, stamping and roll-forming of metal; powder metallurgy (2891);
- Manufacture of other non-metallic mineral products (2692, 2694, 2695 and 2610);

[52]Detailed explanation on the ISIC rev. 3.1, and codes for every industry can be found in https://unstats.un.org/unsd/cr/registry/regcst.asp?Cl=17.

- Other mining and quarrying (1410 and 1420);
- Manufacture of chemicals and chemical products (2411, 2412, 2413, 2421, 2422, 2423, 2424, 2429 and 2430);
- Manufacture of paper and paper products (2101, 2102 and 2109);
- Production, processing and preserving of meat products (1511, 1512, 1513 and 1514).

Note that these industries were only selected in 2010, five years after the publication of the AQA. They are part of a broader group of industries—called "listed activities"—that require more stringent environmental regulation because of their pollution potential.

Control Groups

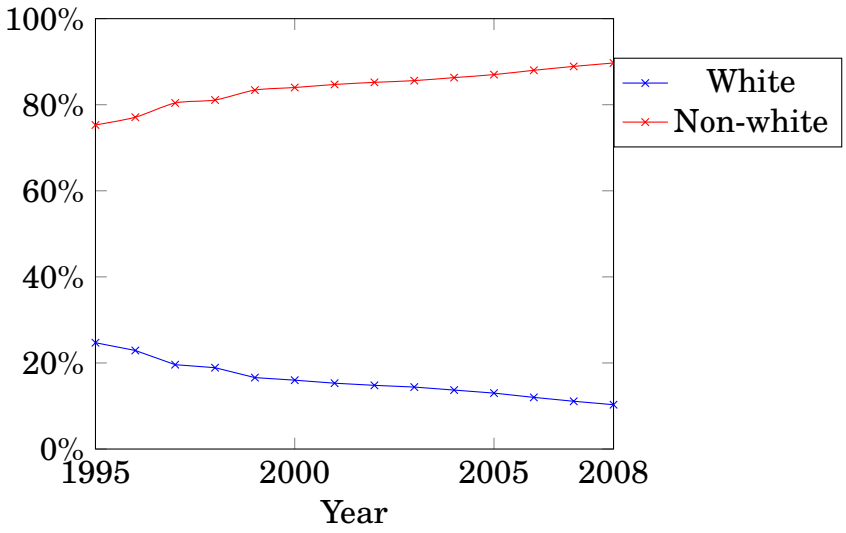
These are the three control groups we use in our regressions (the numbers in parentheses are their ISIC codes):

1. 14 firms, **non-manufacturers**: Publishing, printing and reproduction of recorded media (22); Wholesale trade and commission trade (51); Retail Trade (52); Hotels and Restaurants (55); Other business activities (74); Sewage and refuse disposal (90);
2. 25 firms, **non-manufacturers plus manufacturers with very low air pollution levels**: Publishing, printing and reproduction of recorded media (22); Wholesale trade and commission trade (51); Retail Trade (52); Hotels and Restaurants (55); Other business activities (74); Sewage and refuse disposal (90); Spinning, weaving and finishing of textiles (171); Tanning and dressing of leather (19); Manufacture of wood and products of wood (20); Manufacture of medical, precision and optical instruments (33);
3. 46 firms, **non-manufacturers plus manufacturers with very low and low air pollution levels**: Publishing, printing and reproduction of recorded media (22); Wholesale trade and commission trade (51); Retail Trade (52); Hotels and Restaurants (55); Other business activities (74); Sewage and refuse disposal (90); Spinning, weaving and finishing of textiles (171); Tanning and dressing of leather (19); Manufacture of wood and products of wood (20); Manufacture of medical, precision and optical instruments (33); Manufacture of wearing apparel (18); Manufacture of office, accounting and computing (30); Manufacture of radio, television and communication equipment (32); Manufacture of furniture (36).

Appendix C: Evidence on Distributional Change

The change from the APPA to the AQA can be characterized as a change from full to partial delegation of regulation. This happened amid a series of reforms that began after the Apartheid regime ended. Their objective was to expand and restructure the national government by incorporating social and ethnic groups that were not part of the public service during the autocratic regime. Our argument is that this process of transformation towards a more representative public service widened the distribution of rent-seeking motivations of public employees and might have triggered the air quality regulation change.

Figure 4: Ethnic Distribution of Public Employees (Source: Naidoo (2008), Hassen and Altman (2010) and the Equity Labor Report)



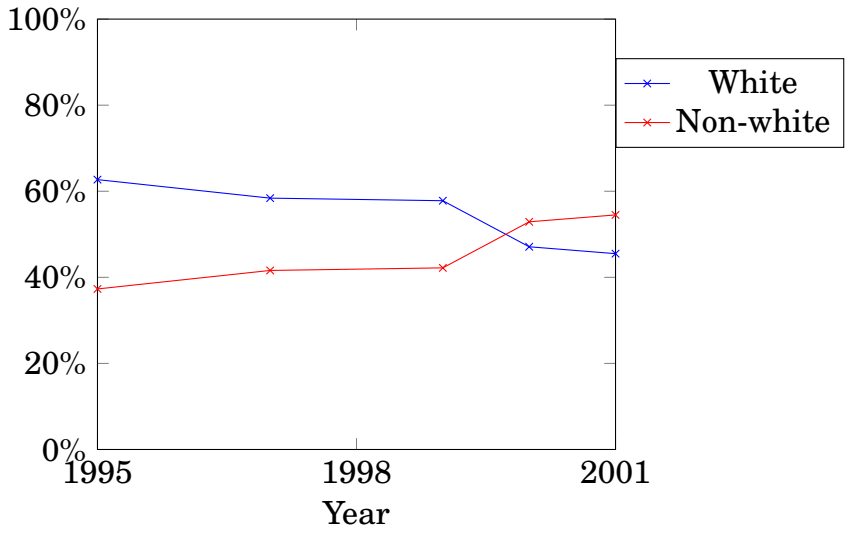
In 1995, when democracy was finally established in South Africa, the public service was controlled by male Afrikaners (Hyslop (2005)). This ethnic group was employed in all levels of the government, with particular presence at higher levels and positions of command, such as senior managers. As Posel (1999) points out, during the Apartheid, the National Party introduced a tacit policy of affirmative action for white Afrikaners. They were given preferential access to jobs in the civil service and were protected from competition. The National Party's objective was to change the ethnic composition[53] and political leanings of the government[54], and to encourage a political culture of Afrikaner nation-

[53]According to Posel (1999), by 1976 only seven out of 146 senior posts in government departments were held by people with English surnames, the rest was held by Afrikaners.

[54]Posel (1999) reports the case of the Department of Native Affairs that replaced officials considered to be liberal with loyal Afrikaner nationalists.

alism[55]. The result of these policies was a public service that was ethnically and ideologically homogeneous, tightly linked by a network of cultural, social and political organizations (Hyslop (2005)).

Figure 5: Ethnic Distribution of Senior Managers (Source: Naidoo (2008), Hassen and Altman (2010) and the Equity Labor Report)



This scenario has been changing in recent years. The government of democratic South Africa has put in place a series of structural changes since its beginning. It expanded government's reach (both socially and geographically), decentralized operations and responsibilities, increased government's transparency, and, most importantly for our purposes, established a policy of affirmative actions[56] to make the public service more representative of the South African population (Lodge (1998)). Combined, these policies have changed the profile of the public sector in at least three dimensions.

First, they have changed the ethnic profile of the civil service (see Figure 4). In 1995, 64% of public employees were African or black and 25% were white. In 2005, ten years later, 74% of public employees were African or black, while 13% were white. These figures account for the entire public sector, that is, they include all hierarchical levels. But the changes are even more striking for senior managers (see Figure 5). In 1995, 63% of senior managers were white, against 33% who were African or black. In 2001, only six years later, 45% of South African senior managers were white and 43% were African or black. Accord-

[55]Hyslop (2005) indeed reports that, for many years, the Afrikaner dominated public service had a "genuine, if misplaced, sense of mission".

[56]Affirmative action began in November 1995 with the publication of the White on Paper on the Transformation on the Public Sector (Thompson and Woolard (2002)). This document aimed at Blacks, women, and people with disabilities.

ing to Naidoo (2008), in 2006, the proportion of African or black senior managers reached almost 60%. The trend is similar for India/Asian and Colored managers. In 1995, there were 4% senior managers in these two categories; six years later, this number jumped to 12%.

Second, there was a substantial increase in the proportion of women in the public workforce. Female employment has grown from 48.8% in 1995 to 55.6% in 2008 (Hassen and Altman (2010)). This increase was mainly driven by the incorporation of African women. In 1995, they represented 30% of the public service; in 2008, they were 43%. The trend is similar for women at higher hierarchical levels. In 1995, 7.9% of all senior managers were women, while in 2001, this number increased to 19% (Thompson and Woolard (2002)).

Finally, the restructuring of the public sector changed the skill profile of its employees. The high skilled supervision category has grown from 2% of total employment in 1995 to 14% in 2008; senior management service has grown from 0.2% to 1%; and lower skilled and skilled category has declined from 50% to 38% in the same period (Hassen and Altman (2010)).

There are two consequences of this change. First, it transformed the South African public service into a more representative group of the national population. Second, it increased the number of high level positions in the public sector. Overall, this means that the group that takes most day-to-day decisions—managers and senior managers—became more heterogeneous and bigger than it was during the Apartheid. Lower ranking groups, such as lower skilled workers, also became more heterogeneous.

Our rationale is that the uncertainty in terms of rent-seeking behavior—that is, behavior associated to petty corruption—tended to increase with the incorporation of a more heterogeneous population into the public service. This happened because the distribution of the relative importance public employees gave to the public good, or to the welfare of society in general, widened. That is, the dispersion of this intrinsic measure—how important private interests are in relation to the public interest—widened (this corresponds to our variable β, see Section 4).

However, there is no evidence to make us believe that the new public service is more prone to appropriate rents or is more capable of doing so.[57] Some new forms of corruption emerged and other forms vanished. It seems that corruption levels reamined more or less the same.

[57]Note that, since there is no big variation in corruption levels in the period that goes from the 1990s to 2005 (see Posel (1999), Lodge (1998) and Hyslop (2005)), it is reasonable to believe that neither average rent-seeking motivations nor agents' capacity to appropriate rents increased. "Capacity to appropriate rents" is the equivalent of what we defined in the model as bureaucratic cost.

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