The Economics of Collusion Between Public Officials and Firms

by
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Contents

Introduction

In this PhD dissertation, I investigate the risk of collusion between public officials and private firms using both theoretical and empirical methods. Such collusion leads to an exchange of favors where the officials distort decisions for firms' benefit in exchange for bribes or beneficial job offers. The studies in this thesis aim to contribute to our understanding of collusive forms of corruption and policies designed to prevent them. Below I present a brief discussion on corruption and the contributions of the following studies.

1 Rent-seeking and corruption

In situations where firms or markets, while generating private benefit, cause public harm, societies demand regulations that secure public interest. To this end, societies all over the world delegate the task of enacting and enforcing robust regulations to public officials. Profit maximizing firms possess private information and officials are given the difficult task of ensuring that firms do not misuse that private information. Despite being subject to complex rules and controls, public officials operate in environments of information asymmetry, sometimes with little oversight of their decision-making. Not only can such a situation lead to the standard agency problems of moral hazard and adverse selection but can also lead to rent-seeking by public officials. Such rent-seeking has long been the subject of economic inquiry (Tullock 1967, Krueger 1974) where traditionally rent-seeking has included both legal and illegal activities.

Illegal rent-seeking activities can take various corrupt forms such as bribery, extortion, conflicts of interest, cronyism, nepotism, embezzlement, collusion, among others.[1] These activities may not necessarily be mutually exclusive. For example, a firm may buy favors from a public official through a bribe. In such an exchange, bribery is collusion. Similarly, cronyism may be accompanied by collusion whereby an associate is rewarded with a job in an exchange of favors. Such activities can have severe welfare consequences. Some of these consequences are discussed in the next section.

In this thesis, I focus solely on collusion and not on extortion[2] whereby certain firms may offer bribes and/or jobs in exchange for favorable rulings at the expense of the public at-large.

There is considerable empirical evidence regarding the impact of collusion between an official and a firm for both other honest firms and society. First, collusion between inefficient firms and

[1] See Rose-Ackerman & Palifka (2016, p. 8-9) for more details.

[2] Two other commonly used channels for corruption are collusion between politicians and firms and between firms (through formation of cartels). Both of these channels are beyond the scope of the work in this thesis.

public officials can stifle competition which makes efficient firms suffer (Raballand et al. 2012, Colonnelli & Prem 2021). This could be through weakening of regulations or selective application of existing regulations. It also adversely affects the decisions of investors (Vagliasindi 2013, Fung et al. 2011) thereby limiting the supply of funds to firms. Corruption in the education and healthcare sectors can lead to a lack of qualified talent (Rumyantseva 2005). It also discourages entrepreneurship (Avnimelech et al. 2011, Van Reenen 2011) and creates conditions where only corrupt firms may remain in the market (Hallward-Driemeier 2009).

Second, corruption is correlated with several problems in society. These include underprovision and/or inflated prices of goods and services (Reinikka & Svensson 2006), lower public trust in government (OECD 2015, p. 65), facilitation of other crimes like tax evasion (Uslaner 2007, Alm et al. 2016), and lower economic growth (Mauro 1995, Dreher & Herzfeld 2005).[3] These consequences reiterate the need for research on corruption.

Across the world, governments have used various initiatives to prevent and deter corruption. These include laws, guidelines, and information campaigns. Most countries have some form of public service ethics regulations.[4] Several countries have also introduced transparency laws which may include data disclosure laws and the right-to-information. Furthermore, there are also oversight mechanisms which limit discretionary powers of public servants.[5]

Regulations to prevent corruption are highly harmonized due to the efforts of organizations such as the OECD, the World Bank, and the UN including on topics like foreign bribery, procurement corruption, and public service ethics. Søreide (2019) highlights several reasons why regulations against corruption are poorly implemented and enforced in many countries . These include, first, a criminal law approach requires a high burden of proof to prove guilt. Given the hidden nature of corruption, it may not always be possible to gather sufficient proof. Second, if optimal sanctions are equal to the social costs of wrongdoing, the offenders may be unable to pay such large fines when gains from corruption are very large (Arlen & Kraakman 1997). Third, enforcement agencies may induce self reporting by showing leniency towards those that disclose their own acts of bribery (Basu et al. 2016). This may reduce the deterrent effect of anti-corruption regulations (Søreide 2019). Fourth, politicians may want to protect firms from their own countries since any anti-corruption enforcement against these firms may lead to job losses and a lower GDP growth in their constituencies.

[3] See OECD (2015) and the references therein for details on the impact of corruption on infrastructure, health, and education sectors.

[4] For example, in South Africa, public servants need to abide by the Public Service Act, 1994. Similarly, in the US, federal employees have to abide by 18 U.S.C § 207.

[5] Italian public procurement is conducted under the auspices of the Italian Anti-Corruption Authority (ANAC) and the Italian Court of Audits.

2 This thesis: Collusion between public officials and firms

In the following chapters, three situations where public officials could face the temptation to collude with private firms are presented. They span three different themes: corporate criminal liability, regulatory institutions, and public procurement. In all three cases, collusion will have implications for social welfare.

The first study of this thesis, co-authored with Tina Søreide, is related to the resolution of cases of corporate crime through non-trial resolutions (NTRs). An NTR consists of the prosecutor offering an accused firm the option of ending legal proceedings if it acknowledges wrongdoing, pays a fine, and in some cases instates a compliance program. There may also be further leniency if the firm self-reports offences (Alexander & Cohen 2015, OECD 2019). Such resolutions allow for speedier resolutions of corporate crime cases and take place instead of a traditional lawsuit. According to Makinwa & Søreide (2018) and OECD (2019), NTRs grant the prosecutor much greater discretionary power than a traditional lawsuit. They are also subject to weaker external checks in most countries.

As noted by Aidt (2003), discretionary power, existence of rents, and weak institutional oversight are conditions that might lead to corruption. Indeed, in the case of an NTR, an accused firm stands to benefit if it is able to receive leniency from the prosecutor. To do so, it may try to collude with the prosecutor by offering a bribe and/or a job offer.

Such collusion has consequences for society. If corporate offenders receive lenient punishments, they may not be sufficiently deterred from engaging in similar activities in the future. Additionally, this may also send a signal to other firms that collusion with the prosecutor is possible and they do not necessarily have to abstain from criminal activities damaging the overall business climate.

Our study combines the literature on corporate crime and the literature on regulatory economics and argues that the proliferation of NTRs has made the role of a prosecutor similar to that of a regulator. We note certain institutional vulnerabilities in the design of the prosecutor's office when dealing with cases of corporate crime and propose measures to reduce the possibility of collusion between the prosecutor and the firms. These include having safeguards such as greater oversight of prosecutorial activities (Levine & Forrence 1990), division of responsibility (Hiriart et al. 2010), having short and fixed tenures for prosecutors (Martimort 1999), among others. We then combine theoretical evidence with data collected by Makinwa & Søreide (2018) on country-wise laws on non-trial resolutions to discuss the country-wise risk of prosecutorial capture, that is, the risk that the prosecutor may collude with an accused firm during an NTR.

In the second article of this thesis, I, along with Emmanuelle Auriol, present an economic model of the revolving door phenomenon, where individuals in the public sector move to jobs in the private sector or vice versa. We only study the public to private side of the revolving door which may lead to collusion between regulators and the subjects of regulations. The paper studies the following trade-off.[6] The monetary benefits of revolving to the private sector can serve to attract highly skilled individuals to the public sector positions (Luechinger & Moser 2014, Shive & Forster 2016, Luechinger & Moser 2020). On the other hand, the possibility of future jobs in the private sector may motivate some individuals to do favors for the firms at the expense of society (Canayaz et al. 2015, Tabakovic & Wollmann 2018). In the latter case, regulators have a stake in how their decisions might affect the firm that they want to work for in the future. They might misuse their powers to perform favors and secure well-paid job offers. An example of such a conflict-of-interest is the case of Darleen A. Druyun, a former US Air Force official, who admitted to doing favors for Boeing to secure employment for herself after retirement from public office. Her favors for Boeing led to the US Air Force paying much more for military hardware than was otherwise necessary. She consequently served nine months in jail for her misconduct (Wayne 2004). As the example highlights, collusion between public officials and firms in the form of job offers in exchange for favorable decisions undermines regulatory activities and may lead to extra costs and/or lower provision of goods and services for the consumers.

One popular policy instrument to balance this trade-off is the introduction of a time gap between public and private positions, also called a cooling-off period. In our study, the cooling-off period acts to put any gains from revolving further out in the future, lowering their net present value. The study shows that while a cooling-off period is a useful policy instrument to prevent corruption, it is not without its costs. Indeed, while it reduces the benefit of any corrupt exchanges by positioning them further out in the future, it may also make it less beneficial for honest, highly skilled individuals to join the public sector. Such individuals may have better rewarding opportunities elsewhere. We also find that a cooling-off period is only optimal in relatively less cash-constrained economies. Therefore, cooling-off periods must be used with parsimony and may be utilized with other policy instruments. These instruments include restrictions on the kind of employers individuals can work with immediately after their public tenure.

The third and final chapter of this thesis, co-authored with Tina Søreide and Mihaly Fazekas, is an empirical study which utilizes data on Italian Public Procurement to analyze whether is an increase in corruption risks after natural disasters. This work is motivated by the importance

[6] Law & Long (2012) provide empirical support for this trade-off.

of public procurement[7] and the risk of corruption in such processes.[8] Following a disaster, societies need to repair and rebuild damaged infrastructure. Open and competitive procurement procedures form the backbone of a minimally corrupt procurement system. But faced with emergencies, Italian procurement law, similar to other countries, authorizes officials to deviate from the otherwise strict procurement rules to ensure rapid procurement of necessities during emergency periods. Such emergency clauses in procurement rules grant extra discretionary powers to officials.

While there are legitimate reasons to deviate from non-emergency procurement rules, there is also a risk that officials may abuse their extra discretionary powers to engage in illegal rent-seeking (Schultz & Søreide 2008). Schultz & Søreide (2008) also highlight the possibility that those receiving illicit gains, may prefer to prolong emergencies so that they may continue to receive benefits. On the other hand, these risks may not necessarily lead to actual acts of corruption. Due to the importance of saving lives, officials may refuse to collude with firms. Their decisions are also not completely without oversight. There is a risk that acts of corruption may be revealed through ex-post investigations.

Therefore, the question of how procurement officials utilize their discretionary powers is likely to have important welfare implications. If certain suppliers are favored, it may lead to underprovision of urgently needed infrastructure and utilities. Another aspect is the cost element where tax payers may end up bearing the burden of corruption and paying inflated amounts.

We run two different analyses: (a) unmatched comparison before and after disasters and (b) matched comparison before and after disasters. In the unmatched analysis, we show that there is an 11.9% increase in the probability of non-publication of tender calls after disasters. Similarly, the probability of single bidding also increases by 7.92%. In addition, these increases are 4.29% for the probability of non-open procedures and 17.8% in the probability of too-short advertisement period. In the matched analysis, we show that there is a 16.1% increase in non-publication of call for tender due to disasters. We also find that disasters lead to a 10.5% increase in the share of awards through non-open procedures and a 19.6% increase in the share of tenders with a too-short advertisement period. Finally, there is a positive but insignificant increase of 6.5% in the share of single bidding.

While our results show that there is an increase in the use of procedures which are associated with higher corruption risks, an analysis of procedures and single bidding does not provide a complete picture of the extent of increase in corruption risks. Deviations from non-emergency

[7]Public procurement accounts for 10% of the Italian GDP.

[8]In 2012, 22% of all convictions in corruption cases in Italy where from procurement corruption.

procurement rules may be necessary to rapidly procure necessities. Officials may also need to legitimately prolong emergencies to deal with particularly severe disasters.

2.1 A note on methodology

A meaningful study of the mechanisms and consequences of corruption requires a measure of corruption. But given the secretive nature of such exchanges, measuring the extent of corruption in a society is no easy task. Those involved may end up going to extreme lengths to hide monetary payments or other benefits exchanged while being involved in corruption. Therefore, researchers and policymakers need to rely on second or third-best estimates as measures of corruption.

A significant effort has been devoted to measuring the broad phenomenon of corruption through cross-country governance indices. Such indicators usually rely on surveys of different sections of the population and gather the perception of corruption. The Corruption Perception Index compiled by Transparency International and the World Bank Governance Indicators are two examples of survey-based corruption indices. These indicators provide a useful picture of on-the-ground reality and have been used by researchers while analyzing questions related to corruption.[9]

Such cross-country governance indicators suffer from several drawbacks. First, they are too broad and may not reflect the extent of collusion in a particular sector or market. Second, it can be difficult to tease out the mechanisms of how corruption affects various social outcomes by solely using surveys. Third, perceptions change slowly and only relying on surveys to measure the success of anti-corruption policies may not yield reliable results (Rose-Ackerman & Palifka 2016).

Due to these drawbacks, researchers have also used economic theory to study corruption. Going at least as far back as Rose-Ackerman (1975), economists have incorporated countervailing mechanisms into their models to understand the impact of collusion in equilibrium. Important articles that are in this line of research (and relevant for the work in this thesis) include Tirole (1986), Laffont & Tirole (1986), Laffont & Tirole (1993), Che (1995), Martimort (1999), and Auriol (2006).

Such economic models rely on assumptions about the behavior of stakeholders and the world they operate in to derive sharp insights about trade-offs. Over the years, economic theory has continued to be a powerful tool for those researching corruption, because it allows the study of trade-offs in isolation. These benefits are also closely associated with the most common

[9] See Williams & Siddique (2008) for a review.

criticisms of economic models: their abstractness and reliance on assumptions. In practice, complex mechanisms interact with each other in ways that may not be possible to study inside a tractable economic model.

Empirical studies have also become relevant in testing hypotheses generated by theories. Empirical work can also be used as a basis for stylized facts which lend support to new theories. For example, the data from the Lobbying Disclosure Act (1995) in the US has matured in the recent years. This data has been used to shed light on what is it that makes public officials so valuable to the private sector, whether it is their knowledge or their public sector network.[10] Another example is of Dávid-Barrett & Fazekas (2020) who use the World Bank procurement data to show that effects of a World Bank policy change on the risk of corruption in procurement.[11] The final study of this thesis contributes to this line of research.

Further challenges to empirical work on corruption include its internal and external validity aspects. In terms of internal validity, given that there is little systematic data on favors exchanged, one is left inferring motives through decisions implemented. For example, in the third study, the use of problematic procurement practices does not necessarily mean that there is corruption but merely points to a higher risk of corruption. Secondly, the pursuit of causality presents further challenges since data, that is not generated by through field experiments, may be affected by factors that are beyond the control of researchers and matching procedures can only approximate randomization. Thirdly, problems like missing or incomplete data may also undermine identification.

In terms of external validity, a challenge is the uniqueness of each context. Since every institutional context has its own peculiarities, results on corruption in one setting may differ from results in another jurisdiction. Therefore, it may be difficult to generalize empirical results on corruption.

References

Aidt, T. S. (2003), 'Economic analysis of corruption: A survey', *The Economic Journal* **113**(491), F632–F652.

Alexander, C. & Cohen, M. A. (2015), 'The evolution of corporate criminal settlements: An empirical perspective on non-prosecution, deferred prosecution, and plea agreements', *American Criminal Law Review* **52**, 537.

[10]See, for example, Vidal et al. (2012) and Bertrand et al. (2014).

[11]Other papers in this line of work include Fazekas et al. (2016), Decarolis et al. (2020).

Alm, J., Martinez-Vazquez, J. & McClellan, C. (2016), 'Corruption and firm tax evasion', *Journal of Economic Behavior & Organization* **124**, 146–163. Taxation, Social Norms and Compliance.

Arlen, J. & Kraakman, R. (1997), 'Controlling corporate misconduct: An analysis of corporate liability regimes', *NYUL Rev.* **72**, 687.

Auriol, E. (2006), 'Corruption in procurement and public purchase', *International Journal of Industrial Organization* **24**(5), 867–885.

Avnimelech, G., Zelekha, Y. & Sharabi, E. (2011), 'The effect of corruption on entrepreneurship', *International Journal of Entrepreneurial Behavior & Research* **20**(3), 237–262.

Basu, K., Basu, K. & Cordella, T. (2016), 'Asymmetric punishment as an instrument of corruption control', *Journal of Public Economic Theory* **18**(6), 831–856.

Bertrand, M., Bombardini, M. & Trebbi, F. (2014), 'Is it whom you know or what you know? An empirical assessment of the lobbying process', *American Economic Review* **104**(12), 3885–3920.

Canayaz, M. I., Martinez, J. V. & Ozsoylev, H. N. (2015), Is the revolving door of Washington a back door to excess corporate returns?, Koç University-TUSIAD Economic Research Forum Working Papers 1507, Koç University-TUSIAD Economic Research Forum.

Che, Y.-K. (1995), 'Revolving doors and the optimal tolerance for agency collusion', *The RAND Journal of Economics* **26**(3), 378–397.

Colonnelli, E. & Prem, M. (2021), 'Corruption and Firms', *The Review of Economic Studies* . rdab040.

Dávid-Barrett, E. & Fazekas, M. (2020), 'Anti-corruption in aid-funded procurement: Is corruption reduced or merely displaced?', *World Development* **132**, 105000.

Decarolis, F., Fisman, R., Pinotti, P. & Vannutelli, S. (2020), Rules, discretion, and corruption in procurement: Evidence from italian government contracting, Working Paper 28209, National Bureau of Economic Research.

Dreher, A. & Herzfeld, T. (2005), The Economic Costs of Corruption: A Survey and New Evidence, Public Economics 0506001, University Library of Munich, Germany.

Fazekas, M., Tóth, I. J. & King, L. P. (2016), 'An objective corruption risk index using public procurement data', *European Journal on Criminal Policy and Research* **22**(3), 369–397.

Fung, K.-C., Garcia-Herrero, A. & Ng, F. (2011), Foreign direct investment in cross-border infrastructure projects, ADBI Working Paper No. 274, Tokyo: Asian Development Bank.

Hallward-Driemeier, M. (2009), Who survives? The impact of corruption, competition and property rights across firms, World Bank Policy Research Working Paper 5084.

Hiriart, Y., Martimort, D. & Pouyet, J. (2010), 'The public management of risk: Separating ex ante and ex post monitors', *Journal of Public Economics* **94**(11-12), 1008–1019.

Krueger, A. O. (1974), 'The political economy of the rent-seeking society', *The American Economic Review* **64**(3), 291–303.

Laffont, J.-J. & Tirole, J. (1986), 'Using cost observation to regulate firms', *Journal of Political Economy* **94**(3), 614–641.

Laffont, J.-J. & Tirole, J. (1993), *A Theory of Incentives in Procurement and Regulation*, Vol. 1, 1 edn, The MIT Press.

Law, M. T. & Long, C. X. (2012), 'What do revolving-door laws do?', *The Journal of Law and Economics* **55**(2), 421–436.

Levine, M. E. & Forrence, J. L. (1990), 'Regulatory capture, public interest, and the public agenda: Toward a synthesis', *Journal of Law, Economics, & Organization* **6**, 167–198.

Luechinger, S. & Moser, C. (2014), 'The value of the revolving door: Political appointees and the stock market', *Journal of Public Economics* **119**, 93–107.

Luechinger, S. & Moser, C. (2020), 'The European Commission and the Revolving Door', *European Economic Review* **127**, 103461.

Makinwa, A. & Søreide, T. (2018), *Structured Criminal Settlements: Towards Global Standards in Structured Criminal Settlements for Corruption Offences*, The International Bar Association (IBA), Anti-Corruption Committee, Structured Criminal Settlements Sub-Committee.

Martimort, D. (1999), 'The life cycle of regulatory agencies: Dynamic capture and transaction costs', *The Review of Economic Studies* **66**(4), 929–947.

Mauro, P. (1995), 'Corruption and Growth', *The Quarterly Journal of Economics* **110**(3), 681–712.

OECD (2015), *Consequences of Corruption at the Sector Level and Implications for Economic Growth and Development.*

OECD (2019), Resolving foreign bribery cases with non-trial resolutions, Technical report, Organisation for Economic Co-operation and Development, Paris.

Raballand, G., Refas, S., Beuran, M. & Isik, G. (2012), *Why does cargo spend weeks in sub-Saharan African ports?: lessons from six countries*, World Bank Publications.

Reinikka, R. & Svensson, J. (2006), 'Using micro-surveys to measure and explain corruption', *World Development* **34**(2), 359–370.

Rose-Ackerman, S. (1975), 'The economics of corruption', *Journal of Public Economics* **4**(2), 187–203.

Rose-Ackerman, S. & Palifka, B. J. (2016), *Corruption and Government: Causes, Consequences, and Reform*, 2 edn, Cambridge University Press.

Rumyantseva, N. L. (2005), 'Taxonomy of corruption in higher education', *Peabody Journal of Education* **80**(1), 81–92.

Schultz, J. & Søreide, T. (2008), 'Corruption in emergency procurement', *Disasters* **32**(4), 516–536.

Shive, S. A. & Forster, M. M. (2016), 'The revolving door for financial regulators', *Review of Finance* **21**(4), 1445–1484.

Søreide, T. (2019), Regulating corruption in international markets: Why governments introduce laws they fail to enforce, *in* J.-M. G. Eric Brousseau & J. Sgard, eds, 'The Oxford Handbook of Institutions of International Economic Governance and Market Regulation', Oxford University Press.

Tabakovic, H. & Wollmann, T. G. (2018), From revolving doors to regulatory capture? evidence from patent examiners, Working Paper 24638, National Bureau of Economic Research.

Tirole, J. (1986), 'Hierarchies and bureaucracies: On the role of collusion in organizations', *Journal of Law, Economics, & Organization* **2**(2), 181–214.

Tullock, G. (1967), 'The welfare costs of tariffs, monopolies, and theft', *Economic Inquiry* **5**(3), 224–232.

Uslaner, E. M. (2007), Tax evasion, corruption, and the social contract in transition, *in* '*Developing alternative frameworks for explaining tax compliance*', Vol. 59, p. 174.

Vagliasindi, M. (2013), *Revisiting Public-Private Partnerships in the Power Sector*, number 13118 *in* 'World Bank Publications', The World Bank.

Van Reenen, J. (2011), 'Does competition raise productivity through improving management quality?', *International Journal of Industrial Organization* **29**(3), 306–316. Special Issue: Selected Papers, European Association for Research in Industrial Economics 37th Annual Conference, Istanbul, Turkey, September 2-4, 2010.

Vidal, J. B., Draca, M. & Fons-Rosen, C. (2012), 'Revolving door lobbyists', *The American Economic Review* **102**(7), 3731.

Wayne, L. (2004), 'Ex-Pentagon Official Gets 9 Months for Conspiring to Favor Boeing', *The New York Times* .

Williams, A. & Siddique, A. (2008), 'The use (and abuse) of governance indicators in economics: a review', *Economics of Governance* **9**(2), 131–175.

The risk of prosecutorial capture in corporate crime cases

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Abstract

Increasingly, across a range of countries, prosecutors conclude cases of profit-motivated corporate crime with a non-trial resolution at the pre-trial stage. In most jurisdictions that enforce corporate criminal liability, the prosecutor holds wide discretionary authority with respect to the charge in question, the enforcement process, conditions for a settlement, the size of fine payments, and the overall magnitude of sanctions. Such authority creates risks of collusion and capture. This problem has been subject to extensive economic analysis in other areas of regulation, and we examine what the enforcement of corporate liability can learn from economic theory on regulation in general. Drawing on results in that literature, we describe the theoretical conditions for risk of prosecutorial capture and use this insight to develop indicators of a capture-prone institutional environment. We find a higher risk of such capture in countries with longer prosecutor tenures, less division of responsibility, low transparency, and high prosecutorial discretion. Applying data on procedural regulations governing non-trial resolutions and enforcement from 26 countries, drawn from an International Bar Association survey and other sources, we evaluate exposure to prosecutorial capture across the countries and identify which of them ought to develop stronger checks on the enforcement of corporate criminal liability.

Keywords: Regulation, enforcement, collusion, negotiated settlements, corporate criminal liability (JEL: K1, K2)

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1. Introduction

The enforcement of corporate criminal liability has undergone a transformation. Two decades ago, most corporate crime cases were subject to court proceedings. Today such cases normally end with a settlement between the corporate defendant and the public prosecutor, that is, a non-trial resolution (NTR), as seen in the cases against Siemens in the United States and beyond and Rolls Royce in the United Kingdom.[1] The prosecutor offers the accused corporation the option of discontinued investigation and no trial in exchange for its cooperation in acknowledging the facts of the case, paying a fine, and, often, accepting external monitoring of its operations for some years. Typically the prosecutor scales down the penalty in line with the defendant's cooperation, offering greater leniency if the corporation actively assists investigators in disclosing the facts of the case and, especially, if it self-reported the offense (OECD 2019, Alexander & Cohen 2015). As this enforcement trend expands the extent of discretionary authority vested in the prosecutor, we ask in this article whether countries have sufficient barriers against collusion between the prosecutor and the accused offender, which we refer to as *prosecutorial capture*.

This trend toward settlement-based enforcement in corporate liability cases is led by the United States, which enforces far more cases of corporate liability per year than any other country and has gone furthest in establishing principles for predictable and consistent settlement practice (Buell & Arlen 2020). Many European and Latin American countries, as well as Australia and Canada, have followed suit in applying such forms of enforcement, but they have done so in more arbitrary fashion, with few regulations and little transparency (Makinwa & Søreide 2018). In many jurisdictions, corporate criminal liability is or was an anomaly because the corporate structure is considered incompatible with criminal justice aims of assigning guilt to blameworthy individuals (Moore 2010, Pieth & Ivory 2011). This might be one reason why NTRs often involve deviation from otherwise well-established

[1] See US Department of Justice prese release, 15 December 2008, https://www.justice.gov/archive/opa/pr/2008/December/08-crm-1105.html, and UK Serious Fraud Office press release, 17 January 2017, https://www.sfo.gov.uk/2017/01/17/sfo-completes-497-25m-deferred-prosecution-agreement-rolls-royce-plc/.

principles on rule of law and legitimate enforcement. Another reason is the difficulty associated with investigation of corporate crime cases, which often involve corporate structures spanning multiple countries and partners, with various components hidden behind financial secrecy. These other actors may have incentives not to cooperate, whereas both prosecutor and corporate defendant have an interest in completing the case (Pieth 2020).

The forms of offenses most frequently subject to corporate liability include antitrust violations, tax evasion, bribery, various sorts of fraud, breach of anti-money laundering regulations, environmental crime, and violation of safety requirements. Across jurisdictions there is variation as to what sorts of offenses are regulated by criminal law. Enforcement of non-criminal regulation is the responsibility of specialized agencies, such as competition authorities, tax authorities, and financial regulatory authorities. While these agencies may also offer settlements when sanctioning offenses, we limit this study to criminal cases under the responsibility of public prosecutors. Our main concern is how the framework conditions for public prosecutors affect the risk of political interference in the enforcement of corporate liability. We focus in particular on the enforcement of corporate bribery cases, for which there is more systematically collected information across countries. Key data sources include a survey by the International Bar Association (IBA) of enforcement practices in 66 countries (Makinwa & Søreide 2018) and a report by the Organisation for Economic Co-operation and Development (OECD) Working Group on Bribery (OECD 2019).[2]

According to these surveys, enforcement by NTRs implies much broader discretionary authority for the prosecutor than is the case with trial-based enforcement. First, at the investigation stage, when the accused corporation will often contribute with facts about the alleged crime, the prosecutor determines the scope of the fact-finding mission and decides when there is sufficient information to allow discussion of the next step. Second, the prosecutor controls the charge and, therefore, the offenses to be listed, and decides whether the corporation's self-reporting and cooperation qualify for leniency. These elements strongly in-

[2]While there is comprehensive information about settlement-based enforcement in the United States (see Garrett (2014)), cross-country information about enforcement practices is quite limited, generally because of observers' difficulty in obtaining facts about enforcement cases.

fluence the eventual magnitude of the sanction, even if this decision is also guided by official penalty instructions. The exchange of information between the corporate defendant and the prosecutor tends to give the pre-settlement communication a character of negotiation. The corporation brings its knowledge of the facts to the table, but it is the prosecutor who has the authority to bring the case to court, or not. In some countries, including the United States, the accused will face additional and sometimes substantial indirect consequences if it is found guilty in court, and this may lead a corporation to accept the offered settlement even if the question of liability is uncertain (Søreide & Vagle forthcoming). Third, as part of the settlement, the prosecutor may require the accused corporation to make changes to its operations, improve compliance systems, and, as mentioned, hire an external compliance monitor (Arlen 2016). It is normally up to the prosecutor, however, to monitor how well these measures are implemented following the enforcement case. In total, therefore, the corporation stands to gain considerably if the prosecutor is sympathetic and inclined to offer soft treatment rather than a harsh penalty-maximizer. The question we raise in this article is whether and when an accused corporation is likely to succeed in securing the prosecutor's sympathy. Under what circumstances will settlement-based enforcement intensify the risk of collusion between the prosecutor and the corporate defendant? Where are such problems likely to materialize?

The above-mentioned surveys of enforcement by non-trial resolutions in corporate bribery cases reveal various institutional vulnerabilities, which are typically the same for several forms of corporate crime. External checks on settlement-based enforcement are generally weak, and in most countries there is no external approval of the resolution, such as by a court or judge. Compared to cases concluded by trial, far fewer facts about NTRs are shared with the public; many governments merely issue a brief press release about the sanction, often pre-approved (or even written) by the corporate defendant itself. Observers have pointed to the lack of legitimacy surrounding such cases, the risk of soft treatment of corporate offenders (and the responsible managers), the risk of inconsistent treatment across similar cases, and the possibility of political interference in the enforcement process (Hawley et al. 2020). The OECD Working Group on Bribery, which is the main governmental coalition on the matter, endorses the use of NTRs for efficient enforcement of bribery cases, but it is also preparing recommendations that will guide governments in making reforms for more principled enforcement practices (Ivory & Søreide 2020).

Despite a common awareness of institutional vulnerabilities attached to settlement-based enforcement, neither policy makers nor academics have paid much attention to the risk of prosecutorial capture. In countries where authorities enforce corporate criminal liability, prosecutors are generally respected for their competence and commitment, and normally the focus is on addressing obstacles to their efficient performance. At the same time, capture of regulatory or political institutions is a serious concern in many other contexts (Shughart & Thomas 2019), and in some countries corruption severely impedes the judiciary (Damania et al. 2004, Gloppen 2016). Prosecutors, like other public officials, may be exposed to subtle benefits from corporate offenders and their legal advisers, such as future job opportunities, if not bribes. They may also come under pressure from politicians who side with the accused corporation (Kangt & Shepherd 2011, Firth et al. 2011).[3]

Within the field of law and economics, a substantial literature explains the performance of prosecutors, including analyses of judicial administrative strategies (Posner 1973, Forst & Brosi 1977, Polinsky & Shavell 2000), litigation and plea bargaining (Reinganum 1988, Spier 1992, Grossman & Katz 1983, Miceli 1996, Easterbrook 1992), and sanction principles (Becker & Stigler 1974, Arlen & Kraakman 1997). Generally, however, this literature assumes that officials are honest. They experience personal costs and benefits, which may influence some aspects of institutional performance, but this is not a sufficient basis for evaluating the risk of collusion with corporate defendants. Beyond the researched and logical likelihood that a society's pervasive corruption affects the judiciary as well, it is difficult to find research-based indicators of the risk of prosecutorial capture. However, although it is less developed in the area of corporate criminal liability, the risk of collusion between a regulator and the subjects of regulation is well treated in other areas of economic theory.

[3] For a cross-country comparison of institutional weaknesses in the judiciary, see The World Justice Project: https://worldjusticeproject.org/. For a specific example of political influence on enforcement process, see 'Andrew Scheer to Launch Inquiry into SNC-Lavalin Corruption Scandal' (Conservative Party of Canada 2019); New Democratic Party, 'The Courage to Do What's Right' (New Democratic Party 2019).

Within economics, there is a substantial literature on business regulation, including the regulation of utilities and industrial safety. Theories using a principal-agent framework are particularly useful in describing the risks of capture. Here, therefore, we consider the main takeaways from that literature and analyze results that help us understand the risk of capture in governmental enforcement of corporate criminal liability. On that basis we present a "theoretical risk of capture" and propose applicable risk indicators. Next, with a view to investigating the theoretical predictions, we present data drawn from the IBA survey (Makinwa & Søreide 2018) combined with statistics on enforcement in foreign bribery cases from the OECD and TRACE International. Finally, we apply the theoretical insights in order to identify capture-prone jurisdictions, considering institutional features as well as enforcement intensity.

While this approach identifies certain countries as more vulnerable than others to prosecutorial capture, we do not have evidence to verify the actual presence of capture problems in any country. Our research merely proposes an economic methodology for identifying *risk* of such capture within the judiciary. This, however, may be quite useful at a time when we see rapid increase in the use of settlement-based enforcement practices and a corresponding expansion in the discretionary authority of public prosecutors.

2. The problem of prosecutorial capture

Before turning to the risk of capture, we want to specify what the capture problem implies in the context of corporate liability. Let us first zoom in on the prosecutor, ignoring, for now, the risk of political interference with the prosecutor's work.

Estache & Wren-Lewis (2011) define regulatory capture as "the manipulation of government regulating agencies by special interests," which can manifest as "favouritism, fraud, cronyism, patronage, embezzlement, regulatory capture, cash bribes or even extortion." While this definition is useful in many settings, it is not directly applicable to the problem of *prosecutorial* capture. Most countries that enforce corporate liability are low-corruption countries where it is rare to hear of prosecutors being bribed or extorted or misusing public funds.

In such contexts, it is more relevant to consider subtle forms of influence, often with more modest consequences, what we might call "prosecutorial favoritism." This favoritism could be the result of a quid pro quo exchange, such as a personal favor or job offer for the prosecutor. It could also reflect regulators' sensitivity to political or economic concerns (for example, a desire to shield large national firms that employ thousands), or simply the regulator's pro-business point of view.

To clarify the concept of prosecutorial capture and its consequences, we present a simple model that shows the impact of prosecutorial favoritism on sanctions for guilty firms. We use the standard principal-agent framework and assume that the prosecutor has to set the optimal sanction. The firm can be one of two types: either criminal, with probability ν, or innocent, with probability $(1-\nu)$. To keep matters simple we assume that both types have the same profit function but that the criminal firm is able to make Δ_c extra exogenous per-unit profit by using criminal means. Therefore, the profit functions for the two types are:

$$\pi_i = q - \frac{\beta q^2}{2} \tag{1}$$

$$\pi_c = q + q\Delta_c - \frac{\beta q^2}{2} - \xi f \tag{2}$$

To restrict our focus to a two-tier framework, we let ξ, the probability of detection, be exogenous, and normalize the price of the good to 1. Lastly, β is the efficiency of production and is small enough to ensure that firms produce and make non-zero profit. The firms optimize the above in terms of the following profit values:

$$\pi_i = \frac{1}{2\beta}$$

$$\pi_c = \frac{(1+\Delta_c)^2}{2\beta}$$

The prosecutor then chooses f to maximize the following welfare function, where crime costs the society $(1 + \lambda)\Delta_c$ and k is the minimum sanction stipulated by law:

$$EW = (1 - \nu)\frac{1}{2\beta} + \nu\left[\frac{(1 + \Delta_c)^2}{2\beta} - (1 + \lambda)\Delta_c - \xi b f\right] \tag{3}$$

such that:

$$\frac{(1 + \Delta_c)^2}{2\beta} - \xi f \geq 0 \tag{4}$$

$$f - k \geq 0 \tag{5}$$

where (4) ensures that the criminal firm does not make negative profit and (5) ensures that fines are at least as high as the minimum stipulated fines. The solution to this problem is shown in the proposition below.

Proposition 1. *(i) When the prosecutor is unbiased ($b = 0$), and $(\Delta_c)^2 > 2f\beta\xi - 1 > 2k\beta\xi - 1$, then the sanction is strictly larger than k.*
(ii) When the prosecutor is biased ($b > 0$) and $(\Delta_c)^2 > 2k\beta\xi - 1$, then the sanction is always equal to k.

The solution to the above problem is presented in appendix A. Proposition 1 highlights, in a very simple framework, the relationship between the sanction level f, the benefit from crime Δ_c, the presence of prosecutorial bias b, and the minimum stipulated fine k. When the prosecutor is unbiased and there are potential gains from being corrupt, then the sanction level is always larger than the minimum fine. But when the prosecutor displays favoritism toward the firm, the sanction level is always the minimum possible fine. Therefore, any factor that can bias the prosecutor in favor of the firm will reduce the fine level for the firm. Interactions with the firm over a long period of time and/or possibilities of private sector job offers can lead to prosecutorial favoritism. Lack of judicial oversight and/or lack of transparency (captured by a low ξ in the our model) along with higher discretion are likely to increase the possibility that prosecutors will, first, develop relationships with firms, and second, award sanctions that are beneficial to criminal firms.

While the clarification of the term "capture" and the illustration of impacts make the problem clearer, this does not tell us when the problem materializes. This is why we need to review results in the literature on regulation and capture.

3. The economics of regulation and capture

With respect to the risk of capture, the economic literature on regulation examines critical questions: What is the optimal compensation scheme for public officials whose performance is difficult to monitor? What is the best way to organize institutions responsible for regulation and enforcement? What is the right level of institutional independence? To what extent can corporations exert influence through offers of post-public employment opportunities? And how does the risk of regulatory capture depend on competition in markets?

Authors in this literature consider such questions to be *agency problems*, meaning that some "agent," in this case a representative of a regulatory institution, acts on behalf of a "principal," representing a higher level of management or governance, in a setting where the principal has limited ability to observe the agent's performance or there are costs attached to such monitoring. As in principal-agent situations more generally, the agent-as-regulator may take advantage of the principal's limited information to optimize his or her own choices in light of perceived costs and benefits, even if this means deviation from the principal's objectives (Ross 1973, Laffont & Martimort 2002). As a result, a regulator may perform differently than the government and society expect. Regulatory capture, that is, collusion between the regulator and the subjects of regulation is one of the reasons why this might occur.

The literature on agency problems presents a range of different circumstances that may intensify the risk of regulatory capture, and these can be categorized as relating either to compensation for employees (who receives what) or to institutional organization (who controls what). We address these classes of arguments in turn.

3.1. *Compensation and employment contracts*

Personal compensation for staff employed by a regulator comprises several elements, including financial remuneration (wages), job security, and post-public employment opportunities. The impact of the various sorts of compensation on the risk of capture depends on the incentives associated with the specific arrangement. Whereas a low wage may increase the risk of capture, a high level of job security may have the opposite effect.

As regards wage remuneration of regulatory agency staff and the budget available for executing regulatory tasks, several authors explain a principal's difficulty in letting benefits depend on performance (Levine & Forrence 1990). This is a classic moral hazard problem, one that relates to the difficulty of observing and evaluating the agent's (in this case, the regulator's) work. It can sometimes be resolved by structuring contracts to depend on aspects of the work that are in fact observable, and/or on officials' self-selection into a contract type that fits their character.[4] When an employment contract does not contain proper incentives, there is an increased risk of regulatory capture through means like bribery and attractive job offers (Could & Amaro-Reyes 1983, Palmier 1983).

The economic literature explains why sub-optimal incentives in this context might lead to corruption. Models by Becker & Stigler (1974), Shapiro & Stiglitz (1984), and Besley & McLaren (1993) describe the conditions under which low wages and low probability of detection will lead a utility-maximizing public official to accept bribes to augment her income. The incentive to take bribes when wages are low does not stem only from the official's personal financial situation; it is also a matter of the external relative risk. A poorly paid official has less to lose if detected in misconduct, while a highly paid official stands to forfeit more if caught.[5] However, the wage-corruption relationship may also have moral aspects. Presenting

[4]Starting with Hölmstrom (1979), there is a large literature in economics on the design of wage incentives to overcome moral hazard. When the agent's effort is unobservable, the principal can optimize incentives by identifying the output that indicates the agent's effort and awarding the agent a bonus when higher output is achieved, relying on the assumption that higher output is more likely to occur under high effort than under low effort.

[5]In some settings with a high corruption risk, a government may find it prohibitively expensive to pay wages high enough to remove incentives for corruption. The government may then resort to the use of "capitulation wages" (Besley & McLaren 1993), which refers to wage incentives that are so low that they only attract corrupt individuals, a clear indicator of dysfunctional state institutions.

the *fair wage–effort hypothesis*, Akerlof & Yellen (1990) explain that "when people do not get what they deserve, they try to get even." This suggests that public officials are more inclined to be corrupt if they believe that they are receiving an unfair income. In theoretical terms, Laffont & Tirole (1993) show that it is possible to offer *capture-proof wages* that make the net benefit of collusion negative for the regulator (and its staff). Yet implementing such a solution in practice obviously depends on state budget.

The risk of capture may also depend on non-wage elements of the employment contract, such as tenure length. Using a repeated-game framework, David Martimort, one of the central authors in this literature, argues that capture can stem from agreements between public officials and firms (Martimort 1999). These agreements are not explicitly enforceable side contracts but arise informally from personal relationships, which are likely to be strengthened over time by repeated interactions between the regulatory agency and the firm. Furthermore, when a regulatory agency is first set up, its activities are closely monitored by the public and the government, but over time this scrutiny tends to become weaker, leaving the agency susceptible to unrelenting private pressure. If collusive agreements are secured through substantial corrupt benefits, Faure-Grimaud & Martimort (2003) explain, it is easier to keep such deals hidden if the exchange of benefits plays out over a longer time period. For these reasons, longer tenure terms for regulatory agency officials facilitate collusion and capture, even if political regimes and/or attitudes toward the regulator change.

Another non-wage benefit consists of post-public employment opportunities in the regulated firm, associated with the *revolving-door* phenomenon. This may function as a bribe or at least a quid pro quo if the promise of a better-paid job secures regulatory leniency toward the firm that is also the private sector employer (Dal Bó 2006, Estache & Wren-Lewis 2011). While the revolving door may offer some benefits as well, such as a stronger regulatory effort to signal qualifications (Che 1995) and higher investment due to more commitment (Salant 1995), weak regulation of this phenomenon can lead to regulatory capture.[6]

[6] Several governments have recognized the risk and imposed revolving-door regulations on certain agencies. For example, CRE, the French energy regulation agency, has a cooling-off period between public and private employment of three years. Similarly, the Italian regulators AEEGSI, AGCOM, and ART have a cooling-off period of two years (OECD 2016, p. 78).

3.2. Institutional organization and market structure

A second broad category of circumstances affecting risk of capture concerns the organization of regulatory agencies and of the market where regulated firms operate. Authors have examined various aspects of this, including the institutional independence of regulators, their internal lines of authority, and the nature of the authority in question, as well as the extent of competition in the regulated industry and market.

Institutional independence for the regulatory agency is associated with a lower risk of political interference, and this is especially important when politicians themselves are captured by industry or have shortsighted aims driven by populist ambitions (Coen & Thatcher 2008, Benitez et al. 2010). Institutional independence is also assumed to increase the regulator's discretion in applying and interpreting rules, which improves efficiency when the regulator is honest and competent. However, as pointed out by Thatcher (2002), Maskin & Tirole (2004), and Estache & Wren-Lewis (2011), among others, greater institutional independence also implies that the regulator is more exposed to collusion. Independence means fewer checks on performance, including with respect to post-public employment opportunities for officials, as mentioned above. In fact, several authors assert that a regulatory agency's discretionary authority, which follows from its institutional independence, is a central condition for collusive behavior. Susan Rose-Ackerman, one of the first to analyze how corruption depends on public power, explains how features of the authority influence the risk of capture. Officials who control a limited benefit, such as the allocation of a large public contract, are in a much better position to take bribes than those who control benefits that are available to all, such as access to electricity. When allocation of a public benefit is based upon discretionary judgment, as in complex circumstances that are difficult to regulate explicitly, there is greater risk of collusion than in cases where benefits are allocated nearly automatically, following clear criteria (Rose-Ackerman 1975, 2013).[7]

The risk of collusion between regulators and the subjects of regulation also depends on lines of responsibility within the regulatory agency. Estache & Martimort (2000) point to

[7] See also Spiller & Levy (1994), Aidt (2003), Estache & Wren-Lewis (2011), and Søreide & Rose-Ackerman (2018).

the relevance of each official's scope of authority. If regulatory powers are designed in such a way that each official possesses limited regulatory power and is only partially informed, the position of the individual official weakens, which decreases the benefit a firm can derive from capturing that official. Consistent with that argument, Laffont & Martimort (1999) explain that a government can reduce the risk of regulatory capture by splitting regulatory tasks among different agencies. Collusion with a firm occurs only when a regulator has private information about the firm. Such collusion is thwarted if another informed official or agency might reveal the private information. As long as there is no collusion between different regulators who hold sensitive information, a separation of responsibilities will reduce the risk of corruption. While tasks can be divided in different ways, it appears especially effective to maintain separation between the responsibility for routine inspections (ex-ante monitoring) and the responsibility for controls after incidents, such as accidents (ex-post monitoring). Hiriart et al. (2010) explain why combining the responsibility for ex-ante and ex-post monitoring allows collusive transactions to be spread out over several contingencies and over time, thus intensifying the problem of collusion. Although their conclusion hinges on the assumption that the transaction costs of collusion are convex (as is the case if, for example, the chance of being caught is higher when bribe transfers are larger), it is an argument against combining such responsibilities in one and the same regulatory agency.[8]

Because collusion happens in interaction between regulators and the subjects of regulation, features on the corporate side may also be relevant to the risks. Estache & Wren-Lewis (2011) note that intensified competition in oligopoly may increase a firm's incentives to capture the regulator, resulting in more capture. Olson (1965), on the other hand, argues that firms in competitive markets are *less* inclined to engage in such behavior, but that applies to cases in which they seek benefits for the industry as a whole. The more firms, the fewer benefits can be obtained by each firm, and therefore the incentive for each firm to seek benefits through capture decreases.[9] Intense competition reduces both the potential rents and each

[8]The argument that separation of powers leads to less capture is made by other economists too, including Rose-Ackerman (2013), Dewatripont & Tirole (1999), and Faure-Grimaud & Gromb (2004).

[9]See Estache & Wren-Lewis (2011) for more details.

firm's capacity to influence regulators.[10]

The extent of competition in a given market may affect regulators' enforcement practices as well. This may occur, for example, if politicians seek to shield large employers from sanctions and the regulator is not sufficiently independent to rebuff these attempts at interference. Such soft treatment of powerful firms may depend in part on a strong market situation, as described by Auriol et al. (forthcoming).[11] However, the literature is not conclusive when it comes to the relationship between market power and the general risk of regulatory capture.

4. Theoretical risk of prosecutorial capture

As described, there are many possible reasons for an overly industry-friendly enforcement climate or preferential treatment of specific corporate offenders. Let us now consider how the economic literature on regulatory capture that we reviewed sheds light on the specific risk of *prosecutorial* capture. Applying the findings in Section 3, we theorize that the risk of prosecutorial capture will be higher under the following circumstances:

- Prosecutors have long tenure lengths. Prosecutors without term limits have time to develop long-term relationships with firms, increasing the chance that they will be captured by the industry (Martimort 1999).
- A sole agency handles the entire settlement-based enforcement process. According to Estache & Martimort (2000) and Hiriart et al. (2010), the risk of capture is higher when a single agency is responsible for multiple tasks.
- There is very limited transparency around the enforcement and justification of sanctions. Transparency about structured settlements allows society to observe and to some extent monitor the outcomes of settlements. Lack of transparency allows self-interested prosecutors more freedom to pursue their own goals (Levine & Forrence 1990).
- Judicial oversight is weak. The trend toward non-trial resolutions decreases judicial oversight and increases information asymmetry in the resolution of corporate criminal

[10]Rose-Ackerman (1975, 2013), Mauro (1995), and Bardhan (1997).

[11]The issue of favoritism has also been studied by, for example, Rose-Ackerman (1975) for government contracting and Laffont & Tirole (1991) for auctions.

liability. This makes it more likely that prosecutors will be able to shirk their obligations and/or collude with firms during the negotiation stage (Levine & Forrence 1990). It also leads to further concentration of power and responsibility in the hands of the prosecutor (Estache & Martimort 2000).

- Prosecutors have broad discretion. Several studies, including Rose-Ackerman (1975), Rose-Ackerman (2013), and Aidt (2003), point to discretion as the necessary condition for capture.

The indicators on this list all refer to distinguishable features of criminal regulation and enforcement of corporate liability.[12] We now ask what they can tell us about the real-world risks of prosecutorial capture.

5. Assessing enforcement systems' vulnerability to capture

To estimate the actual risk of prosecutorial capture, we aim to quantify the indicators listed in the previous section and derive a measure that combines insights from the literature on regulatory capture. By identifying data for each of the five indicators, we can construct a ”risk of prosecutorial capture (RPC) index” and estimate actual risk at country level.

The turn from an analytic to an empirical dimension raises several concerns and caveats. First, it is essential to note that having vulnerable institutions does not necessarily mean that capture will occur. Capture depends on the individuals and the context. That should not prevent us from applying existing information to estimate *risk*, as long as the result is not interpreted as establishing the true extent of the problem, or – in cases of apparently low risk – as confirming the absence of problems.

Second, use of the indicators requires that we accept certain simplifications associated with the assumptions underlying the theoretical results. We need to treat each country's enforcement system as one unit; this means, for example, overlooking all nuances associated

[12]Many studies stress the importance of regulatory independence to free regulators from the possibility of political interference. However, independence from government can also reduce accountability and increase the possibility of capture by the private sector. Therefore, it is unclear in practice whether more independence reduces capture or not. For this reason, we leave it out of the construction of the index detailed in the next section.

with official tenure and focusing only on the term of the country's head prosecutor. This assumption is reasonable because in high-profile cases of corporate misconduct, the top prosecutor of a jurisdiction quite often leads the settlement process from the prosecution side. We also consider transparency in a one-dimensional manner by assuming that transparency implies greater oversight by society, which is not always the case.[13]

Third, even if the identified indicators are empirically distinguishable, the available data are never perfect. As a general problem, enforcement of criminal law is not readily subject to empirical research. There are no reliable data on the extent of crime, and countries are not very open about criminal law cases. Across jurisdictions there is scant information available on the use of non-trial resolutions in corporate liability cases. Most countries that regulate and enforce corporate criminal liability endorse the use of such enforcement modes, even if they have no proper principles for such enforcement.

5.1. Data

Keeping to the case of corporate bribery, we apply the results of the International Bar Association survey (Makinwa & Søreide 2018), mentioned in the introduction, which provides data on enforcement systems and practices in 66 countries.[14] Specifically, the survey contains data on prosecutorial discretion, judicial oversight, division of responsibility, and transparency (see the appendix to this article for the survey questions).

We could not include all 66 countries from the IBA survey, however, because some do not use non-trial resolutions, and among those that do, sufficient information on the indicators is not available for all. In certain countries like Italy, even though structured settlements do take place, the process is not formalized by law, and thus survey respondents reported that non-trial resolutions are not possible. We excluded all such countries. Considering only countries that formally allow non-trial resolutions, we gave preference to those with the fewest missing values for the relevant indicators. This dual selection process yielded a set of 26 countries:

[13] See Bac (2001) for an example of a theoretical set-up where transparency may in fact increase the problem of corruption, in contrast to what is normally expected.

[14] The survey is available at `https://www.oecd.org/corruption/anti-bribery/IBA-Structured-Settlements-Report-2018.pdf`.

Belgium, Canada, Chile, Colombia, Czech Republic, England and Wales, Estonia, Finland, France, Germany, Hungary, Israel, Japan, Latvia, Lithuania, Mexico, Netherlands, Norway, Poland, Russia, Serbia, Slovak Republic, Slovenia, Spain, Switzerland, and United States.

For these countries, we combined the survey results with data collected from various government sources, as described for each indicator below. The information on term limits was collected from relevant government documents for each of the countries included. Nevertheless, our data contain some missing values. In the tables below, if a column contains NR (no response) for a particular country, that indicator is left out of the mean for that country. For example, we do not have survey responses for "division of responsibility" and "judicial oversight" for Lithuania, so when we calculate the mean of the indicators, we divide by 3 instead of 5. This has an impact on our results, but given that the IBA survey is the only source of this kind of information, we have to accept some missing values.

5.2. Methodology for the index

We develop an index in two steps. The first step is to obtain an individual score for each country that reflects the vulnerability of its institutions. As described above, we used the literature on regulatory capture to develop a set of indicators. These are substitutable, that is, the risk associated with an increase in one indicator can be offset by a decrease in another indicator. For example, the increase in risk when the prosecutor is responsible for all aspects of the non-trial resolution can be offset by higher transparency around the settlement process. Therefore, following the guidelines of Mazziotta & Pareto (2013), we aggregate the indicators using a simple arithmetic mean (see Table 1).

The second step involves estimating the likelihood that individuals will engage in corruption, broadly speaking, in a given country. This aspect is important because even in vulnerable settings, capture also requires the willingness of individuals to engage in corrupt activities. To measure this dimension, we introduce the Corruption Perceptions Index, developed by Transparency International, which estimates the aggregate perception of corruption across countries. Finally, combining the two measures, we multiply the country's institutional vulnerability score, shown in Table 1 below, by its score on the CPI. Therefore, the index has the following form:

$$\text{Risk of prosecutorial capture} = \text{Weakness of institutions} \times \text{Likelihood that individuals will engage in corruption}$$

For each country, this functional form assigns the same weight to each indicator, the weight being equal to the country's CPI score. Therefore, in our index, a higher probability that individuals will engage in corruption (demonstrated by a higher CPI score) indicates a higher probability of each institutional weakness being exploited to obtain corrupt benefits.

5.3. Application of relevant IBA survey results

Using the available data, we compiled the facts most relevant to the list of indicators in Section 4. We then prepared the data for the index as shown below. For each question on the survey, countries receive a score of 1 if the response indicates higher risk and 0 if it indicates lower risk.

1. *Term limits.* The prosecutor's tenure is regulated by law in most countries, and its length differs across countries. For example, in the United States it is four years, while in Switzerland it is six years. Given these differences, we only consider whether the jurisdiction imposes a term limit (of any length) on the prosecutor's tenure. If the jurisdiction has no prosecutorial term limits, we give the country a score of 1, indicating increased risk of prosecutorial capture. If there is a term limit, we give a score of 0. We found that most countries in our sample do have term limits for their head prosecutors. However, Czech Republic, Germany, Japan, and Norway do not have term limits and therefore face higher risk that prosecutors may develop collusive relations with firms.
2. *Division of responsibility.* We use the IBA survey on structured settlements to quantify differences between jurisdictions on this indicator. In all jurisdictions that allow for non-trial resolutions, it is mainly up to the prosecutor to reach a settlement with the firm

in question. Monitoring whether the firm is complying with terms of the settlement, however, is a separate task, and arrangements for this vary across countries. Based on the theoretical work of Estache & Martimort (2000) and Hiriart et al. (2010), we assume that the risk of prosecutorial capture increases when the prosecutor is also tasked with monitoring compliance with the settlement terms. Countries with a score of 0 in Column 6 of Table 1 have an authority other than the prosecutor monitoring compliance with structured settlements. In the remaining countries, it is the prosecutor's duty to monitor compliance, and they receive a score of 1.

3. *Transparency.* This indicator is an aggregation of responses to four questions concerning transparency and disclosure of settlement details.[15] The questions have binary responses, and in each case we assign a score of 1 to the answer that represents higher risk. For example, if facts about the case in non-trial resolutions are not accessible to the public, indicating greater risk, we code the response as 1, but if the information is accessible we code 0. Using this approach across the four questions provides a score that is higher when the risk of prosecutorial capture is higher. Column 3 of Table 1 shows the aggregate transparency risk of the structured settlement process for each country. Czech Republic, Hungary, Mexico, Serbia, and Slovenia are the least transparent and have the highest transparency risk.

4. *Judicial oversight.* Similar to transparency, the indicator for judicial oversight is also an aggregated response to four questions on the IBA survey. These relate to court involvement in the settlement process, specifically the need to obtain court consent before engaging in negotiation, dropping charges, or engaging in plea bargaining. For each question, if the court has greater oversight over that aspect, we code the response as 0, while if there is no oversight, we code the response as 1. The mean of the four responses is shown in Column 4 of Table 1, where a higher mean value indicates lower judicial oversight and higher risk of prosecutorial capture. Belgium, the Netherlands, and Norway have the least oversight over the settlement process and the highest over-

[15] More details available in the appendix.

sight risk score. Except for Lithuania, which lacks data, all other countries in the sample have some sort of oversight over settlements, with Russia and Serbia having complete oversight over the process.

5. *Prosecutorial discretion.* We use the four questions related to prosecutorial discretion on the IBA survey to develop the prosecutorial discretion indicator. The questions ask whether the prosecutor has unfettered power to file charges, decide what charges to file, drop the charges, or engage in plea bargaining. If the response to any of these four questions is yes, we code it as 1, and we code 0 if the response is no. Column 5 of Table 1 shows the mean of the responses on the four questions about prosecutorial discretion. The results show that prosecutors have high discretion in Belgium, Finland, France, Hungary, Israel, Norway, and Serbia, and low discretion in England and Wales, Estonia, Poland, and the United States. Thus, even within the OECD countries there are huge differences in prosecutorial discretion. Søreide & Vagle (2020) discuss potential reasons for these differences across all the countries included in the IBA survey.

Table 1 below shows scores on the five indicators of institutional vulnerability for the 26 countries included in study.

6. Identifying capture-prone jurisdictions

Institutional vulnerability, as reflected in the Table 1 data, is not the only element that determines the risk of capture. Such risk also depends on whether or not officials and firms are inclined to exploit the vulnerabilities that exist. This inclination depends on a number of factors, and it varies across individuals in a society. For example, more corrupt officials will be more inclined to misuse their discretionary authority or to exploit a lack of oversight for corrupt gain. Yet it is reasonable to expect that overall willingness to engage in capture will be higher in societies where levels of corruption, broadly speaking, are high. Therefore, we use the estimated perceived extent of corruption in a society as a proxy for the inclination of individuals in that society to engage in capture. We then combine those estimates with the

Country	Term Limits	Transparency	Judicial Oversight	Prosecutorial Discretion	Div of Responsibility
Belgium	0	0.67	1.00	1.00	1.00
Canada	0	0	0.50	0.75	0
Chile	0	0.67	0.50	0.75	0
Colombia	0	0.33	0.75	0.25	NR
Czech Republic	1.00	1.00	0.50	0.50	0
England and Wales	0	0.33	0.25	0	1.00
Estonia	0	0	0.50	0	1.00
Finland	0	0.33	0.50	1.00	0
France	0	0	0.50	1.00	1.00
Germany	1.00	0	0.25	0.25	1.00
Hungary	0	1.00	0.50	1.00	1.00
Israel	NR	0.33	0.75	1.00	1.00
Japan	1.00	0.67	0.75	0.75	1.00
Latvia	0	0.33	0.50	0.50	0
Lithuania	0	0.33	NR	1.00	NR
Mexico	0	1.00	0.75	0.25	1.00
Netherlands	0	0.33	1.00	0.50	1.00
Norway	1.00	0.67	1.00	1.00	NR
Poland	0	0	0.50	0	0
Russia	0	0.67	0	0.50	1.00
Serbia	0	1.00	0	1.00	0
Slovak Republic	0	0	0.50	0.75	0
Slovenia	0	1.00	0.50	0.75	1.00
Spain	0	0.67	0.50	0.25	0
Switzerland	0	0.33	0.625	0.50	0
United States	0	0	0.50	0	0

Table 1: Country scores on institutional vulnerability indicators

mean scores for institutional vulnerability to gauge the risk of prosecutorial capture in each of the sample countries.

6.1. *Estimating corruption levels*

To estimate the extent of corruption we apply the widely cited Corruption Perceptions Index (CPI), which ranks 180 countries and territories (including all the countries in our study) by their perceived levels of public sector corruption.[16]

The CPI data are arranged in descending order, with a higher score representing less corruption. We do the following normalization:

$$CorrInd_i = 1 - \frac{CPI_i - Min(CPI)}{Max(CPI) - Min(CPI)} \tag{6}$$

where $Max(CPI)$ and $Min(CPI)$ are the maximum and minimum values of CPI for countries in our data set. The second part of the above expression normalizes the data between 0 and 1, and we subtract the value from 1 to arrange the data in ascending order, so that a higher value represents a higher perception of corruption. Table 2, column 3, shows the $CorrInd$ for all countries in our data set.

6.2. *Constructing the RPC index*

For each country, we then multiply the mean of the vulnerability indicators (Table 2, column 2) by the estimate of society-wide corruption (column 3) to derive the RPC index (column 4). We use the following formula:

$$\begin{aligned} RPC_i = CorrIndex_i \times Mean(&Discretion_i + JudicialOversightRisk_i + Division\_Responsibility_i \\ &+ TransparencyRisk_i + TermLimitsRisk_i) \end{aligned} \tag{7}$$

Based on this methodology, Table 2 presents the risk of prosecutorial capture for each

[16] Details on the index are available at https://www.transparency.org/en/cpi/2019

country in our sample, listed in order of descending risk.

Country	Mean of indicators	CorrIndex	RPC
Mexico	0.60	0.98	0.59
Hungary	0.70	0.72	0.51
Russia	0.43	1.00	0.43
Israel	0.77	0.45	0.35
Serbia	0.40	0.81	0.32
Czech Republic	0.60	0.52	0.31
Slovenia	0.65	0.45	0.30
Colombia	0.33	0.84	0.28
Lithuania	0.44	0.45	0.20
Japan	0.83	0.22	0.18
Slovak Republic	0.25	0.62	0.16
France	0.50	0.29	0.15
Latvia	0.27	0.52	0.14
Belgium	0.73	0.19	0.14
Chile	0.38	0.33	0.13
Spain	0.28	0.41	0.12
Estonia	0.30	0.22	0.07
Germany	0.50	0.10	0.05
Poland	0.10	0.48	0.05
England and Wales	0.32	0.15	0.05
Canada	0.25	0.15	0.04
Netherlands	0.57	0.07	0.04
Norway	0.92	0.03	0.03
United States	0.10	0.29	0.03
Switzerland	0.29	0.02	0.01
Finland	0.37	0	0
Mean			0.18

Table 2: Risk of prosecutorial capture in 26-country sample

A high RPC implies more serious institutional weaknesses associated with the enforcement of corporate criminal liability, as well as pervasive corruption in the society at large. Translated into behavioral terms, this implies a greater risk that representatives of the prosecutor's office will operate with a view to how their decisions may benefit themselves and the corporate defendant, even if such benefits come at the expense of society. As noted above, firms may try to capture the prosecutor through future job offers or even outright bribery. In countries where the RPC is high, we may surmise that firms are more likely to offer such benefits and officials are more likely to accept, compared to societies where the RPC is low.

Among the countries included in the sample, the countries at greatest risk of prosecutorial capture are Mexico and Hungary. Those at least risk are Finland, Switzerland, the United States, and Norway. Finland is assigned a zero value for the RPC. That does not mean there is zero risk; it simply means that Finland has the smallest RPC relative to other countries in our sample. Figure 1 shows the relative risk illustrated on a map. Higher numbers (shown darker red) represent higher risk.

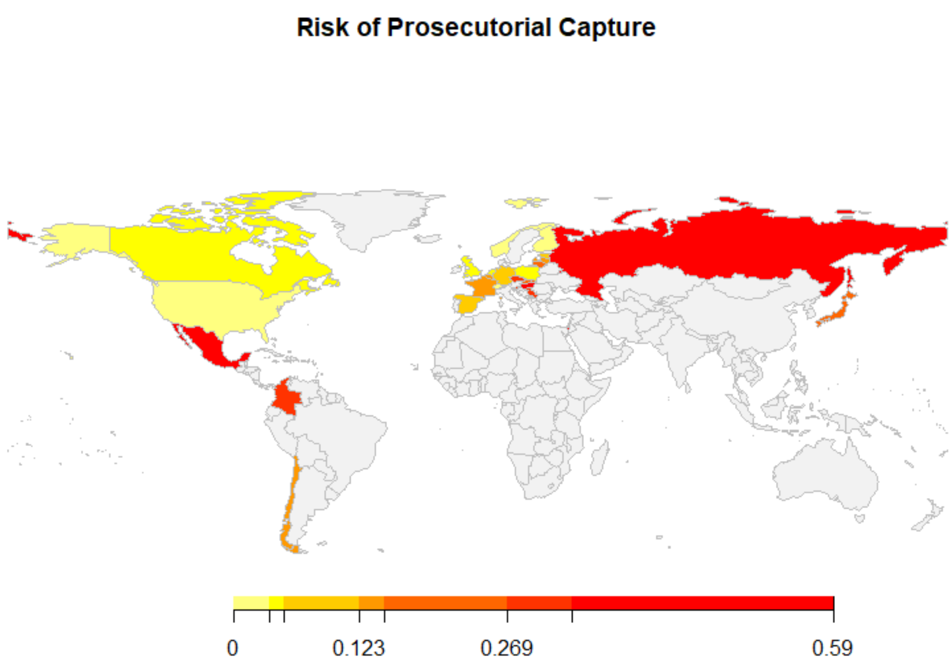


Fig. 1. Relative risk of prosecutorial capture

6.3. Correlation with enforcement action

A further question is whether there is reason to expect the risk of prosecutorial capture to lead to actual capture. A country may have deep institutional vulnerabilities and serious problems with corruption, but if no corporate liability enforcement cases are pursued, prosecutorial capture will not be a concern. In reality, the absence of enforcement cases might be the result of *complete* capture if suspected corporate crime is not even investigated because the prosecutor's office is controlled by corporate interests that profit from illegal business practices. This state of affairs would not be likely to continue unless there were a situation of political capture as well (see Section 6). Still, a low level of enforcement activity may be a result of prosecutorial capture if investigators repeatedly are induced to close cases on grounds that the evidence is too weak. Therefore, as the next step in our exercise, we narrow the interpretation of RPC to an estimated risk of capture *per case that is subject to law enforcement*, which we refer to as RPC/e.

Drawing data from the TRACE Global Enforcement Report 2019,[17] we divide the countries in our sample into three categories based on the number of enforcement actions up until 2019. Countries with more than ten enforcement actions are classified as high enforcers; countries with ten or fewer enforcement actions are classified as low enforcers; and countries that have not engaged in any enforcement actions are classified as non-enforcers. The data are too limited to allow any interpretation as to why a jurisdiction's level of enforcement activity is high or low.

Table 3 shows that the countries with the highest number of enforcement actions – Germany, the United States, England and Wales, and the Netherlands – are among those with the lowest risk of prosecutorial capture per case pursued. In addition to having extensive experience with cases of this sort, a measure on which the United States leads, these countries also have strong legal traditions. Germany, England and Wales, and the Netherlands all fall in the highest quartile on the World Justice Project 2020 Rule of Law index.[18]

At the other end of the scale, the countries highlighted red in Table 3 – Mexico, Israel, Colombia, and Japan – have the highest risk of prosecutorial capture per case enforced ($RPC_i^* \geq 0,18$) among countries in our sample that have enforcement activity.

[17] Available at https://www.traceinternational.org/publications

[18] https://worldjusticeproject.org/sites/default/files/documents/WJP-ROLI-2020-Online_0.pdf

Country	RPC/e	Enforcement Actions	Enforcement Activity
Mexico	0.59	3	Low
Israel	0.35	6	Low
Colombia	0.28	1	Low
Japan	0.18	5	Low
France	0.15	4	Low
Latvia	0.14	1	Low
Belgium	0.14	1	Low
Spain	0.12	2	Low
Germany	0.05	19	High
Poland	0.05	1	Low
England and Wales	0.05	44	High
Canada	0.04	7	Low
Netherlands	0.04	14	High
Norway	0.03	5	Low
United States	0.03	283	High
Switzerland	0.01	9	Low
Hungary	0.51	0	Non-enforcer
Russia	0.43	0	Non-enforcer
Serbia	0.32	0	Non-enforcer
Czech Republic	0.31	0	Non-enforcer
Slovenia	0.30	0	Non-enforcer
Lithuania	0.20	0	Non-enforcer
Slovak Republic	0.16	0	Non-enforcer
Chile	0.13	0	Non-enforcer
Estonia	0.07	0	Non-enforcer
Finland	0	0	Non-enforcer

Table 3: Risk of prosecutorial capture per enforcement action

6.4. Indicative results

This exercise suggests that some jurisdictions are more exposed to prosecutorial capture than others, given the characteristics of their enforcement systems and the risk of corruption in society, when it comes to the specific form of crime considered for this study, corporate bribery.

Our approach makes it easier to see why countries with the highest levels of perceived corruption society-wide are not necessarily the ones with the highest risk of prosecutorial capture. Some corruption-ridden countries' enforcement systems may have arrangements in place that, according to criteria in the literature, curb the risk of capture. Latvia and Poland, for example, might fall in this category, as they have relatively low RPC despite high levels of perceived corruption. On the other hand, Israel and Japan are examples of countries that exhibit a higher risk of prosecutorial capture than what their perceived levels of corruption might suggest.

Generally speaking, countries with higher levels of enforcement activity tend to have lower RPC values. This is a promising result, especially in view of the increasing use of non-trial resolutions in corporate bribery cases. Contrary to what one might expect, intensified use of such a flexible enforcement practice does not necessarily bring a higher risk of capture, but there are too few observations to support clear conclusions. Instead, the estimates may help policymakers understand what kinds of institutions are most capture-prone and what can be done to prepare for greater use of settlements. It should be kept in mind that the true risk level depends on the actual likelihood of individuals behaving in a corrupt manner, and this remains unknown, despite the use of data on estimated perceived corruption. Even if a country has some institutional weaknesses, these indicators of vulnerability cannot be read as reflections of the actual extent of prosecutorial capture.

As far as the interpretation of empirical results, there are reasons to be cautious. The IBA survey, which provides facts about country enforcement systems, relies on information provided by one respondent per country. Even if this respondent is a lawyer who describes known features of the country's enforcement system and puts his/her name on the report, some parts of the information provided remain subject to interpretation. This is especially true with respect to the use of non-trial resolutions in settings where no clear rules exist, and this is relevant to the estimate of the prosecutor's discretionary authority. Also, ”the prosecutor” is treated as if it were a single institution, but in practice, several institutions may have different prosecutorial responsibilities, all relevant in this context. In some countries such as Germany, enforcement patterns and practices vary across federal states. It might be unfair to treat different institutions as if they were one unit and subject to the same risk, when in reality there is variation between them. Still, as we are mainly concerned with generic aspects of the prosecutor as a central part of the enforcement system, we believe that our analysis captures important factors and risks. In sum, the specific institutional context must be taken into account in interpreting and applying our results, and if these results are used as a reason for reform, they ought to be combined with other facts and indicators.

7. The broader context: politicians and firms

This study investigates the risk of capture of a specific institution, the prosecutor's office, and examines features of this institution that may affect the risk. However, the prosecutor's office is not isolated from the overall set of institutions and activities in society. Given results in the literature on regulation, the prosecutor's exposure to external pressures and capture can be expected to correlate inversely with the functioning of political accountability mechanisms, the efficiency of governance institutions, the extent of press freedom, and the general integrity of law enforcement institutions. While a full review of external and macro-level factors relevant to capture is beyond the scope of this article, we mention here some concerns with respect to politicians and firms that are addressed in the reviewed literature.

Most importantly, prosecutors are not always as independent as their constitutional standing might suggest (Van Aaken et al. 2004, Hayo & Voigt 2007). The institution may be subject to pressure from the political level. An example is a 2006 case in the United Kingdom in which then Prime Minister Tony Blair ordered the UK Serious Fraud Office (the public prosecutor in cases of this sort) to close the investigation against British Aerospace, a defense sector producer. A similar situation unfolded in Canada in 2019 when Prime Minister Justin Trudeau sought to protect a company from his home region from being charged and brought to court for bribery.[19] Such concerns are especially valid when the prosecutors are appointed through a political process, as they are in the United States.[20] While the behavior of individual elected officials might be influenced by personal connections and exchange of

[19]See *Swiss Info* on 9 March 2019 'Corruption: Is Trudeau like Blair?'by Mark Pieth. For details on the case in Canada, see (Dion 2019); on the UK case, see (Feinstein 2011)

[20]As shown by Maskin & Tirole (2004), appointed officials, in this case appointed prosecutors, who would like to please their principals are less likely to say no to political intervention, thereby leading to prosecutorial capture.

undue benefits, certain circumstances may lead a government, more broadly, to defend its interference in the prosecutor's work. The government may find it politically impossible to accept a heavy penalty – if, for example, the corporate defendant is an important service provider (Sorkin 2010) or an important employer (Donahue 1989, Boycko et al. 1996), or, more generally, if the incumbent regime places substantial weight on producer surplus. In the latter case, the trade-off between the value of efficient crime control and the value of securing a high producer surplus might imply a higher risk of government interference if there are few or no harmful consequences of the crime domestically. Frequently, Auriol et al. (forthcoming) explain, corporate bribery will be treated more softly if bribes are paid abroad than if they are paid domestically.

For several reasons, the risk of political interference in the prosecutor's work may depend on the corporate defendant's market situation. If the interference is the result of a firm's influence at the political level, the benefits shared with politicians – in terms of campaign finance, bribes, compensated seats on a company board, or well-paid jobs – may depend on the firm's ability to make a profit, and thus on market concentration (Ades & Tella 1999, Søreide 2008). Olson (1965) adds nuance to this point by explaining why competition in markets reduces the risk of industry lobbyism and capture by broad corporate interests. As the number of firms increases, any political decision that benefits all firms will reduce the benefits *per firm*, which eventually reduces each firm's incentive to invest in such rent-seeking. Nonetheless, individual firms may have an incentive to seek narrow benefits for themselves and may succeed in securing profitable special treatment (Harstad & Svensson 2011).[21] The line between lobbyism and bribery is blurred when it comes to some forms of financial support to political parties, especially if campaign finance is offered in exchange for a favorable political policy (Fisman 2015).[22] When an incumbent regime or individual elected official seeks to shield a corporate offender from investigation and severe sanctions – for whatever reason – their likelihood of succeeding will depend on factors such as those described in this analysis.

[21] For corporate profits and corruption, see also Rose-Ackerman (1975, 2013), Mauro (1995), and Bardhan (1997). Additional concerns are associated with state ownership in the market, as discussed by Martimort & Straub (2009) and Sykes (1999).

[22] For an early analysis of the economics of campaign financing, see Welch (1974).

In jurisdictions with few measures in place to secure legitimate and fair enforcement in cases that end with a non-trial resolution, the opening for political interference in the management of cases will be higher because it will be harder for observers to identify deviation from the norm.

8. Conclusion

At a time when many governments have just started to hold corporations criminally liable for their misconduct, while those that are more experienced with such regulation intensify their use of non-trial resolutions, there has been insufficient debate about the prosecutor's ability to withstand pressure from accused corporations and politicians allied with them.

Prosecutors are the ones who lead investigations, decide on charges, consider whether a defendant's self-reporting and cooperation qualify for penalty discounts, propose a settlement that may end the case, or decide to bring the case to trial. Even the most powerful corporate leaders will feel threatened under such circumstances, as the outcome of the case may affect their firm's performance and reputation. With incomplete information about the prosecutor's facts, they cannot know whether the case will lead to prosecution of employees, possibly including themselves. The possibility that some of these corporate figures may try to influence the prosecutor with threats or offers, or seek protection by consulting their friends in politics, cannot be ruled out. In most countries, few rules regulate the prosecutor's use of non-trial resolutions for efficient enforcement, and far less information is released for public scrutiny than is the case with trials. Even if we expect the great majority of prosecutors to be committed and honest, those who are inclined to give in to pressures will easily find ways to avoid accusations.

This article examines the likelihood that prosecutorial institutions will withstand the risk of capture. By reviewing the economic literature on capture of other sorts of regulatory bodies, we identified factors relevant to understanding prosecutors' exposure to such risk. We then compiled available data for a limited sample of countries with respect to (a) how they enforce their corporate bribery regulations and the vulnerability of their institutions, and

(b) perceived levels of corruption society-wide. Combining these data, we listed jurisdictions according to their relative risk of prosecutorial capture, or RPC. We then introduced data on each country's number of enforcement actions. The results show that there is no reason to expect jurisdictions with the highest enforcement activity to be the most exposed to capture. These countries may have put more robust measures in place to reduce the risk of undue influence on their enforcement cases. Also, considered in isolation, the extent of corruption in society is an inadequate indicator of risk. Countries with higher perceived levels of corruption may have instituted measures to reduce the risk of capture, while countries with lower levels of corruption may have a lax attitude toward such concerns. In addition to the features of prosecutor institutions, other aspects of society may intensify the risk, including low political accountability, political disinclination to sanction corporate offenders for certain forms of offenses, and markets dominated by a handful of powerful firms.

The approach we applied does not inform about the actual extent of capture in a given country; it merely provides an estimate of the *risk* of capture. It thus points to a set of countries for which we have sufficient information to say that they ought to introduce stronger checks on this area of law enforcement. The analysis may also serve as a tool for reform-friendly governments, and in this sense the discussion is timely. In recent years, several governments have strengthened their regulations on enforcement of corporate liability, including France, Australia, and Canada, and in 2021 the OECD Working Group on Bribery intends to present recommendations for the use of non-trial resolutions in such cases.[23] Although that working group focuses solely on bribery, governments will consider its recommendations on NTRs as guidance for their procedural regulation with respect to all sorts of corporate crime. The question is whether (and which) governments will appreciate that guidance, since a more principled use of non-trial resolutions will curb the flexibility that now allows them to shield some corporations from heavy sanctions.

[23] See the OECD website for information about the Review of the 2009 Recommendations: http://www.oecd.org/corruption/oecdantibriberyconvention.htm

References

Ades, A. & Tella, R. D. (1999), 'Rents, competition, and corruption', *The American Economic Review* **89**(4), 982–993.

Aidt, T. S. (2003), 'Economic analysis of corruption: A survey', *The Economic Journal* **113**(491), F632–F652.

Akerlof, G. A. & Yellen, J. L. (1990), 'The fair wage-effort hypothesis and unemployment', *The Quarterly Journal of Economics* **105**(2), 255–283.

Alexander, C. R. & Cohen, M. A. (2015), 'The evolution of corporate criminal settlements: An empirical perspective on non-prosection, deferred prosecution, and plea agreements', *Am. Crim. L. Rev.* **52**, 537–593.

Arlen, J. (2016), 'Prosecuting Beyond the Rule of Law: Corporate Mandates Imposed through Deferred Prosecution Agreements', *Journal of Legal Analysis* **8**(1), 191–234.

Arlen, J. & Kraakman, R. (1997), 'Controlling corporate misconduct: An analysis of corporate liability regimes', *NYUL Rev.* **72**, 687–779.

Auriol, E., Hjelmeng, E. & Søreide, T. (forthcoming), 'The economics of corporate liability and enforcement', *Under review* .

Bac, M. (2001), 'Corruption, connections and transparency: Does a better screen imply a better scene?', *Public Choice* **107**(1), 87–96.

Bardhan, P. (1997), 'Corruption and development: A review of issues', *Journal of Economic Literature* **35**(3), 1320–1346.

Becker, G. S. & Stigler, G. J. (1974), 'Law enforcement, malfeasance, and compensation of enforcers', *The Journal of Legal Studies* **3**(1), 1–18.

Benitez, D., Estache, A. & Søreide, T. (2010), Dealing with politics for money and power in infrastructure, Technical Report Working Paper 5455, Chr. Michelsen Institute, Bergen.

Besley, T. & McLaren, J. (1993), ‘Taxes and bribery: The role of wage incentives’, *The Economic Journal* **103**(416), 119–141.

Boycko, M., Shleifer, A. & Vishny, R. W. (1996), ‘A theory of privatisation’, *The Economic Journal* **106**(435), 309–319.

Buell, S. & Arlen, J. (2020), ‘The law of corporate investigations and the global expansion of corporate criminal enforcement’, *Southern California Law Review* **93**, 697.

Che, Y.-K. (1995), ‘Revolving doors and the optimal tolerance for agency collusion’, *The RAND Journal of Economics* **26**(3), 378–397.

Coen, D. & Thatcher, M. (2008), ‘Network governance and multi-level delegation: European networks of regulatory agencies’, *Journal of Public Policy* **28**(1), 47–71.

Could, D. J. & Amaro-Reyes, J. A. (1983), ‘The effects of corruption on administrative performance: Illustration from developing countries’, *World Bank Staff Working Paper* (580).

Dal Bó, E. (2006), ‘Regulatory capture: A review’, *Oxford Review of Economic Policy* **22**(2), 203–225.

Damania, R., Fredriksson, P. G. & Mani, M. (2004), ‘The persistence of corruption and regulatory compliance failures: Theory and evidence’, *Public Choice* **121**(3/4), 363–390.

Dewatripont, M. & Tirole, J. (1999), ‘Advocates’, *Journal of Political Economy* **107**(1), 1–39.

Dion, M. (2019), Trudeau II Report, Technical report, Office of the Conflict of Interest and Ethics Commissioner, Parliament of Canada.

Donahue, J. D. (1989), *The Privatization Decision*, New York: Basic Books.

Easterbrook, F. H. (1992), ‘Plea bargaining as compromise’, *The Yale Law Journal* **101**(8), 1969–1978.

Estache, A. & Martimort, D. (2000), Transaction costs, politics, regulatory institutions and regulatory outcomes, ULB Institutional Repository 2013/44072, ULB – Universite Libre de Bruxelles.

Estache, A. & Wren-Lewis, L. (2011), *Anti-corruption policy in theories of sector regulation*, Edward Elgar Cheltenham, UK, chapter 9.

Faure-Grimaud, A. & Gromb, D. (2004), 'Public Trading and Private Incentives', *The Review of Financial Studies* **17**(4), 985–1014.

Faure-Grimaud, A. & Martimort, D. (2003), 'Regulatory inertia', *The RAND Journal of Economics* **34**(3), 413–437.

Feinstein, A. (2011), *The shadow world: Inside the global arms trade*, Macmillan.

Firth, M., Rui, O. M. & Wu, W. (2011), 'The effects of political connections and state ownership on corporate litigation in China', *The Journal of Law Economics* **54**(3), 573–607.

Fisman, R. (2015), Political connections and commerce: a global perspective, *in* S. Rose-Ackerman & P. Lagunes, eds, 'Greed, Corruption, and the Modern State: Essays in Political Economy', Edward Elgar Publishing.

Forst, B. & Brosi, K. B. (1977), 'A theoretical and empirical analysis of the prosecutor', *The Journal of Legal Studies* **6**(1), 177–191.

Garrett, B. (2014), *Too Big to Jail: How Prosecutors Compromise with Corporations*, Harvard University Press.

Gloppen, S., ed. (2016), *Courts and power in Latin America and Africa*, Basingstoke: Palgrave MacMillan.

Grossman, G. M. & Katz, M. L. (1983), 'Plea bargaining and social welfare', *The American Economic Review* **73**(4), 749–757.

Harstad, B. & Svensson, J. (2011), 'Bribes, lobbying, and development', *American Political Science Review* **105**(1), 46–63.

Hawley, S., King, C. & Lord, N. (2020), Justice for whom? the need for a principled approach to deferred prosecution agreements in england and wales, *in* T. Søreide & A. Makinwa, eds, 'Negotiated Settlements in Bribery Cases: A Principled Approach', Edward Elgar Publishing.

Hayo, B. & Voigt, S. (2007), 'Explaining de facto judicial independence', *International Review of Law and Economics* **27**(3), 269–290.

Hiriart, Y., Martimort, D. & Pouyet, J. (2010), 'The public management of risk: Separating ex ante and ex post monitors', *Journal of Public Economics* **94**(11-12), 1008–1019.

Hölmstrom, B. (1979), 'Moral hazard and observability', *The Bell Journal of Economics* **10**(1), 74–91.

Ivory, R. & Søreide, T. (2020), 'The international endorsement of corporate settlements in foreign bribery cases', *International and Comparative Law Quarterly* pp. 945–978.

Kangt, M. S. & Shepherd, J. M. (2011), 'The partisan price if justice: an empirical analysis of campaign contributions and judicial decisions', *New York University Law Review* **86**(1).

Laffont, J.-J. & Martimort, D. (1999), 'Separation of regulators against collusive behavior', *The RAND Journal of Economics* **30**(2), 232–262.

Laffont, J.-J. & Martimort, D. (2002), *The Theory of Incentives: The Principal-Agent Model*, Princeton University Press.

Laffont, J.-J. & Tirole, J. (1991), 'Auction design and favoritism', *International Journal of Industrial Organization* **9**(1), 9 – 42.

Laffont, J.-J. & Tirole, J. (1993), *A theory of incentives in procurement and regulation*, MIT press.

Levine, M. E. & Forrence, J. L. (1990), 'Regulatory capture, public interest, and the public agenda: Toward a synthesis', *Journal of Law, Economics, Organization* **6**, 167–198.

Makinwa, A. & Søreide, T. (2018), 'Structured criminal settlements: Towards global standards in structured criminal settlements for corruption offences', *The International Bar Association (IBA), Anti-Corruption Committee, Structured Criminal Settlements Sub-Committee* .

Martimort, D. (1999), 'The life cycle of regulatory agencies: Dynamic capture and transaction costs', *The Review of Economic Studies* **66**(4), 929–947.

Martimort, D. & Straub, S. (2009), 'Infrastructure privatization and changes in corruption patterns: The roots of public discontent', *Journal of Development Economics* **90**(1), 69 – 84.

Maskin, E. & Tirole, J. (2004), 'The politician and the judge: Accountability in government', *American Economic Review* **94**(4), 1034–1054.

Mauro, P. (1995), 'Corruption and Growth*', *The Quarterly Journal of Economics* **110**(3), 681–712.

Mazziotta, M. & Pareto, A. (2013), 'Methods for constructing composite indices: One for all or all for one', *Rivista Italiana di Economia Demografia e Statistica* **67**(2), 67–80.

Miceli, T. J. (1996), 'Plea bargaining and deterrence: An institutional approach', *European Journal of Law and Economics* **3**(3), 249–264.

Moore, M. S. (2010), *Placing Blame: A Theory of the Criminal Law*, Oxford University Press, USA.

OECD (2016), *Being an Independent Regulator*.

OECD (2019), Resolving foreign bribery cases with non-trial resolutions, Technical report, Organisation for Economic Co-operation and Development, Paris.

Olson, M. (1965), *The Logic of Collective Action: Public Goods and the Theory of Groups, Second Printing with a New Preface and Appendix*, Vol. 124, Harvard University Press.

Palmier, L. (1983), 'Bureaucratic corruption and its remedies', *Corruption: Causes, consequences and control* pp. 207–219.

Pieth, M. (2020), Negotiating settlements in a broader law enforcement context, *in* T. Søreide & A. Makinwa, eds, 'Negotiated Settlements in Bribery Cases: A Principled Approach', Edward Elgar Publishing.

Pieth, M. & Ivory, R., eds (2011), *Corporate Criminal Liability: Emergence, Convergence, and Risk*, Springer.

Polinsky, A. M. & Shavell, S. (2000), 'The economic theory of public enforcement of law', *Journal of Economic Literature* **38**(1), 45–76.

Posner, R. A. (1973), 'An economic approach to legal procedure and judicial administration', *The Journal of Legal Studies* **2**(2), 399–458.

Reinganum, J. F. (1988), 'Plea bargaining and prosecutorial discretion', *The American Economic Review* **78**(4), 713–728.

Rose-Ackerman, S. (1975), 'The economics of corruption', *Journal of Public Economics* **4**(2), 187 – 203.

Rose-Ackerman, S. (2013), *Corruption: A Study in Political Economy*, Academic Press.

Ross, S. A. (1973), 'The economic theory of agency: The principal's problem', *The American Economic Review* **63**(2), 134–139.

Salant, D. J. (1995), 'Behind the revolving door: A new view of public utility regulation', *The RAND Journal of Economics* **26**(3), 362–377.

Shapiro, C. & Stiglitz, J. E. (1984), 'Equilibrium unemployment as a worker discipline device', *The American Economic Review* **74**(3), 433–444.

Shughart, W. F. & Thomas, D. W. (2019), Interest groups and regulatory capture, *in* R. D. Congleton, B. Grofman & S. Voigt, eds, 'The Oxford Handbook of Public Choice, Volume 1', Oxford University Press.

Søreide, T. & Vagle, K. (2020), Prosecutors' discretionary authority in efficient law enforcement systems, *in* T. Søreide & A. Makinwa, eds, 'Negotiated Settlements in Bribery Cases: A Principled Approach', Edward Elgar Publishing.

Sorkin, A. R. (2010), *Too big to fail: The inside story of how Wall Street and Washington fought to save the financial system–and themselves*, Penguin.

Spier, K. E. (1992), 'The dynamics of pretrial negotiation', *The Review of Economic Studies* **59**(1), 93–108.

Spiller, P. & Levy, B. (1994), 'The institutional foundations of regulatory commitment: A comparative analysis of telecommunications regulation', *Journal of Law, Economics and Organization* **10**, 201–46.

Sykes, A. (1999), 'The (limited) role of regulatory harmonization in international goods and services markets', *Journal of International Economic Law* **2**(1), 49–70.

Søreide, T. (2008), 'Beaten by bribery: Why not blow the whistle?', *Journal of Institutional and Theoretical Economics (JITE) / Zeitschrift für die gesamte Staatswissenschaft* **164**(3), 407–428.

Søreide, T. & Rose-Ackerman, S. (2018), Corruption in state administration, *in* J. Arlen, ed., 'Research Handbook on Corporate Crime and Financial Misdealing', Edward Elgar Publishing.

Søreide, T. & Vagle, K. (forthcoming), 'Settlements in corporate bribery cases: An illusion of choice?', *TBD* .

Thatcher, M. (2002), 'Delegation to independent regulatory agencies: Pressures, functions and contextual mediation', *West European Politics* **25**(1), 125–147.

Van Aaken, A., Salzberger, E. & Voigt, S. (2004), 'The prosecution of public figures and the separation of powers. confusion within the executive branch–a conceptual framework', *Constitutional Political Economy* **15**(3), 261–280.

Welch, W. P. (1974), 'The economics of campaign funds', *Public Choice* **20**(1), 83–97.

A. Appendix

A.1. Solution of the model

Assuming that a fine imposed on a corporate offender is costlessly passed through to consumers, the welfare function is given as:

$$EW = (1-\nu)\frac{1}{2\beta} + \nu\left[\frac{(1+\Delta_c)^2}{2\beta} + \xi f - \xi f - (1+\lambda)\Delta_c - \xi b f\right] \tag{8}$$

such that

$$\frac{(1+\Delta_c)^2}{2\beta} - \xi f \geq 0 \tag{9}$$

$$f - k \geq 0 \tag{10}$$

where the prosecutor chooses f. The Lagrangian becomes:

$$\mathcal{L} = (1-\nu)\frac{1}{2\beta} + \nu\left[\frac{(1+\Delta_c)^2}{2\beta} - (1+\lambda)\Delta_c - \xi b f\right] + \Omega_1\left[\frac{(1+\Delta_c)^2}{2\beta} - \xi f\right] + \Omega_2[f-k]$$

The foc is:

$$-\xi b f \nu - \xi\Omega_1 + \Omega_2 = 0 \tag{11}$$

When $b = 0$, we obtain two cases:

Case I: $\Omega_1 = 0, \Omega_2 = 0$

This implies that $f > k$ and $\frac{(1+\Delta_c)^2}{2\beta} > \xi f$.

Case II: $\Omega_1 > 0, \Omega_2 > 0$

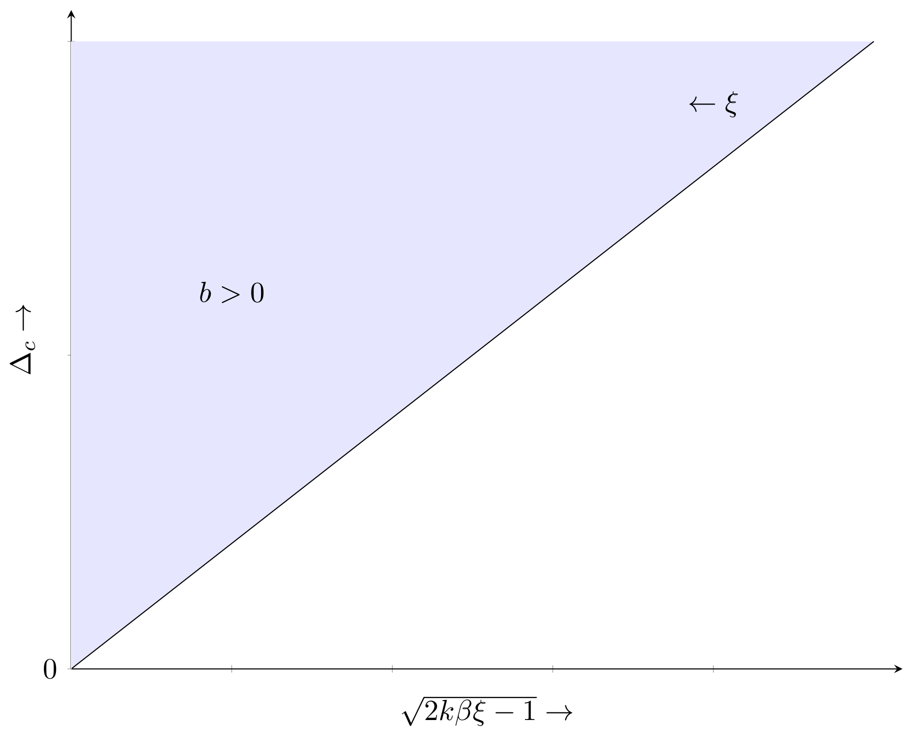
In this case, $f = k$ and $\frac{(1+\Delta_c)^2}{2\beta} = \xi k$. But this case is a point case and is therefore ignored.

When $b > 0$, we obtain only one case:

Case III: $\Omega_1 = 0, \Omega_2 > 0$

This implies that $f = k$ and $\frac{(1+\Delta_c)^2}{2\beta} > \xi k$.

The solution of the optimization problem can be represented in the figure below:



A.2. Prosecutorial discretion

Our index includes a measure of prosecutorial discretion, captured by the following four questions on the IBA survey:

Do prosecutors have unfettered discretion in regard to the following:

- *Deciding whom to charge with a crime? (Q 2.1.1)*
- *Deciding what charges to file? (Q 2.1.2)*
- *Deciding whether to drop charges? (Q 2.1.3)*

- *Deciding whether or not to plea bargain? (Q 2.1.4)*

For each question, the response was coded as 1 if the prosecutor has unfettered discretion and as 0 if the prosecutor does not have unfettered discretion. Therefore, a higher mean represents higher discretion. We obtain the following table:

Country	Q 2.1.1	Q 2.1.2	Q 2.1.3	Q 2.1.4	MeanDiscretion
Belgium	1	1	1	1	1.00
Canada	1	0	1	1	0.75
Chile	1	1	1	0	0.75
Colombia	0	0	0	1	0.25
Czech Republic	0	1	0	1	0.50
England and Wales	0	0	0	0	0
Estonia	0	0	0	0	0
Finland	1	1	1	1	1.00
France	1	1	1	1	1.00
Germany	0	1	0	0	0.25
Hungary	1	1	1	1	1.00
Israel	1	1	1	1	1.00
Japan	1	1	1	0	0.75
Latvia	0	0	1	1	0.50
Mexico	0	1	0	0	0.25
Netherlands	0	1	1	0	0.50
Norway	1	1	1	1	1.00
Poland	0	0	0	0	0
Russia	0	0	1	1	0.50
Serbia	1	1	1	1	1.00
Slovak Republic	0	1	1	1	0.75
Slovenia	1	1	1	0	0.75
Spain	0	0	0	1	0.25
Switzerland	0	1	0	1	0.50
United States	0	0	0	0	0

A.3. Judicial oversight

To capture judicial oversight, we look at responses to the following four questions on the IBA survey:

Please explain the role of the courts with respect to any structured settlement reached:

- *Is it necessary to obtain the court's consent before engaging in a settlement negotiation? (Q 3.3.1.1)*

■ *Does the court have any other involvement before the settlement has been reached? (Q 3.3.1.2)* Please explain/provide further information:

■ *Deciding whether to drop charges? (Q 3.3.2.1)* Please explain/provide further information:

■ *Deciding whether or not to plea bargain? (Q 3.3.2.2)*

For each question, the response was coded as 1 if the response was no and as 0 if the response was yes. A higher score therefore means less oversight. Furthermore, for Question 3.3.2.1, the respondent from Switzerland answered a conditional yes, so we coded 0.5 for that question. There were no responses to these questions for Lithuania, so that row is marked NR. We obtain the following table:

A.4. Division of responsibility

The respondents were asked:

■ *Which authority is involved in determining whether the settling company has properly observed the terms of the settlement?*

☐ A judge

☐ Another authority. Please specify:

Please explain/provide further information:

The responses to this question were coded as 0 if it is a judge's responsibility to monitor compliance. On the other hand, if the response was another authority and the respondents specified that it is the prosecutor's responsibility to monitor compliance, the response was coded as 1; thus 1 indicates a higher risk of prosecutorial capture. Non-responses were coded as NR. We obtain the following table:

Country	Q 3.3.1.1	Q 3.3.1.2	Q 3.3.2.1	Q 3.3.2.2	MeanOversight
Belgium	1	1	1	1	1.00
Canada	1	1	0	0	0.50
Chile	1	1	0	0	0.50
Colombia	1	1	0	1	0.75
Czech Republic	1	1	0	0	0.50
England and Wales	1	0	0	0	0.25
Estonia	1	1	0	0	0.50
Finland	1	1	0	0	0.50
France	1	1	0	0	0.50
Germany	1	0	0	0	0.25
Hungary	1	1	0	0	0.50
Israel	1	1	1	0	0.75
Japan	1	1	0	1	0.75
Latvia	1	1	0	0	0.50
Lithuania	NR	NR	NR	NR	-
Mexico	1	1	1	0	0.75
Netherlands	1	1	1	1	1.00
Norway	1	1	1	1	1.00
Poland	1	1	0	0	0.50
Russia	1	1	1	1	1.00
Serbia	1	1	1	1	1.00
Slovak Republic	1	1	0	0	0.50
Slovenia	1	1	0	0	0.50
Spain	1	1	0	0	0.50
Switzerland	1	1	0.5	0	0.625
United States	1	1	0	0	0.50

Country	Division of Responsibility
Belgium	1
Canada	0
Chile	0
Colombia	NR
Czech Republic	0
England and Wales	1
Estonia	1
Finland	0
France	1
Germany	1
Hungary	1
Israel	1
Japan	1
Latvia	0
Lithuania	NR
Mexico	1
Netherlands	1
Norway	NR
Poland	0
Russia	1
Serbia	0
Slovak Republic	0
Slovenia	1
Spain	0
Switzerland	0
United States	0

A.5. Transparency

The respondents were asked:

- *Is information about settlements available to the public? (Q 4.1)*
- *Is data regarding investigation, prosecution, and resolution of foreign bribery allegations collected and processed by a public authority? (Q 4.2)*
- *If yes, is this data publicly available? (Q 4.2.1)*

The response to each question was coded as 1 for no and 0 for yes. A higher mean represents lower transparency.

Country	Q 4.1	Q 4.2	Q 4.2.1	MeanTransparency
Belgium	1	0	1	0.67
Canada	0	0	0	0
Chile	0	1	1	0.67
Colombia	0	0	1	0.33
Czech Republic	1	1	1	1.00
England and Wales	0	0	1	0.33
Estonia	0	0	0	0
Finland	0	0	1	0.33
France	0	0	0	0
Germany	0	0	NR	0
Hungary	1	1	1	1.00
Israel	0	0	1	0.33
Japan	0	1	1	0.67
Latvia	0	0	1	0.33
Lithuania	1	0	0	0.33
Mexico	1	NR	NR	1.00
Netherlands	0	0	1	0.33
Norway	0	1	1	0.67
Poland	0	0	0	0
Russia	1	0	0	0.67
Serbia	1	1	1	1.00
Slovak Republic	0	0	0	0
Slovenia	1	1	1	1.00
Spain	1	0	1	0.67
Switzerland	0	0	1	0.33
United States	0	0	0	0

A.6. Term limits

For term limits we consider only whether the head prosecutor of a country has limited or unlimited tenure. If the country has a limited tenure for its head prosecutor, it is coded as 0 in Column 3 of the table below. When tenure is unlimited, the country receives a 1.

Country	Tenure	Term Limits
Belgium	5 years	0
Canada	7 years	0
Chile	10 years	0
Colombia	4 years	0
Czech Republic	no fixed tenure	1
England and Wales	5 years	0
Estonia	5 years	0
Finland	4 years	0
France	7 years	0
Germany	lifetime tenure	1
Hungary	9 years	0
Israel		
Japan	tenure until age 65	1
Latvia	5 years	0
Lithuania	7 years	0
Mexico	9 years	0
Netherlands	3 years	0
Norway	no fixed tenure	1
Poland	5 years	0
Russia	5 years	0
Serbia	6 years	0
Slovak Republic	7 years	0
Slovenia	5 years	0
Spain	4 years	0
Switzerland	6 years	0
United States	4 years	0

Spinning the revolving door to attract talent: A principal-regulator-firm perspective*

Emmanuelle Auriol and Shrey Nishchal

Abstract

When individuals from the public sector move to jobs in the private sector, it presents a trade-off to governments across the world. While on the one hand, the possibility of future jobs may serve to attract highly competent individuals to public positions, on the other hand, it may also lead to capture where the private sector rewards an official with a job for favors done while holding public office. Many governments have introduced 'cooling-off periods' between public and private employment to minimize the incentive to favor the private sector. We develop a three-tier principal-regulator-firm model and show that [i] cooling-off periods are optimal only in relatively rich economies, and [ii] that they should be longer in more innovative sectors.

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1. Introduction

Public officials are entrusted with the power to make decisions that have significant effects on society. If a public official intends to work in a firm/sector that she regulates, she faces a conflict of interest which has serious implications for tax payers. This movement is also referred to as 'the Revolving Door'.

The conflict of interest associated with the revolving door gained attention in 2004 following the case of Darleen A. Druyun, a former US Air Force official. She admitted to doing favors for Boeing in the hope of getting a job there, and subsequently received 9 months in jail for misconduct. During her time as a public official, she negotiated an expensive leasing contract for hi-tech military hardware that favored Boeing and provided them proprietary pricing data (Wayne 2004). The favors were supposed to be a 'parting gift' to Boeing and a way to express 'her desire to ingratiate herself with Boeing, her future employer'.[1] Former United States attorney, Paul McNulty commented at the time that '*Darleen Druyun owed her primary allegiance to the American taxpayer...Instead she put her own personal interests ahead of the United States Air Force*'.

Several other recent high profile departures of public officials to jobs in the private sector have ensured that the revolving door has continued to create controversy. These include Adam Farkas, former head of the European Banking Authority who moved to a lobbying firm, and José Manuel Barroso, former European Commission President who to moved to an investment bank. Both Farkas[2] and Barroso[3] received sharp criticism and several commentators[4] re-emphasized the need for stricter regulations, such as introducing longer cooling-off periods, to slow down the revolving door. This paper sheds light on the trade-offs associated with such future employment possibilities and aims to understand the optimality of the cooling-off period as an instrument to regulate the revolving door.

Despite the controversy, moving to the private sector remains a common career path for many public servants. According to Transparency International, as many as 20% of the most accredited lobbyists in Brussels have previous experience from European public institutions. That percentage

[1] For more details, see Darleen A. Druyun's plea agreement at `https://www.govexec.com/pdfs/druyunpostpleaadmission.pdf`

[2] `https://www.politico.eu/article/adam-farkas-european-banking-authority-eba-job-switch-draws-probe/`

[3] `https://www.opendemocracy.net/en/can-europe-make-it/damage-done-by-eu-s-revolving-doors/`

[4] For example, Shonan Kothari of the Change Finance Coalition and the NGO Finance Watch noted that 'the EBA has imposed restrictions on Farkas, but these restrictions are too weak'.

is 57% for lobbyists working for Google in Brussels. In the United States, out of the 107 members of the US Congress that were in office until 2019, around 42 moved into lobbying or private sector positions. In both the EU and the US, sectors like telecom, finance, technology, and pharmaceuticals attract the largest number of former public servants (Transparency International 2017, Center for Responsive Politics 2021). These sectors are fast developing, highly innovative, and regulating them requires specialized knowledge.

This movement of public sector officials to the private sector has attracted criticism due to the inherent conflict of interest it creates. Firms may try to obtain favors from public officials by offering them well paid jobs, also called the regulatory capture hypothesis. On the other hand, the revolving door can also be beneficial to society since it helps to attract highly competent individuals to public positions. This is because regulatory experience is highly valued in the private sector and former public officials can earn significantly larger amounts than those that have only private sector experience. This is the regulatory schooling hypothesis.[5] Since Governments usually cannot match private sector level salaries for high skilled individuals,[6] they must carefully balance this trade-off knowing that blanket bans on revolving might make it difficult to attract talented individuals to positions in the public sector, while no regulation might lead to capture of public officials.

One answer to this trade-off is to introduce a time gap between positions in the public and private sectors, also called a 'cooling-off period'. The idea of cooling-off periods goes at least as far back as 1872 when the US Congress extended ethics restrictions to former employees, codified as 5 U.S.C § 99. The statute forbade any executive department employee from working on a claim for two years post-retirement that she was responsible for during her tenure. Due to the weaknesses of this statute (Morgan 1980), 18 U.S.C § 207 was adopted in 1962. This included a one-year cooling-off period for lobbying positions. This statute was amended in 1978 and a one-year ban on communication between a public agency and a former employee was introduced. Following the 1992 election campaign where the revolving door was an election issue, Bill Clinton signed Executive Order 12834 which placed a 5-year cooling-off period for public officials wanting to join lobbying firms. The order was eventually revoked in 2000 and shorter cooling-off periods were

[5] Several studies highlight the benefit of the regulatory experience in the private sector. See, for example, Luechinger & Moser (2020) and Luechinger & Moser (2014).

[6] Several studies highlight that high skilled individuals tend to receive higher wages in the private sector than the public sector. These include Melly (2005) for Germany, Lucifora & Meurs (2006) for Britain, Italy and France, and Mizala, Romaguera & Gallegos (2011) for Latin America.

introduced gradually. Currently, all US federal employees have to abide by the rules laid out in 18 U.S.C § 207. From the 50 US states, 42 have introduced some form of post-public employment restrictions for state employees and 39 have mandatory cooling-off periods varying from 6 months to 2 years.[7] Out of the OECD countries, 66% (21 countries) have a cooling-off period (OECD 2015) for public officials. For example, Austria has a cooling-off period of less than a year, while in Germany it can last up to 5 years. In many cases however, cooling-off periods tend to be quite narrow, applying only to particular clients or projects that a former public official dealt with while in office. Restrictions also vary with seniority of the public officials. In Brazil, for example, 6-month cooling-off periods are only applicable to members of the cabinet, directors of regulatory agencies, governors and directors of the Central Bank of Brazil, and presidents of public sector companies.[8]

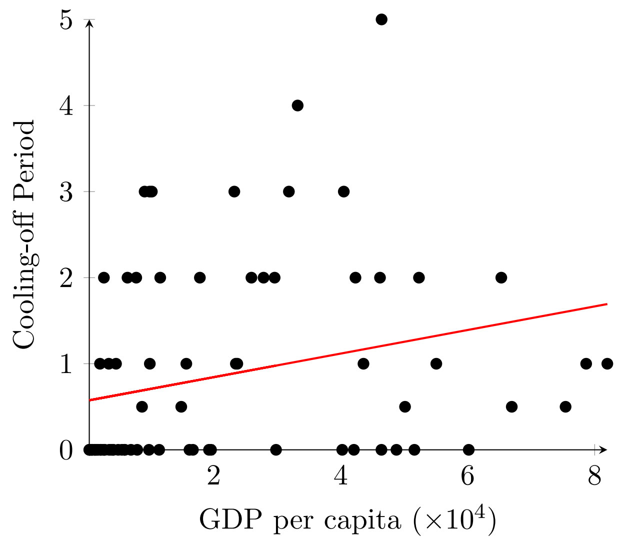


Fig. 1. Correlation between GDP per capita and the cooling-off Period

Table 1 and Figure 1 above highlight two points regarding the cooling-off periods across the world: first, that there is considerable variation across countries in the length of the cooling-off period, and second that there is a correlation between higher GDP and the length of the cooling-off period for public officials (Correlation = 0.26^{**}).

Despite the fact that many governments have recognized the conflicts of interest associated with the revolving door, there seem to be very few theoretical studies that analyze the optimality of the cooling-off period as an instrument to balance the trade-off between regulatory schooling and regulatory capture. In this paper, we capture this trade-off in a standard regulation model

[7]See https://www.ncsl.org/research/ethics/50-state-table-revolving-door-prohibitions.aspx

[8]For an analysis of the revolving door in the procurement sector in Brazil, see Barbosa & Straub (2017).

and derive the conditions under which it is optimal to have a cooling-off period and its optimal length. Consistent with Figure 2, we demonstrate that the cooling-off period is only optimal in rich countries where the shadow cost of raising public funds is low. This result arises from the fact that in our model, the optimal regulation depends on this cost which also drives the optimal incentives offered to the regulator. When this cost is relatively low, the regulatory capture hypothesis tends to dominate (hence non-zero cooling-off period) while when the cost of raising public funds is high, the regulatory schooling hypothesis dominates and a zero cooling-off period is optimal.

The paper is arranged in the following manner. Section 2 provides a review of the literature on the revolving door. The model set up is introduced in section 3. Section 4 derives optimal incentives under the assumption that all regulators are honest. This section incorporates the regulatory schooling hypothesis. In Section 5, we introduce possibilities for regulatory capture along with the schooling hypothesis. Section 6 presents a discussion of our results and section 7 concludes.

2. Related Literature

Our paper is primarily related to the literature on the movement of individuals from the public sector to the private sector. Within this literature, our study is built on the trade-off between (a) the regulatory schooling hypothesis, which states that former public officials are hired by the private sector due to the experience they have acquired during their public tenure, and (b) the regulatory capture hypothesis, which states that firms may try to capture regulators by offering them jobs in exchange for favors. Below we provide a review of closely related empirical and theoretical studies on the revolving door and restrictions imposed on it.

Starting with the regulatory schooling hypothesis, Luechinger & Moser (2014) note a positive stock market reaction for firms that hire former US politicians (Luechinger & Moser (2020) show similar results for firms hiring former EU commissioners). For financial firms hiring ex-regulators, along with positive stock market reactions, Shive & Forster (2016) find a decrease in the firm's idiosyncratic risk in the quarter after the hiring. Lucca, Seru & Trebbi (2014) show higher gross inflows and outflows for regulatory positions during periods of intense regulatory activity, which they argue is due to the desire to educate themselves in the regulatory sector and reap the benefits of that in the private sector. Duchin & Sosyura (2014) find that a bank's application for the Capital Purchase Program during the financial crisis of 2008-09 was more likely to be approved if it had board members with Treasury, regulatory, or congressional experience. Other papers arguing that former public officials are hired due to their regulatory experience include Zaring (2013), and DeHaan, Kedia, Koh & Rajgopal (2015). A branch of this literature also discusses whether it is 'what they know' or 'who they know' that makes former public officials valuable to the private sector.[9]

There are also several papers that highlight the regulatory capture side of the revolving door. Spiller (1990) shows that regulators presiding over more lenient regulatory periods are more likely to get jobs in the regulated industry. Canayaz, Martinez & Ozsoylev (2015) provide evidence that firms to which current public officials revolve in the future outperform other firms in the two year period immediately preceding the hiring and also receive more favorable government contracts before hiring. Tabakovic & Wollmann (2018) find that US patent officers grant significantly more patents from future employers and the leniency is higher when firms are hiring more. DeHaan et al. (2015) also find some support (though less than regulatory schooling) for the capture hypothesis for trial lawyers based in Washington DC, where trial lawyers relax enforcement efforts to develop networks for future employment. While not directly related to the capture of public officials, Cornaggia, Cornaggia & Xia (2016) also provide evidence for the perverse incentives that revolving doors can create. They show that credit analysts provide inflated ratings to their future employers as opposed to other firms. Kempf (2020), while also studying ratings analysts, shows that while probability of being hired increases ratings accuracy, providing optimistic ratings to a deal underwritten by a specific bank, increases the chances of being hired by that bank. Other papers providing evidence for the capture hypothesis include Tenekedjieva (2021), and Emery & Faccio (2020).

There is a small literature evaluating the impact of post-public employment restrictions such as the cooling-off period. Gely & Zardkoohi (2001) compared the Carter, Reagan, and Bush Sr. administrations with the Clinton administration and show that the introduction of a 5-year cooling-off period during the Clinton administration lead to a reduction in the value of the public official's connections. Law & Long (2011) discuss, more generally, all laws that restrict the revolving and find that public utility commissioners from states with revolving door laws tend to have shorter terms

[9] See, for example, Vidal, Draca & Fons-Rosen (2012) and Bertrand, Bombardini & Trebbi (2014).

and lower likelihood of revolving to the private sector than those from states without revolving door laws. In addition, they also show that states with revolving door laws tend to discourage high skilled individuals from becoming public utility regulators. Law & Long (2012) show that such laws that restrict post public employment lead to a temporary and negative effect on electricity prices for industrial consumers. They also show that commissioners from states with such laws work shorter terms and have a smaller probability of being employed in the private sector after their regulatory tenure.

Theoretical Literature: In a seminal paper, Che (1995) studies the impact of the revolving door on a public official's performance incentives in a principal-public official-firm framework. The public official's desire to signal qualifications to the private sector may lead to higher monitoring effort. When collusion is allowed, a public official may increase her effort to attain pivotal information and to try to collude with the firm. This increased effort benefits the principal in the non-collusive states. Therefore, Che (1995) shows that it maybe optimal for the principal to allow for some collusion. While Che (1995) argues that there are costs associated with rooting out all collusion, he does not analyse the trade-offs associated with the cooling-off period. We extend his argument to show the conditions under which it is optimal to use the cooling-off period to ensure that there is no collusion.

Chiara & Schwarz (2021) develop an infinitely repeated game between a firm and a policymaker where the policymaker hires an expert to regulate the firm. Collusion can take place between the firm and the expert either through bribes or through revolving door job offers. Since all collusion depends on implicit promises, the offer of a bribe may not be able to capture a regulator. This is because bribes are illegal and there is always a threat that the firm might renege on its promise to pay the bribe. The revolving door might be used as a signaling device by the firm to signal its commitment to keeping its promise in exchange for the expert's favors. Chiara & Schwarz (2021), like us, show that the revolving door represents both costs and benefits and argue against blanket bans on revolving. But in their model, the optimal regulation does not depend on the shadow cost of raising public funds, whereas we employ a pure regulation framework where the optimal regulation and, consequently, the regulator's incentives do depend on the shadow cost of public funds.

Salant (1995) evaluates the revolving door issue with a long-run incentive approach and shows how the revolving door can promote a firm's unverifiable investment and consequently improve the firm's performance and enhance welfare. Bar-Isaac & Shapiro (2011) use an economic model to show that the accuracy of credit rating agencies is likely to be increase in boom times when investment bank profitability increases, as analysts work harder to get better training and signal their expetise to get a higher salary after they revolve. Bond & Glode (2014) show similar results for bankers and regulators, and predict that the most skilled regulators will go on to work for banks at higher salaries.

3. The Model

As in Tirole (1986), we use a three tier model with a principal, a regulator, and a firm. All the players are assumed to be risk neutral. The infinitely lived principal wants to maximize the net surplus associated with the provision of a good and hires a regulator to monitor the infinitely lived firm, learn its type, and implement decisions that maximise social surplus.

3.1. The regulated firm

We consider a regulation problem over an infinite horizon $t \in \{1, 2, 3..., \infty\}$. As in Baron & Myerson (1982), the production cost of the infinitely-lived firm is:

$$c_t(q_t) = \beta_t q_t$$

where β_t is its marginal cost which is private information of the firm. q_t is the quantity produced in each period. The principal and the regulator have a common a priori on the distribution of β_t, which is independent and identically distributed. In each period β_t is subject to random shocks due to, for example, general competition or the prevailing demand conditions. Let ν be the probability that the firm is of type $\underline{\beta}$ (efficient) in any period t and $1 - \nu$ be the probability that the firm is of type $\bar{\beta}$ (inefficient). The profit of the firm in period t is:

$$\pi_t = T_t + P(q_t)q_t - \beta_t q_t$$

where T_t is the transfer from the principal to the firm. It is positive when the firm receives a subsidy and negative when the firm pays a tax to the principal. $P(q_t)$ is the price of the good produced by the firm.

3.2. The agent: Regulator or private sector employee

Both the public sector and the private firm require workers. Each worker works for two periods. He is characterized by a fixed parameter θ, which is inversely related to the skill of the worker. The disutility of the worker's effort is defined as:

$$\psi(e) = \frac{\theta e^2}{2} \tag{1}$$

where e is the effort exerted by him. Each worker maximizes his expected utility which is the difference between expected wage and the disutility of effort. In addition, we allow the worker's skill parameter θ to be observable to both the public and private sectors through, for example, their curriculum vitae and experiences.

After entering the labor market, the worker can work for the private firm or join the public sector to regulate that firm. Those joining the firm, work there for both periods and produce the surplus C_i were $i \in \{j, s, r, \overline{r}\}$ with probability e_i. Subscripts j and s denote junior (those in the first period of their working life) and senior employees (those that are in the second period of their working life) respectively. Those that join the public sector in the first period have the opportunity to revolve and move to the private sector in the second period. $\overline{r}$ denotes revolvers who were successful in the first period, i.e., who produced evidence that the firm is of the efficient type, while r denotes those that were unsuccessful in the first period.

3.3. The principal: Public authority managing the regulatory agency

The infinitely lived principal is utilitarian. She maximizes the intertemporal expected sum of net producer and taxpayer surpluses weighted under the participation and incentive constraints of the regulator. The tax payer's surplus is weighted by $(1 + \lambda)$ where λ is the shadow cost of raising public funds due to a distortive tax collection system constant over time.

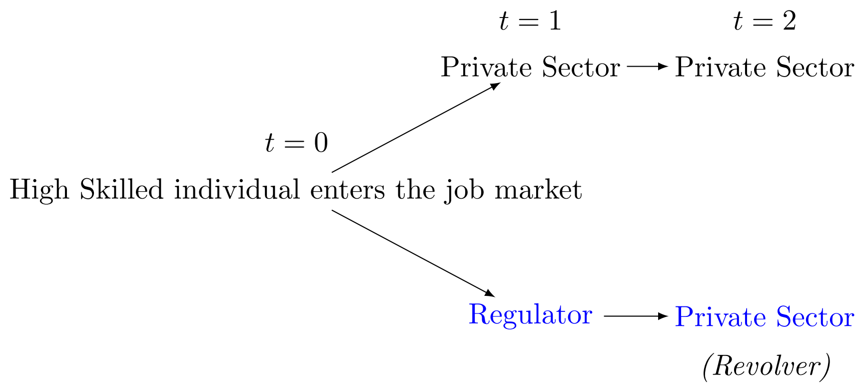
To achieve the maximum welfare, the principal would like the firm to produce according to its types and its economic environment. For achieving this goal, the principal needs to hire a high skilled regulator. The regulator implements the optimal contract by leveraging her expertise for complex regulation. We call this type of regulation regulation-by-expertise (RBE). Therefore, one of the goals of the principal is to attract a high skilled individual to the regulatory position. Note that we let the individual have a reservation utility equal to 0.

3.4. Timing

Under regulation-by-expertise, the players follow the timing shown below:

1. The principal sets the regulator's and firm's contracts and the cooling-off period.
2. The principal entrusts the monitoring of the firm to the regulator.
3. Nature chooses β_t.
4. The regulator exerts costly effort to know β_t and announces her report.
    (a) If the regulator is honest, she truthfully reports β_t.
    (b) If the regulator is dishonest and $\beta_t = \underline{\beta}$, she hides her report to favor the firm.
5. Contracts are signed, production and transfer occur.
6. The regulator revolves to the private sector after the cooling-off period and receives rents according to the decisions she implemented while she was acting as a regulator.
7. Fresh talent joins the labor market and Steps (2)-(6) are repeated again.

Collusion takes place in Step 4b, where the regulator manipulates her information to favor the firm (that is, she hides that the firm is of the efficient type). This allows the efficient firm to make a rent and benefit from the contract designed for the inefficient type.



The above figure shows the career path for an individual entering the job market.

4. Revolving Door for honest regulators

Under the honesty assumption, there is no possibility of collusion between the firm and the regulator, rather the regulator wants to use her time as a public official to learn and make herself more attractive to the private firm. This is referred to as the regulatory schooling hypothesis.

We model the problem in steps. At the start of the first period, individuals have the opportunity to either join the regulatory agency or a private firm. The purpose of joining the regulatory agency for high skilled individuals in the first period is to obtain knowledge that is valued by the private sector in the second period. The section below presents the firm's problem and the private sector incentives for both junior employees (those that join the firm in the first period) and revolvers.

4.1. The private firm's problem for junior employees and revolvers

For workers joining the private sector, the firm's problem is to offer optimal contracts when there is repeated moral hazard. Let the instantaneous profit of the firm be:

$$E\pi_i^f = e_i^f(C_i - \Delta w_i^f) - w_i^f \tag{2}$$

where e_i^f is the effort exerted in the private sector by agent $i \in \{j, s, r, \overline{r}\}$, Δw_i^f is the bonus awarded to the individual in case of success and w_i^f is the fixed wage. Finally, $C_i \in \{C_j, C_s, C_r, C_{\overline{r}}\}$ is the private firm's benefit of hiring an agent i. The instantaneous expected utility of the firm employee and her optimal effort are, respectively:

$$EU_i^f = w_i^f + e_i^f \Delta w_i^f - \frac{\theta (e_i^f)^2}{2} \tag{3}$$

$$e_i^f = \frac{\Delta w_i^f}{\theta} \tag{4}$$

Since all players are risk neutral and all utility functions are additively separable across periods, as shown by Fellingham, Newman & Suh (1985), the optimal intertemporal incentives will be a replication of the optimal one period incentives. Let $\min\{C_j, C_s, C_r, C_{\overline{r}}\} > 2\sqrt{2\theta u}$, then the lemma below presents the optimal contracts offered by the private firm.

Lemma 4.1. ***Private sector optimal contracts:***

1. *Recall that $C_i \in \{C_j, C_s, C_r, C_{\overline{r}}\}$, then the optimal incentives offered by the private firm are given by:*

$$w_i^f = 0 \qquad i \in \{j, s, r, \overline{r}\}$$
$$\Delta w_i^f = \frac{C_i}{2} \qquad i \in \{j, s, r, \overline{r}\}$$

2. *In each period, $E\pi_i^f = \frac{{C_i}^2}{4\theta}$ and type θ receives $EU_i^f = \frac{C_i^2}{8\theta}$.*

Proof. The proof is available in Appendix A. □

Next, we derive optimal incentives for the individuals that join regulatory agencies. For the remainder of this paper, we allow for $C = C_j = C_s$.

4.2. Optimal contracts for high skilled regulators

4.2.1. The principal's problem

Under regulation-by-expertise, the regulator needs to exert effort, denoted $e_t \geq 0$, to carry out her mission which implies gathering information on the type of the firm. With probability e_t, the regulator observes $\beta_t \in \{\underline{\beta}, \bar{\beta}\}$ and with complementary probability $1 - e_t$ she observes nothing denoted $\emptyset$. After exerting effort, the regulator makes a report to the principal, $\sigma_t \in \{\underline{\beta}, \bar{\beta}, \emptyset\}$. The regulator can always hide her information and announce $\emptyset$, but she cannot fake a report of

$\underline{\beta}$ or $\bar{\beta}$ as this is hard information. Upon observing the regulator's report, the principal pays the regulator's wage, w_t when the report is either $\emptyset$ or $\bar{\beta}$, and $w_t + \Delta w_t$ when the report is $\underline{\beta}$. For incentives reasons, Δw_t is the bonus awarded to the regulator for obtaining and reporting pivotal information. The expected utility of the regulator is:

$$EU_t = Ew_t - \psi(e_t) \geq u \tag{5}$$

where Ew_t is the regulator's expected wage. We assume in the sequel that θ is large enough so that the optimal effort is always an interior solution (i.e., in equilibrium $e_t \in [0, 1)$). The expected wage paid by the principal, Ew_t, is defined by the following expression:

$$Ew_t = w_t + e_t \nu \Delta w_t \tag{6}$$

The principal's objective function at time t is:

$$EW_t = (1 - \nu) W_t(\bar{q}_t) + \nu W_t(\underline{q}_t) - (1 - e_t)\nu\lambda\bar{q}_t\Delta\beta_t - (1 + \lambda)Ew_t \tag{7}$$

where $W(q_t) \equiv S(q_t) + \lambda P(q_t)q_t - (1 + \lambda)\beta_t q_t$ and $S(q_t)$ is the gross consumer surplus.

Since high skilled regulators are able to revolve and work in the private sector in the second period, we only need to solve the principal's problem for the first period. By virtue of lemma 4.1, individuals of type θ receive $\frac{(C_{\overline{r}})^2}{8\theta}$ utility in the second period when they are successful in the first period, that is in state $e_1\nu$, and utility $\frac{(C_r)^2}{8\theta}$ in the second period in all other states. Let k be the cooling-off period between the public sector and private sector jobs. Then the expected utility of the high skilled future revolver is:

$$EU_r = w_1 + \frac{(C_r)^2}{8\theta(1+\delta)^{k+1}} + e_1\nu\left[\Delta w_1 + \frac{\Delta_r}{(1+\delta)^{k+1}}\right] - \frac{\theta(e_1)^2}{2}$$

where $\Delta_r \equiv \frac{(C_{\overline{r}})^2 - (C_r)^2}{8\theta}$. The optimal effort that maximizes the above expected utility is:

$$e_1 = \frac{\nu}{\theta}\left[\Delta w_1 + \frac{\Delta_r}{(1+\delta)^{k+1}}\right] \tag{8}$$

The above expression highlights that when regulators can revolve, there are two bonuses available to incentivize regulatory effort. First, the principal can use higher Δw_1 to motivate effort, but at a cost to the society. Instead, regulatory effort is also motivated by the possibility of obtaining Δ_r after revolving. Since Δ_r is paid by the firm and not the principal, the society benefits because regulatory effort is exerted at no additional cost to society. The lemma below provides the optimal quantities produced under regulation-by-expertise when the principal solves the static problem (7), the regulator is honest and produces effort e_1.

Lemma 4.2. ***Regulation-by-expertise***

Let η_q denote the price elasticity of demand, $\bar{p} = P(\bar{q})$, and e_1 be the effort produced by the regulator in equilibrium, given by (8). *Then the optimal quantities produced under regulation-by-expertise by the efficient* ($\underline{q}$) *and inefficient firm* ($\bar{q}(e_1)$) *are respectively given by the following Lerner indices:*

$$L_{\underline{q}} = \frac{\lambda}{1+\lambda}\frac{1}{\eta_{\underline{q}}} \tag{9}$$

$$L_{\bar{q}} = \frac{\lambda}{1+\lambda}\frac{1}{\eta_{\bar{q}}} + \frac{\nu\lambda\Delta\beta}{\bar{p}(1+\lambda)(1-\nu)}\Big(1-e_1\Big) \tag{10}$$

Proof. The proof is available in Appendix A. □

The Lerner index is a measure (between 0 and 1) of the firm's market power. A higher value reflects higher power. Lemma 4.2 provides the standard result that under asymmetric information, there is no distortion for the efficient firm, while there is a downward distortion for the inefficient firm. In other words, the lemma implies that $\underline{q} \geq \bar{q}(e_1)$, which is described by Laffont & Martimort (2002) as the implementability condition.[10] Furthermore, note that the quantity produced by the inefficient firm depends on the effort exerted by the regulator, e_1.

When the regulator does not learn anything, the efficient firm receives an extra $\bar{q}\Delta\beta$ because the principal cannot discern the true type of firm. To lower this, the principal would lower the $\bar{q}$ thereby reducing the amount of good supplied to consumers. Due to the regulator's effort, the probability that the efficient firm receives $\bar{q}\Delta\beta$ is reduced because the regulator can determine the true state and report truthfully to the principal. Therefore, the principal can allow a higher $\bar{q}$ when

[10] Laffont & Martimort (2002) define the implementability condition as 'any pair of outputs $(\bar{q}, \underline{q})$ that is implementable, i.e., that can be reached by an incentive compatible contract, must satisfy this condition which is here necessary and sufficient for implementability'.

there is a regulator. We are now ready to determine the optimal cooling-off period and wages for the regulators. For ease of exposition, we assume $C = C_r = C_j = C_s$.

Proposition 1. ***(The schooling theory of revolving)***

When there are only honest individuals, the optimal cooling-off period is zero: $k^* = 0$. Furthermore, let $\bar{q}$ be defined in Lemma 4.2 and e_1 be given by (8). Then the optimal incentives offered to high skilled individuals who choose to become regulators in the first stage of their career are:

1. $w_1 = 0, \Delta w_1 = \max\left\{0, \frac{\lambda\bar{q}\Delta\beta}{2(1+\lambda)} - \frac{\Delta_r}{2(1+\delta)}\right\}$ *if* $\frac{C}{2\nu} < \max\left\{\frac{\lambda\bar{q}\Delta\beta}{2(1+\lambda)} + \frac{\Delta_r}{2(1+\delta)}, \frac{\Delta_r}{1+\delta}\right\}$.
2. $w_1 = 0, \Delta w_1 = \frac{C}{2\nu} - \frac{\Delta_r}{(1+\delta)}$ *if* $\max\left\{\frac{\lambda\bar{q}\Delta\beta}{2(1+\lambda)} + \frac{\Delta_r}{2(1+\delta)}, \frac{\Delta_r}{1+\delta}\right\} < \frac{C}{2\nu} < \frac{\Delta_r}{(1+\delta)} + \frac{\lambda\bar{q}\Delta\beta}{1+\lambda}$.
3. $w_1 > 0, \Delta w_1 = \frac{\lambda\bar{q}\Delta\beta}{1+\lambda}$ *if* $\frac{\lambda\bar{q}\Delta\beta}{1+\lambda} + \frac{\Delta_r}{(1+\delta)} < \frac{C}{2\nu}$.

Proof. The proof is available in Appendix A. □

Part 1 of Proposition 1 follows from the fact that, when there is no corruption, revolving involves only benefit and no cost. This is because Δ_r is borne by the private sector. In cases when Δ_r is large enough, it is optimal to pay minimal wages and set both $w_1 = \Delta w_1 = 0$. When the revolving door is only beneficial, a non-zero cooling-off period will reduce the value of $\frac{\Delta_r}{(1+\delta)^{k+1}}$ and thereby reduce effort motivated by the bonus of revolving provided by the firm, without providing any benefit. Hence, it is optimal to set a zero cooling-off period in the absence of capture threat.

Given a linear demand system, the solution to the honest revolver's problem can be represented by Figure 2. The figure shows the relationship between the incentive compatibility constraint parameter, $\frac{\Delta_r}{1+\delta}$, and the individual rationality constraint parameter, $\frac{C}{2\nu}$. A low value of $\frac{C}{2\nu}$, that is a lower outside option, implies that it is not very expensive to attract high skilled individuals to public sector jobs. In case 1, on the left of the dashed line, a low $\frac{C}{2\nu}$ and a low value of $\frac{\Delta_r}{1+\delta}$ imply that the bonus from revolving is not sufficient to motivate effort. Therefore, it is optimal to also offer performance pay. As $\frac{\Delta_r}{1+\delta}$ gets larger, it becomes enough to motivate optimal regulatory effort. This refers to the region on the right of the dashed line in case 1, where $\frac{C}{2\nu}$ is low enough to attract high skilled workers and it is optimal to offer zero wages. An example of this would be unpaid public sector traineeships.

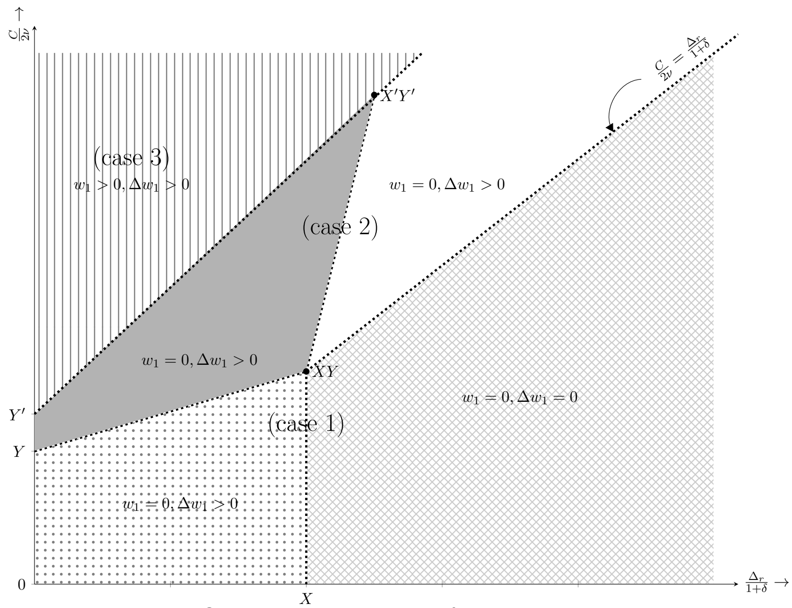


Fig. 2. Optimal incentives for honest revolvers

As the individual rationality parameter $\frac{C}{2\nu}$ gets larger, the principal needs to offer larger bonuses to attract high skilled individuals as in case 2. Lastly, when $\frac{C}{2\nu}$ is very large as in case 3, the principal needs to offer a combination of fixed wage and performance pay. Figure 3 shows the evolution of quantities with respect to the uncertainty $\Delta\beta$. $\bar{q}^{FB}$ denotes the *first best* quantities, that is the case where there is no asymmetric information. When there is asymmetric information, the figure shows the value of regulatory effort. Then quantity produced by the inefficient firm is always less when the regulator exerts no effort. This is because without regulatory effort, the principal would like to reduce the loss due to asymmetric information by reducing the value of $\bar{q}$.

Figure 4 presents the optimal incentives from Proposition 1 with respect to the cost of raising public funds, λ. It highlights that the incentive compatibility parameter $\frac{\Delta_r}{1+\delta}$ acts to shift both curves $\frac{\lambda}{1+\lambda}$ and $\frac{\lambda}{2(1+\lambda)}$ upwards, thereby highlighting the value of future possibilities in motivating effort in period 1. For example, in case 1, $\Delta_r \neq 0$ allows the principal to use the minimal unconstrained bonus to be optimal for larger values of $\frac{C}{2\nu}$ compared with the case where $\Delta_r = 0$.

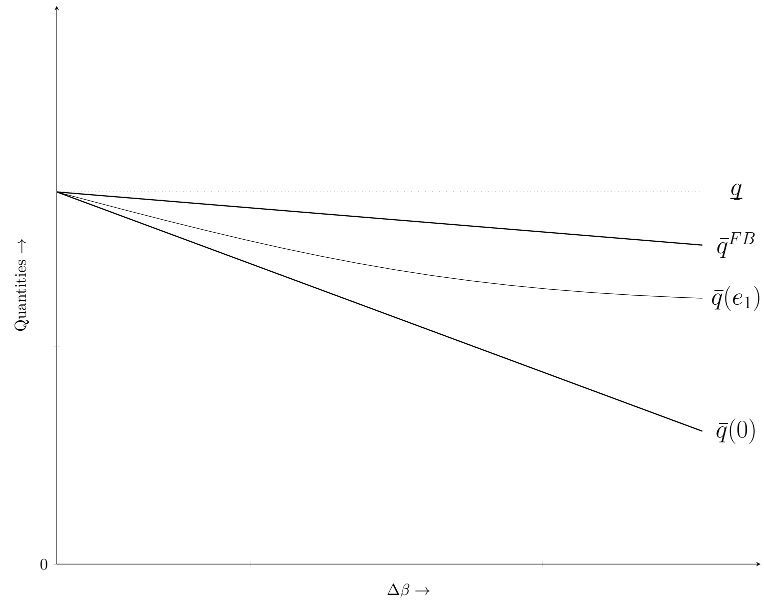


Fig. 3. Quantities when the regulator is honest when $\min\left\{\frac{C}{2\nu}, \frac{\lambda\bar{q}\Delta\beta}{1+\lambda}\right\} > \frac{\Delta_r}{1+\delta}$

One of the key parameters of interest in this article is the social cost of raising public funds λ. Therefore, we present the results of Proposition 1 in the figure below with respect to λ when demand is inelastic, that is $\underline{q} = \bar{q} = Q$.

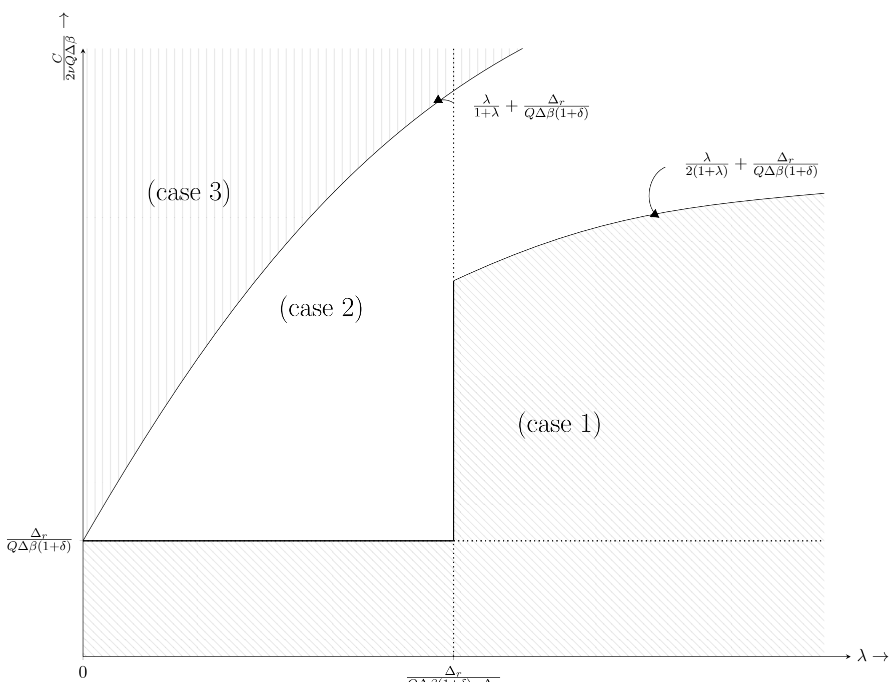


Fig. 4. Incentives from proposition 1 when $\underline{q} = \bar{q} = Q$

5. Revolving door and regulatory capture

Once the regulator has acquired pivotal information, the efficient firm stands to lose $\bar{q}\Delta\beta$ if the regulator reveals this information to the principal. By capturing the regulator such that she hides her pivotal information, the firm can retain part of $\bar{q}\Delta\beta$ by offering a well paying job to the regulator in the following period. In addition to $\frac{(C_r)^2}{8\theta}$, which every revolver receives, we allow the firm to offer $B = \tau\bar{q}\Delta\beta$, where $\tau \in (0, 1]$ is the observable share that the regulator receives in exchange for hiding the true type of the firm. Since the amount B is a reward for a favorable decision during the time the agent is acting as a regulator, it can only be received after revolving. Paying B directly would be an illegal act of corruption leading to prosecution and jail time if uncovered. Giving a good job to a revolver is harder to forbid and almost impossible to prosecute as a corrupt act.

The problem for the firm and the revolver is that it is delayed in time. The regulator discounts this amount B by $\frac{1}{(1+\delta)^{k+1}}$, where $1+\delta$ is the time discount rate with k being the cooling-off period. Therefore, in this section, we introduce both regulatory schooling (due to the term $\frac{C_r^2}{8\theta(1+\delta)^{k+1}}$ in the IR constraint) and corruption (due to the capture-proofness constraint (11) below). In our setup, capture occurs when the regulator manipulates her information to favor the efficient firm. In the previous section, the bonus Δ_r served to motivate effort in the first period because it is a reward for success in the first period. By contrast, when the firm wants to capture the regulator, it prefers leniency in the first period and therefore, the bonus Δ_r to reward the regulator for being honest and tough in the first period is optimally set to zero. This result serves as a test for regulatory capture. Several empirical studies like Tabakovic & Wollmann (2018) and DeHaan et al. (2015) test whether the public official is lenient or not before revolving. Therefore, when revolving is a reward for regulatory capture, $\Delta_r^* = 0$. When the regulator has pivotal information, that is in state $e_1\nu$, the total reward of collusion and revolving is:

$$R_c = w_1 + \frac{(C_r)^2}{8\theta(1+\delta)^{k+1}} + \frac{B}{(1+\delta)^{k+1}}$$

where the corrupt regulator foregoes Δw_1 but receives the bonus B later by colluding with the firm. This reward has to be compared to the reward in case of the honest revelation of regulator's information:

$$R_h = w_1 + \frac{(C_r)^2}{8\theta(1+\delta)^{k+1}} + \Delta w_1$$

Recall that $B = \tau\bar{q}\Delta\beta$. To ensure capture-proofness, the principal structures Δw_1 and k such that there is no incentive to collude by introducing the following constraint in the optimization problem:

$$\Delta w_1 \geq \frac{\tau\bar{q}\Delta\beta}{(1+\delta)^{k+1}} \tag{11}$$

We first analyze the case where there is only the possibility of regulatory capture, that is, $C_r = 0$. The proposition below provides the optimal incentives.

Proposition 2. *Let $\underline{q}, \bar{q}$ be defined in Lemma 4.2, $e_1 = \frac{\nu\Delta w_1}{\theta}$ and $C_r = 0$. Then when capture is a threat and the principal wants to hire a high skilled individual, the optimal cooling-off period $k^* \geq \left\{\frac{ln\left[\frac{2\tau(1+\lambda)}{\lambda}\right]}{ln(1+\delta)} - 1\right\}$ and the principal offers the following incentives:*

1. *$w_1 = 0$ and $\Delta w_1 = \frac{\lambda\bar{q}\Delta\beta}{2(1+\lambda)}$ if $\frac{\lambda\bar{q}\Delta\beta}{2(1+\lambda)} > \frac{C}{2\nu}\sqrt{\frac{2+\delta}{1+\delta}}$.*
2. *$w_1 = 0$ and $\Delta w_1 = \frac{C}{2\nu}\sqrt{\frac{2+\delta}{1+\delta}}$ if $\frac{\lambda\bar{q}\Delta\beta}{2(1+\lambda)} < \frac{C}{2\nu}\sqrt{\frac{2+\delta}{1+\delta}} < \frac{\lambda\bar{q}\Delta\beta}{1+\lambda}$.*
3. *$w_1 > 0$ and $\Delta w_1 = \frac{\lambda\bar{q}\Delta\beta}{1+\lambda}$ if $\frac{\lambda\bar{q}\Delta\beta}{1+\lambda} < \frac{C}{2\nu}\sqrt{\frac{2+\delta}{1+\delta}}$.*

Proof. The proof is available in Appendix A. □

The above result hinges on the fact that when $C_r = 0$, there is no benefit of the revolving door for the principal. Therefore, introducing the cooling-off period is costless and can be set large enough to ensure that the capture-proofness constraint never binds. Assuming that demand is linear, we can depict the incentives in Proposition 2 in the figure below:

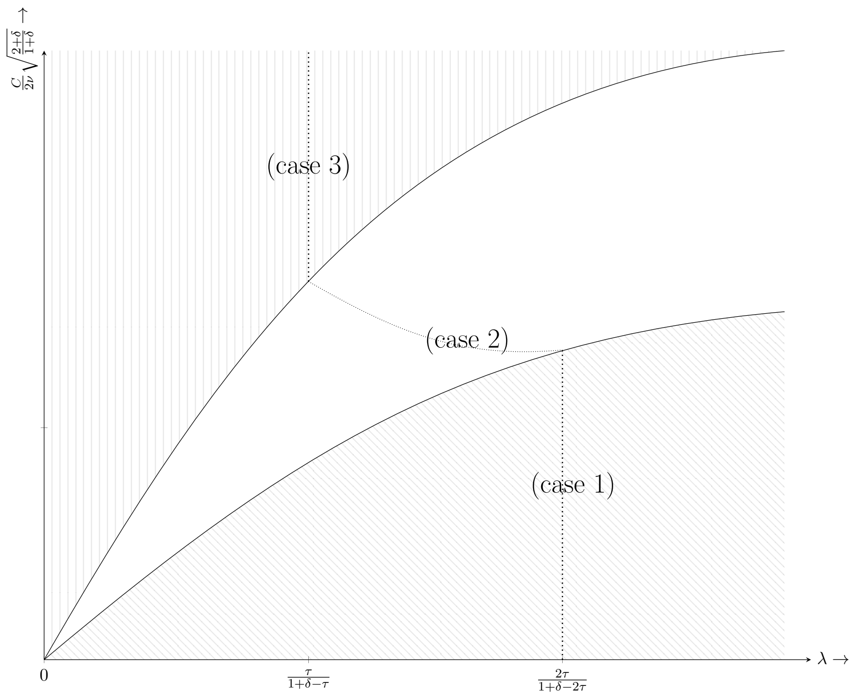


Fig. 5. Optimal incentives when $C_r = 0$ and $\underline{q} = \bar{q} = Q$

Note that the optimal incentives when $C_r = 0$ coincide with the optimal incentives when there are only honest regulators and $\Delta_r = 0$ but with $k^* = 0$. We now move on the case where $C_r > 0$.

Lemma 5.1. ***Schooling versus capture***

Let η_q denote the price elasticity of demand, $\bar{p} = P(\bar{q})$, and $e_1 = \frac{\nu \Delta w_1}{\theta}$ be the effort produced by the regulator in equilibrium . Then the optimal quantities produced under regulation-by-expertise by the efficient ($\underline{q}$) and inefficient firm ($\bar{q}(e_1)$) are respectively given by the following Lerner indices:

$$L_{\underline{q}} = \frac{\lambda}{1+\lambda}\frac{1}{\eta_{\underline{q}}} \tag{12}$$

$$L_{\bar{q}} = \frac{\lambda}{1+\lambda}\frac{1}{\eta_{\bar{q}}} + \frac{(1-e_1)\nu\lambda\Delta\beta}{\bar{p}(1+\lambda)(1-\nu)} + \frac{\tau\xi\Delta\beta}{\bar{p}(1+\lambda)(1-\nu)(1+\delta)^{k+1}} \tag{13}$$

where $\xi \geq 0$ is the Langrangian of the capture-proofness constraint.

Proof. The proof is available in Appendix A. □

The term $\frac{\tau\xi\Delta\beta}{\bar{p}(1+\lambda)(1-\nu)(1+\delta)^{k+1}}$ represents the extra distortion due to capture-proofness constraint. While the regulator's effort reduces the distortion due to asymmetric information, the revolving door gives rise to a new distortion. Note that when $e_1 < \frac{\tau\xi}{\lambda(1+\delta)^{k+1}}$, the principal may prefer not to hire the high skilled individual. Before providing the incentives, we need to characterize the optimal cooling-off period. Let $2\nu\bar{q}\Delta\beta R(k) \equiv \sqrt{\max\left\{\left[\frac{2+\delta}{1+\delta}\right]C^2 - \frac{C_r^2}{(1+\delta)^{k+1}}, 0\right\}}$. The optimal cooling-off period is presented in the lemma below:

Lemma 5.2. *The optimization problem yields three cases with the following cooling-off period expressions:*

$$k_1^* = \frac{ln\left[\frac{2\tau(1+\lambda)}{\lambda}\right]}{ln(1+\delta)} - 1 \tag{14}$$

$$k_2^* = \frac{ln\left[\frac{\frac{C_r^2}{4}+\sqrt{\frac{C_r^4}{16}+\left[\frac{2+\delta}{1+\delta}\right](\nu\tau C\bar{q}\Delta\beta)^2}}{\frac{C^2}{2}\left[\frac{2+\delta}{1+\delta}\right]}\right]}{ln(1+\delta)} - 1 \tag{15}$$

$$k_3^* = \frac{ln\left[\frac{\tau}{\frac{\lambda}{1+\lambda}+\frac{C_r^2}{8\nu^2\tau(\bar{q}\Delta\beta)^2}}\right]}{ln(1+\delta)} - 1 \tag{16}$$

Proof. The proof is available in Appendix A. □

The following proposition presents the optimal incentives offered when $C_r \neq 0$.

Proposition 3. *When capture is a threat and the principal wants to hire a high skilled individual, the principal offers the following incentives:*

1. $w_1 = 0, \Delta w_1 = \frac{\lambda\bar{q}\Delta\beta}{2(1+\lambda)}, k_1^* \geq 0$ *if* $\frac{\lambda}{2(1+\lambda)} > \max\left\{R(k_1^*), \frac{\tau}{(1+\delta)^{k_1^*+1}}\right\}$
2. $w_1 = 0, \Delta w_1 = \max\left\{\frac{\tau}{(1+\delta)^{k_2^*+1}}, R(0)\right\}\bar{q}\Delta\beta, k_2^* \geq 0$ *if* $\frac{\lambda}{1+\lambda} + \frac{C_r^2}{8\nu^2\tau(\bar{q}\Delta\beta)^2}\mathbb{1}_{\{R(0)<\frac{\tau}{1+\delta}\}} > R(k_2^*) > \frac{\lambda}{2(1+\lambda)}$
3. $w_1 > 0, \Delta w_1 = \max\left\{\frac{\lambda}{1+\lambda}, \frac{\tau}{(1+\delta)^{k_3^*+1}}\right\}\bar{q}\Delta\beta, k_3^* \geq 0$ *if* $R(k_3^*) > \max\left\{\frac{\lambda}{1+\lambda}, \frac{\tau}{(1+\delta)^{k_3^*+1}}\right\}$

Proof. The proof is available in Appendix A. □

Proposition 4. *There exists a* $\tilde{\lambda} > 0$ *such that the principal sets a strictly positive cooling-off period if and only if* $\lambda < \tilde{\lambda}$.

Proof. The proof is available in Appendix A. □

In the above problem, the principal faces a trade-off between preventing capture and regulatory schooling. A higher cooling-off period makes it easier to satisfy the capture-proofness constraint (11) but reduces the value of the term $\frac{C_r^2}{8\theta(1+\delta)^{k+1}}$ thereby making it costlier to satisfy the regulator's individual rationality constraint. For large values of unconstrained solutions (incentives when constraint (11) is not binding) are large, introducing a cooling-off period only makes it costlier to satisfy the individual rationality constraint without reducing the corruption-proof bonus. As λ decreases, the unconstrained solutions cannot satisfy (11) and consequently, (11) must hold with strict equality. Further smaller values of $\lambda(< \tilde{\lambda})$ make it optimal to introduce a positive cooling-off period. The crucial insight that this results offers is that a cooling-off period is optimal only in rich economies with low values of λ. The key driving factor behind this result is the fact that when λ is very small, the cost that the society bears for asymmetry of information about firm type is low and therefore, incentives which are increasing in the cost to society are not large enough to satisfy the capture-proofness constraint (11). Hence, constraint (11) needs to bind when λ is small. A non-zero cooling-off period arises when preventing capture dominates regulatory schooling and the principal can economize over the bonus payment offered to the regulator by introducing a positive cooling-off period.

To obtain closed form solutions for the cooling-off period and allow for comparative statics, we assume that $\underline{q} = \bar{q} = Q$. Figures 5 and 6 show how the optimal incentives change when the regulatory schooling parameter C_r changes. As C_r increases, the areas under which a cooling-off period is optimal decreases. This aligns with intuition because as the regulatory schooling becomes more valuable, the cooling-off period becomes more costly and high cooling-off periods make it more expensive to satisfy the individual rationality constraints.

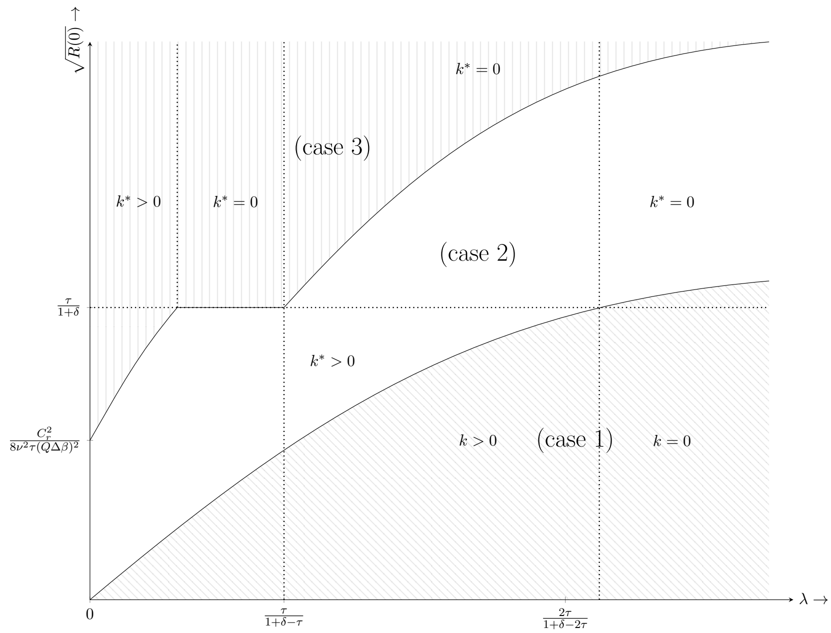


Fig. 6. Incentives from proposition 3 when $\underline{q}=\bar{q}=Q$ and $\frac{C_r}{Q\Delta\beta}<\frac{\nu\tau 2\sqrt{2}}{\sqrt{1+\delta}}$

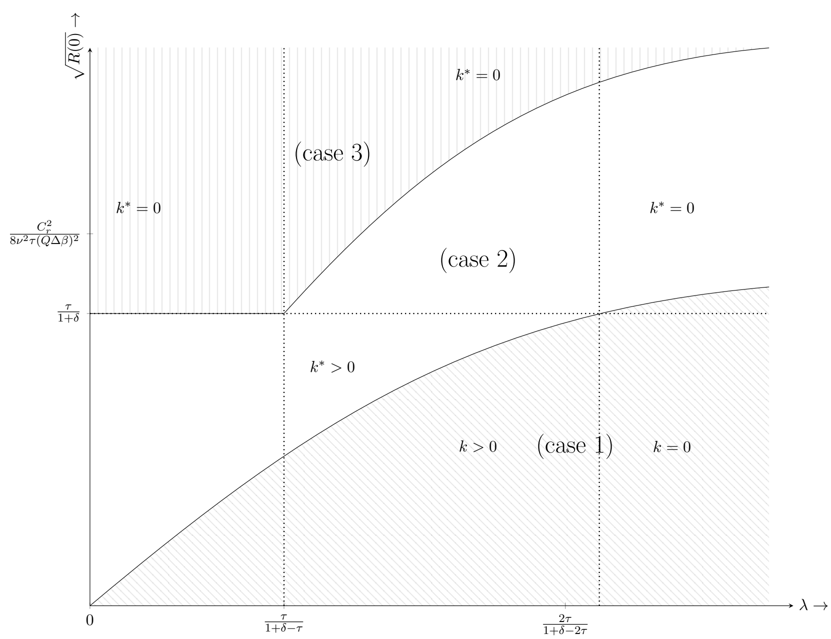


Fig. 7. Incentives from proposition 3 when $\underline{q}=\bar{q}=Q$ and $\frac{C_r}{Q\Delta\beta}>\frac{\nu\tau 2\sqrt{2}}{\sqrt{1+\delta}}$

We can now turn to some comparative statics to better understand the characteristics of the cooling-off period.

Corollary 1. *When the demand is inelastic ($\underline{q}=\bar{q}=Q$), the optimal cooling-off period, k^*, is decreasing in λ.*

Proof. The proof is available in Appendix A. □

In practice, however, the gains from corruption and revolving may be several times greater than what an individual who directly joins the private sector instead can earn in two periods. Only a few cases are valid when $\frac{\tau}{1+\delta} \gg R(0)$ and $\frac{C_\tau}{Q\Delta\beta} < \frac{\nu\tau 2\sqrt{2}}{\sqrt{1+\delta}}$. Under these conditions, the cooling-off period as a function of λ is presented below:

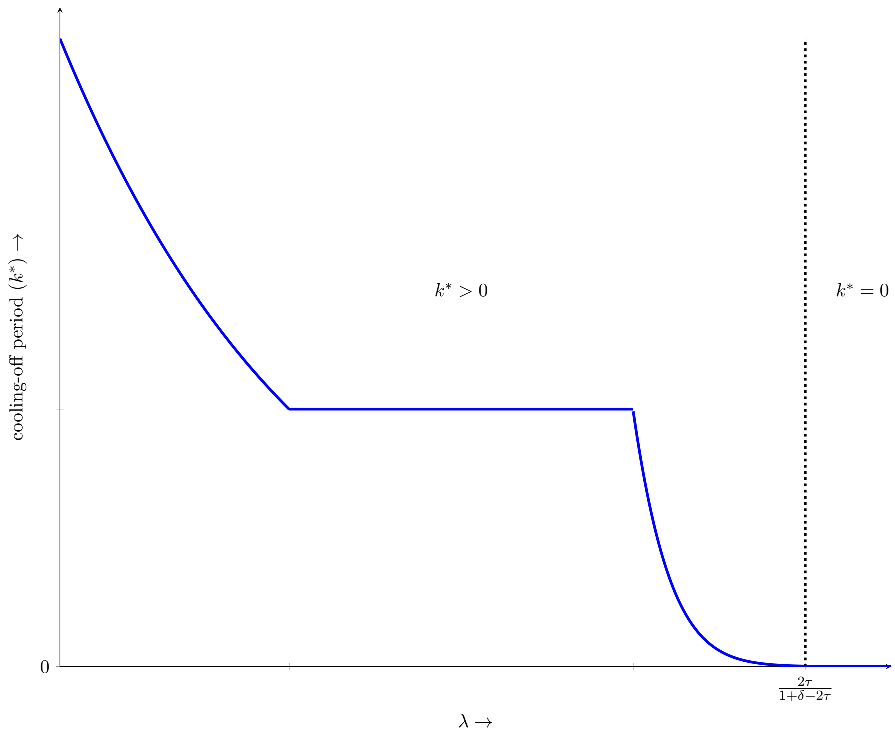


Fig. 8. Cooling-off period as a function of λ when $\frac{\tau Q\Delta\beta}{1+\delta} \gg R(0)$

Corollary 2. *When demand is inelastic, the optimal cooling-off period, k^*, is increasing in $\Delta\beta$, Q, and τ.*

Proof. The proof is available in Appendix A. □

This result has strong implications for the kind of industries where a cooling-off period might be necessary. Industries and sectors that are extensively rule based and the levels of uncertainty are lower (lower $\Delta\beta$, for example in the railroad sector) do not necessitate a high cooling-off period. On the other hand, industries with a high degree of uncertainty, for example, the finance sector where advancements such as algorithmic trading increase the uncertainty, necessitate a high cooling-off period.

The second implication of the above lemma is that larger industries (those with higher demand Q) require longer cooling-off periods. The intuition is straight forward. When the goods from an industry are in greater demand, the stakes are higher and the benefit of collusion ($Q\Delta\beta$) and regulatory capture are higher for the efficient firm. Lastly, when the regulator receives a smaller share for corrupt activities, it reduces the incentives for the regulator to be corrupt and therefore decreases the need for a cooling-off period (regulatory schooling dominates regulatory capture).

6. Discussion

The theory of the revolving door developed in this paper sheds light on a very relevant aspect of life as a regulator. The incentive to revolve is ever present, as are the incentives to bend the rules in favor of the future employer. The key contribution of this paper is to study the use of the cooling-off period (gap between public and private employment) as an instrument to regulate the revolving door. Proposition 1 states that when there is no possibility of regulatory capture, regulators should be allowed to freely revolve out of the public sector and into the private sector. The principal benefits because future revolving possibilities allow the principal to shift some of the first period wage burden onto the private sector in the second period. This is primarily due to regulatory schooling, that is, the knowledge acquired in the public sector is useful for the private sector. Without corruption, the principal faces no trade-off between regulatory schooling and regulatory capture.

Introducing corruption into the model complicates the picture because the principal now faces a trade-off. While there are clear benefits of allowing regulators to revolve, it is possible that the regulators would do favors for the regulated firm in exchange for a big bonus after revolving. Our theory presents strong implications for the wage incentives offered and optimal utilization of the cooling-off period. Proposition 4 shows that the cooling-off period is optimal only for advanced economies where the cost of raising public funds λ is relatively small. This is because public sector compensation depends on λ. When λ is small, the capture-proofness constraint binds. In this case, the principal may use the cooling-off period to economize over this bonus.

Our findings are also in line with what is observed in practice. Figure 1 shows that the cooling-off periods are most commonly observed in countries with higher GDP per capita. Our results also show that cooling-off periods are only optimal in countries with lower social costs of raising public funds. Therefore, the cooling-off period is a tool that must be used with parsimony and a one-size-fits-all approach is not optimal. In practice, revolving appears to be most common in sectors like finance, technology, and pharmaceuticals. All of these sectors are characterized by rapid advancements in technology, requirement of specialized skills and therefore greater uncertainty (higher $\Delta\beta$). Our theory suggests that those revolving into these sectors must face longer cooling-off periods.

7. Conclusion

The revolving door is an inescapable reality of life as a public sector employee. Many countries have come to recognize the perverse effects of future employment possibilities on current behavior. Laws regulating the behavior of former regulators are becoming commonplace including introduction of lengthy cooling-off periods. Yet there is scant evidence relating to the optimality of the cooling-off period. In this paper, we develop a theory of the revolving door and find the conditions under which a cooling-off period is optimal. The revolving door represents a trade-off for the principal. Future job opportunities help in shifting some of the budgetary burden onto the private sector but also allow for collusive activities between the regulator and the firm. We show that without corruption, the cooling-off period only represents a cost without any benefit. On the other hand, when corruption is an explicit risk, cooling-off periods might be useful in rich and advanced economies and in sectors where there is greater uncertainty about the firm costs.

References

Bar-Isaac, H. & Shapiro, J. (2011), 'Credit ratings accuracy and analyst incentives', *The American Economic Review* **101**(3), 120–124.

Barbosa, K. & Straub, S. (2017), The Value of Revolving Doors in Public Procurement, TSE Working Papers 17-873, Toulouse School of Economics (TSE), revised May 2020.

Baron, D. P. & Myerson, R. B. (1982), 'Regulating a monopolist with unknown costs', *Econometrica* **50**(4), 911–930.

Bertrand, M., Bombardini, M. & Trebbi, F. (2014), 'Is it Whom You Know or What You Know? An Empirical Assessment of the Lobbying Process', *The American Economic Review* **104**(12), 3885–3920.

Bond, P. & Glode, V. (2014), 'The labor market for bankers and regulators', *The Review of Financial Studies* **27**(9), 2539–2579.

Canayaz, M. I., Martinez, J. V. & Ozsoylev, H. N. (2015), Is the revolving door of Washington a back door to excess corporate returns?, Koç University-TUSIAD Economic Research Forum Working Papers 1507, Koç University-TUSIAD Economic Research Forum.

Center for Responsive Politics (2021), 'Center for responsive politics', `https://www.opensecrets.org/revolving/top.php?display=I`.

Che, Y.-K. (1995), 'Revolving doors and the optimal tolerance for agency collusion', *The RAND Journal of Economics* **26**(3), 378–397.

Chiara, A. D. & Schwarz, M. (2021), A dynamic theory of regulatory capture, CESifo Working Paper 8968, Munich.

Cornaggia, J., Cornaggia, K. J. & Xia, H. (2016), 'Revolving doors on Wall Street', *Journal of Financial Economics* **120**(2), 400–419.

DeHaan, E., Kedia, S., Koh, K. & Rajgopal, S. (2015), 'The revolving door and the SEC's enforcement outcomes: Initial evidence from civil litigation', *Journal of Accounting and Economics* **60**(2), 65 – 96.

Duchin, R. & Sosyura, D. (2014), 'Safer ratios, riskier portfolios: Banks' response to government aid', *Journal of Financial Economics* **113**(1), 1–28.

Emery, L. P. & Faccio, M. (2020), 'Exposing the Revolving Door in Executive Branch Agencies', *Available at SSRN: https://ssrn.com/abstract=3732484* .

Fellingham, J. C., Newman, D. & Suh, Y. S. (1985), 'Contracts without memory in multiperiod agency models', *Journal of Economic Theory* **37**(2), 340–355.

Gely, R. & Zardkoohi, A. (2001), ‘Measuring the effects of post-government-employment restrictions’, *American Law and Economics Review* **3**(2), 288–301.

Kempf, E. (2020), ‘The job rating game: Revolving doors and analyst incentives’, *Journal of Financial Economics* **135**(1), 41 – 67.

Laffont, J.-J. & Martimort, D. (2002), *The Theory of Incentives: The Principal-Agent Model*, Princeton University Press.

Law, M. T. & Long, C. X. (2011), ‘Revolving door laws and state public utility commissioners’, *Regulation & Governance* **5**(4), 405–424.

Law, M. T. & Long, C. X. (2012), ‘What do revolving-door laws do?’, *The Journal of Law and Economics* **55**(2), 421–436.

Lucca, D., Seru, A. & Trebbi, F. (2014), ‘The revolving door and worker flows in banking regulation’, *Journal of Monetary Economics* **65**, 17–32.

Lucifora, C. & Meurs, D. (2006), ‘The Public Sector Pay Gap In France, Great Britain and Italy’, *Review of Income and Wealth* **52**(1), 43–59.

Luechinger, S. & Moser, C. (2014), ‘The value of the revolving door: Political appointees and the stock market’, *Journal of Public Economics* **119**, 93–107.

Luechinger, S. & Moser, C. (2020), ‘The European Commission and the revolving door’, *European Economic Review* **127**, 103461.

Melly, B. (2005), ‘Public-private sector wage differentials in Germany: Evidence from quantile regression’, *Empirical Economics* **30**(2), 505–520.

Mizala, A., Romaguera, P. & Gallegos, S. (2011), ‘Public–private wage gap in Latin America (1992–2007): A matching approach’, *Labour Economics* **18**, S115–S131.

Morgan, T. D. (1980), ‘Appropriate limits on participation by a former agency official in matters before an agency’, *Duke Law Journal* **1980**(1), 1–63.

OECD (2015), *Managing conflict of interest: Pre- and post-public employment.*

Salant, D. J. (1995), 'Behind the revolving door: A new view of public utility regulation', *The RAND Journal of Economics* **26**(3), 362–377.

Shive, S. A. & Forster, M. M. (2016), 'The revolving door for financial regulators', *Review of Finance* **21**(4), 1445–1484.

Spiller, P. T. (1990), 'Politicians, interest groups, and regulators: A multiple-principals agency theory of regulation, or "let them be bribed"', *The Journal of Law Economics* **33**(1), 65–101.

Tabakovic, H. & Wollmann, T. G. (2018), From revolving doors to regulatory capture? evidence from patent examiners, Working Paper 24638, National Bureau of Economic Research.

Tenekedjieva, A.-M. (2021), 'The revolving door and insurance solvency regulation', *Available at SSRN: https://ssrn.com/abstract=3762573* .

Tirole, J. (1986), 'Hierarchies and bureaucracies: On the role of collusion in organizations', *Journal of Law, Economics, & Organization* **2**(2), 181–214.

Transparency International (2017), 'Access all areas: When EU politicians become lobbyists'.

Vidal, J. B., Draca, M. & Fons-Rosen, C. (2012), 'Revolving door lobbyists', *The American Economic Review* **102**(7), 3731.

Wayne, L. (2004), 'Ex-pentagon Official Gets 9 Months for Conspiring to Favor Boeing', *The New York Times* .

Zaring, D. (2013), 'Against being against the revolving door', *University of Illinois Law Review* **2013**, 507–550.

Appendix A

The principal's instantaneous objective function is given by:[11]

$$EW_t = E\Big\{\pi_t + [S(q_t) - P(q_t)q_t] - (1+\lambda)(w_t + T_t)\Big\} \tag{17}$$

where $S(q_t)$ is the gross consumer surplus, λ

$$\begin{aligned} W &= S(q) - P(q)q - (1+\lambda)[w + \pi - P(q)q + \beta q] + \pi \\ &= S(q) + \lambda P(q)q - \lambda\pi - (1+\lambda)(\beta q + w) \end{aligned}$$

where w is the wage given to the regulator. Therefore, under regulation-by-the-book, the principal maximizes:

$$EW = \nu[S(\underline{q}) + \lambda P(\underline{q})\underline{q} - (1+\lambda)\underline{\beta}\underline{q} - \lambda\underline{\pi}] + (1-\nu)[S(\bar{q}) - \lambda P(\bar{q})\bar{q} - (1+\lambda)\bar{\beta}\bar{q} - \lambda\bar{\pi}] - (1+\lambda)Ew \tag{18}$$

subject to the following constraints:

$$\bar{\pi} = \bar{t} + P(\bar{q})\bar{q} - \bar{\beta}\bar{q} \geq 0 \tag{19}$$

$$\underline{\pi} = \underline{t} + P(\underline{q})\underline{q} - \underline{\beta}\underline{q} \geq 0 \tag{20}$$

$$\bar{t} + P(\bar{q})\bar{q} - \bar{\beta}\bar{q} \geq \underline{t} + P(\underline{q})\underline{q} - \bar{\beta}\underline{q} \tag{21}$$

$$\underline{t} + P(\underline{q})\underline{q} - \underline{\beta}\underline{q} \geq \bar{t} + P(\bar{q})\bar{q} - \underline{\beta}\bar{q} \tag{22}$$

$$EU \geq u \tag{23}$$

where (19) and (20) are the individual rationality constraints for $\bar{\beta}$ and $\underline{\beta}$ respectively. Equations (21) and (22) are the incentive compatibility constraints for $\bar{\beta}$ and $\underline{\beta}$. To simplify the problem, note that (20) can be ignored because of (19) and (22). Now using (22) and $\bar{\beta} > \underline{\beta}$, (21) is redundant.

[11]See Laffont & Martimort (2002) for more details on this formulation.

The reduced constraints for the problem are given below:

$$\bar{\pi} = 0 \tag{24}$$

$$\underline{t} + P(\underline{q})\underline{q} - \underline{\beta}\underline{q} = \bar{t} + P(\bar{q})\bar{q} - \underline{\beta}\bar{q} \tag{25}$$

$$\bar{q} \leq \underline{q} \tag{26}$$

The final condition (26) is obtained by adding constraints (21) and (22). It is called the monotonicity condition. Laffont & Martimort (2002) refer to this condition as the implementability condition. From (24) we have $\bar{t} = \bar{\beta}\bar{q} - P(\bar{q})\bar{q}$. Substituting this into (25), we obtain that $\underline{\pi} = \bar{q}\Delta\beta$. Then the principal maximizes:

$$EW = \nu[S(\underline{q}) + \lambda P(\underline{q})\underline{q} - (1+\lambda)\underline{\beta}\underline{q} - \lambda\bar{q}\Delta\beta] + (1-\nu)[S(\bar{q}) + \lambda P(\bar{q})\bar{q} - (1+\lambda)\bar{\beta}\bar{q}]$$

Maximizing the above with respect to $\underline{q}$ and $\bar{q}$, we obtain:

$$S'(\underline{q}) + \lambda(P'(\underline{q})\underline{q} + P(\underline{q})) = (1+\lambda)\underline{\beta} \tag{27}$$

$$S'(\bar{q}) + \lambda(P'(\bar{q})\bar{q} + P(\bar{q})) = (1+\lambda)\bar{\beta} + \frac{\nu\lambda\Delta\beta}{1-\nu} \tag{28}$$

The Lerner indices are:

$$L_{\underline{q}} = \frac{\underline{p} - \underline{\beta}}{\underline{p}} = \frac{\lambda}{1+\lambda}\frac{1}{\eta_{\underline{q}}} \tag{29}$$

$$L_{\bar{q}} = \frac{\bar{p} - \bar{\beta}}{\bar{p}} = \frac{\lambda}{1+\lambda}\frac{1}{\eta_{\bar{q}}} + \frac{\nu\lambda\Delta\beta}{\bar{p}(1+\lambda)(1-\nu)} \tag{30}$$

where $\underline{p} = P(\underline{q}) = S'(\underline{q}), \eta_{\underline{q}} = -\frac{\underline{p}}{\underline{q}}\frac{1}{P'(\underline{q})}$ and $\bar{p} = P(\bar{q}) = S'(\bar{q}), \eta_{\bar{q}} = -\frac{\bar{p}}{\bar{q}}\frac{1}{P'(\bar{q})}$.

Derivation of the principal's problem

When the regulator exerts effort $e \geq 0$ to obtain pivotal information about the type of the firm, the total welfare is:

$$EW = e(1-\nu)[S(\bar{q}) + \lambda P(\bar{q})\bar{q} - (1+\lambda)\bar{\beta}\bar{q}] + (1-e)(1-\nu)[S(\bar{q}) + \lambda P(\bar{q})\bar{q} - (1+\lambda)\bar{\beta}\bar{q}]$$
$$+ (1-e)\nu[S(\underline{q}) + \lambda P(\underline{q})\underline{q} - (1+\lambda)\underline{\beta q} - \lambda\bar{q}\Delta\beta]$$
$$+ e\nu[S(\underline{q}) + \lambda P(\underline{q})\underline{q} - (1+\lambda)\underline{\beta q}] - (1+\lambda)Ew$$

The regulator's effort is unobservable to the principal. Therefore, to avoid moral hazard, the principal has to offer optimal incentives. We derive these optimal incentives for each case in the following propositions.

Proof of Lemma 4.1

The expected utility of the firm employee is:

$$EU^f = w^f + e^f\Delta w^f - \frac{\theta(e^f)^2}{2} \tag{31}$$

Using the first order condition, we obtain:

$$e^f = \frac{\Delta w^f}{\theta} \tag{32}$$

The firm's problem is to:

$$\max_{w^f,\Delta w^f} e^f C - e^f\Delta w^f - w^f$$

such that

$$w^f + e^f\Delta w^f - \frac{\theta(e^f)^2}{2} \geq u$$
$$e^f = \frac{\Delta w^f}{\theta}$$
$$w^f \geq 0$$
$$\Delta w^f \geq 0$$

Simplifying, we have the following problem:

$$\max_{w^f, \Delta w^f} \frac{\Delta w^f C}{\theta} - \frac{(\Delta w^f)^2}{\theta} - w^f$$

such that

$$w^f + \frac{(\Delta w^f)^2}{2\theta} \geq u \tag{33}$$

$$w^f \geq 0 \tag{34}$$

$$\Delta w^f \geq 0 \tag{35}$$

Setting up the Lagrangian, we have:

$$\mathcal{L} = \frac{\Delta w^f C}{\theta} - \frac{(\Delta w^f)^2}{\theta} - w^f + \xi_1 \left[w^f + \frac{(\Delta w^f)^2}{2\theta} \right] + \xi_2 w^f + \xi_3 \Delta w^f$$

The corresponding FOCs are:

$$\frac{\partial \mathcal{L}}{\partial w^f} : \xi_1 + \xi_2 = 1$$
$$\frac{\partial \mathcal{L}}{\partial \Delta w^f} : \frac{C}{\theta} - \frac{2\Delta w^f}{\theta} + \frac{\xi_1 \Delta w^f}{2\theta} + \xi_3 = 0$$

When the bonus Δw^f is large enough then constraint (33) never binds. This implies that $\xi_1 = 0$. From the first foc, we have that $\xi_2 = 1$ and consequently, $w^f = 0$. Then the only solution arises when $\xi_3 = 0$. Then we have the following:

$$w^f = 0$$
$$\Delta w^f = \frac{C}{2}$$
$$E\pi^f = \frac{C^2}{4\theta}$$

Since (33) is not binding, the above incentives are optimal only when $C > \sqrt{8\theta u}$. Fellingham et al. (1985) show that under risk neutrality and additive separability of utility, the second period incentives are a repetition of the first period.

Lastly, note that this incentive scheme would never attract type $\bar{\theta}$ because when $\sqrt{8\bar{\theta}u} > C$, the bonus is never large enough to satisfy the IR constraint (33) for type $\bar{\theta}$ and the outside option offers higher utility.

Proof of Lemma 4.2

We have the following problem for the firm:

$$\max_{w_r^f, \Delta w_r^f} e_r^f C_r - e_r^f \Delta w_r^f - w_r^f$$

such that

$$w_r^f + e_r^f \Delta w_r^f - \frac{\theta (e_r^f)^2}{2} \geq u + \frac{1}{2\theta}\left[\frac{\nu\lambda\bar{q}\Delta\beta}{1+\lambda}\right]^2$$

$$e_r^f = \frac{\Delta w_r^f}{\theta}$$

$$w_r^f \geq 0$$

$$\Delta w_r^f \geq 0$$

Substituting the value of e_r^f throughout the problem, we have the following reduced problem:

$$\max_{w_r^f, \Delta w_r^f} \frac{\Delta w_r^f C_r}{\theta} - \frac{(\Delta w_r^f)^2}{\theta} - w_r^f$$

such that

$$w_r^f + \frac{(\Delta w_r^f)^2}{2\theta} \geq u + \frac{1}{2\theta}\left[\frac{\nu\lambda\bar{q}\Delta\beta}{1+\lambda}\right]^2 \tag{36}$$

$$w_r^f \geq 0 \tag{37}$$

$$\Delta w_r^f \geq 0 \tag{38}$$

Setting up the Lagrangian, we have:

$$\mathcal{L} = \frac{\Delta w_r^f C_r}{\theta} - \frac{(\Delta w_r^f)^2}{\theta} - w_r^f + \xi_1 w_r^f + \xi_2 \Delta w_r^f + \Omega\left[w_r^f + \frac{(\Delta w_r^f)^2}{2\theta} - u - \frac{1}{2\theta}\left[\frac{\nu\lambda\bar{q}\Delta\beta}{1+\lambda}\right]^2\right]$$

We have the following FOCs:

$$\frac{\partial \mathcal{L}}{\partial w_r^f} : \xi_1 + \Omega = 1 \tag{39}$$

$$\frac{\partial \mathcal{L}}{\partial \Delta w_r^f} : \frac{C_r}{\theta} - \frac{2\Delta w_r^f}{\theta} + \xi_2 + \Omega = 0 \tag{40}$$

Under assumption 3, we have that $C_r > \sqrt{8\theta u + 4(\nu \bar{q} \Delta\beta)^2} > \sqrt{8\theta u + 4\left(\frac{\nu\lambda\bar{q}\Delta\beta}{1+\lambda}\right)^2}$ and that (36) will not bind ($\Omega = 0$), we have only one case when $\xi_2 = 0$. From equations (39) and (40), we have that:

$$\begin{aligned}
\Delta w_r^f &= \frac{C_r}{2} \\
w_r^f &= 0 \\
E\pi &= \frac{C_r^2}{4\theta}
\end{aligned} \tag{41}$$

Substituting the expression for Δw_r^f into the IR constraint, we obtain the necessary condition:

$$\frac{C_r^2}{8\theta} > u$$

and the necessary condition is $C_r > \sqrt{8\theta u}$.

Proof of Lemma 4.3 & Proposition 2

The expected utility of the regulator is:

$$EU_r = w_1 + \frac{(C_r)^2}{8\theta(1+\delta)^{k+1}} + \frac{\nu^2}{2\theta}\left[\Delta w_1 + \frac{\Delta_r}{(1+\delta)^{k+1}}\right]^2 \tag{42}$$

The principal then maximizes the following expected welfare function:

$$EW = (1-\nu)W(\bar{q}) + \nu W(\underline{q}) - (1-e_1)\nu\lambda\bar{q}\Delta\beta - (1+\lambda)Ew_r \tag{43}$$

where $W(q) \equiv S(q) + \lambda P(q)q - (1+\lambda)\beta q$. Substituting the values of e_1, EV_r, and Ew_r, we obtain the following welfare function:

$$EW = (1-\nu)W(\bar{q}) + \nu W(\underline{q}) - \left(1 - \frac{\nu\Delta w_1}{\theta} - \frac{\nu\Delta_r}{\theta(1+\delta)^{k+1}}\right)\nu\lambda\bar{q}\Delta\beta \\ - (1+\lambda)\left[w_1 + \frac{(\nu\Delta w_1)^2}{\theta} + \frac{\nu^2\Delta w_1\Delta_r}{\theta(1+\delta)^{k+1}}\right] \quad (44)$$

The principal maximizes the above subject to:

$$w_1 + \frac{C_r^2}{(1+\delta)^{k+1}} + \frac{\nu^2}{2\theta}\left[\Delta w_1 + \frac{\Delta_r}{(1+\delta)^{k+1}}\right]^2 \geq \frac{C^2}{8\theta}\left[\frac{2+\delta}{1+\delta}\right] \quad (45)$$

$$w_1 \geq 0 \quad (46)$$

$$\Delta w_1 \geq 0 \quad (47)$$

$$k \geq 0 \quad (48)$$

Setting up the Lagrangian, we have:

$$\mathcal{L} = (1-\nu)W(\bar{q}) + \nu W(\underline{q}) - \left(1 - \frac{\nu\Delta w_1}{\theta} - \frac{\nu\Delta_r}{\theta(1+\delta)^{k+1}}\right)\nu\lambda\bar{q}\Delta\beta - (1+\lambda)\left[w_1 + \frac{(\nu\Delta w_1)^2}{\theta} + \frac{\nu^2\Delta w_1\Delta_r}{\theta(1+\delta)^{k+1}}\right] \\ + \Omega_1\left[w_1 + \frac{C_r^2}{(1+\delta)^{k+1}} + \frac{\nu^2}{2\theta}\left[\Delta w_1 + \frac{\Delta_r}{(1+\delta)^{k+1}}\right]^2 - \frac{C^2}{8\theta}\left[\frac{2+\delta}{1+\delta}\right]\right] + \Omega_2 w_1 + \Omega_3 k + \Omega_4\Delta w_1$$

We have the following KKT conditions:

$$\Omega_1 + \Omega_2 = 1 + \lambda \quad (49)$$

$$\lambda\bar{q}\Delta\beta - 2(1+\lambda)\Delta w_1 - \frac{(1+\lambda)\Delta_r}{(1+\delta)^{k+1}} + \Omega_1\left[\Delta w_1 + \frac{\Delta_r}{(1+\delta)^{k+1}}\right] + \frac{\theta\Omega_4}{\nu^2} = 0 \quad (50)$$

$$-\frac{\nu^2\lambda\bar{q}\Delta\beta\Delta_r ln(1+\delta)}{\theta(1+\delta)^{k+1}} - \frac{\Omega_1 C_r^2 ln(1+\delta)}{(1+\delta)^{k+1}} - \frac{\Omega_1 ln(1+\delta)}{\theta}\left[\frac{\nu\Delta_r}{(1+\delta)^{k+1}}\right]^2 \\ + \frac{(1+\lambda-\Omega_1)\nu^2\Delta w_1\Delta_r ln(1+\delta)}{\theta(1+\delta)^{k+1}} + \Omega_3 = 0 \quad (51)$$

$$S'(\underline{q}) + \lambda[P'(\underline{q})\underline{q} + P(\underline{q})] = (1+\lambda)\underline{\beta} \quad (52)$$

$$S'(\bar{q}) + \lambda[P'(\bar{q})\bar{q} + P(\bar{q})] = (1+\lambda)\bar{\beta} + \frac{(1-e_1)\nu\lambda\Delta\beta}{1-\nu} \quad (53)$$

$$\Omega_1\left[w_1 + \frac{C_r^2}{(1+\delta)^{k+1}} + \frac{\nu^2}{2\theta}\left[\Delta w_1 + \frac{\Delta_r}{(1+\delta)^{k+1}}\right]^2 - \frac{C^2}{8\theta}\left[\frac{2+\delta}{1+\delta}\right]\right] = 0 \quad (54)$$

$$\Omega_2 w_1 = 0 \quad (55)$$

$$\Omega_3 k = 0 \quad (56)$$

$$\Omega_4 \Delta w_1 = 0 \quad (57)$$

Where equations (52) and (53) follow from $W(q) = S(q) + \lambda P(q)q - (1+\lambda)\beta q$. Furthermore, these two equations will remain the same for each case of the optimization problem, with the only the equilibrium effort varying across cases. So to avoid repetition, we solve for the Lerner indices and quantities (by assuming a downward sloping demand function) beforehand:

$$L_{\underline{q}} = \frac{\underline{p} - \underline{\beta}}{\underline{p}} = \frac{\lambda}{1+\lambda}\frac{1}{\eta_{\underline{q}}} \quad (58)$$

$$L_{\bar{q}} = \frac{\bar{p} - \bar{\beta}}{\bar{p}} = \frac{\lambda}{1+\lambda}\frac{1}{\eta_{\bar{q}}} + \frac{\nu\lambda\Delta\beta}{\bar{p}(1+\lambda)(1-\nu)} - \frac{e_1\nu\lambda\Delta\beta}{\bar{p}(1+\lambda)(1-\nu)} \quad (59)$$

where $\underline{p} = P(\underline{q}) = S'(\underline{q}), \eta_{\underline{q}} = -\frac{\underline{p}}{\underline{q}}\frac{1}{P'(\underline{q})}$ and $\bar{p} = P(\bar{q}) = S'(\bar{q}), \eta_{\bar{q}} = -\frac{\bar{p}}{\bar{q}}\frac{1}{P'(\bar{q})}$. To solve for quantities, we use $P(q) = m - nq$ and $S'(q) = P(q)$ in equations (52) and (53) to obtain:

$$\underline{q} = \frac{(1+\lambda)[m - \underline{\beta}]}{(1+2\lambda)n}$$

$$\bar{q} = \frac{(1+\lambda)[m - \bar{\beta}] - \frac{\nu\lambda\Delta\beta}{1-\nu} + \frac{e_1\nu\lambda\Delta\beta}{1-\nu}}{(1+2\lambda)n} \quad (60)$$

The equilibrium effort in equations (102) and (103) is determined by the incentives offered by the principal. We can now proceed to solve for the optimal wages in the first period. We then have the following cases:

CASE I: $\Omega_1 = 0, \Omega_2 > 0, \Omega_4 = 0$

In this case, constraint (45) does not bind. First, let $\Omega_3 = 0$, then equation (51) reduces to:

$$\Delta w_1 = \frac{\lambda\bar{q}\Delta\beta}{1+\lambda}$$

but given the conditions for the Lagrangian multipliers, $\Delta w_1 = \frac{\lambda\bar{q}\Delta\beta}{2(1+\lambda)} - \frac{\Delta_r}{2(1+\delta)^{k+1}} < \frac{\lambda\bar{q}\Delta\beta}{1+\lambda}$, therefore $\Omega_3 = 0$ is not possible and it must be that $k = 0$. Here we have $w_1 = 0$ and the IR constraint, equation (45), holds with strict inequality. Now using equation (50), we have the following expressions for Δw_1 and e_1:

$$\Delta w_1 = \frac{\lambda \bar{q} \Delta \beta}{2(1+\lambda)} - \frac{\Delta_r}{2(1+\delta)} \tag{61}$$
$$e_1 = \frac{\nu}{\theta}\left[\frac{\lambda \bar{q} \Delta \beta}{2(1+\lambda)} + \frac{\Delta_r}{1+\delta}\right] \tag{62}$$

Further $w_1 = 0$ because $\Omega_2 > 0$. Using equation (61), $\Omega_4 = 0$ and $\Omega_1 = 0$ and $C_r = C$, we have the following two necessary conditions:

$$\frac{\lambda \bar{q} \Delta \beta}{1+\lambda} > \frac{\Delta_r}{1+\delta}$$
$$\frac{\lambda \bar{q} \Delta \beta}{2(1+\lambda)} + \frac{\Delta_r}{1+\delta} > \frac{C}{2\nu}$$

CASE II: $\Omega_1 = 0, \Omega_2 > 0, \Omega_4 > 0$

Here, we have that $w_1 = \Delta w_1 = 0$. Similar to Case I, $\Omega_3 = 0$ is not possible (since $\Delta w_1 = 0 < \frac{\lambda \bar{q} \Delta \beta}{1+\lambda}$) and k must be 0. The effort exerted in the first period then is:

$$e_1 = \frac{\nu \Delta_r}{\theta(1+\delta)} \tag{63}$$

Using (50) and that $\Omega_4 > 0$, $\Omega_1 = 0$ and $C_r = C$, we have the following two necessary conditions:

$$\frac{\Delta_r}{1+\delta} > \frac{\lambda \bar{q} \Delta \beta}{1+\lambda} \tag{64}$$
$$\frac{\Delta_r}{1+\delta} > \frac{C}{2\nu} \tag{65}$$

CASE III: $\Omega_1 > 0, \Omega_2 = 0, \Omega_4 = 0$

Now, using equation (49), we have the $\Omega_1 = 1 + \lambda$. For the optimal cooling-off period, note that for $\Omega_1 = 1 + \lambda$, (51) becomes:

$$-\frac{\nu^2 \lambda \bar{q} \Delta \beta \Delta_r ln(1+\delta)}{\theta(1+\delta)^{k+1}} - \frac{\Omega_1 C_r^2 ln(1+\delta)}{(1+\delta)^{k+1}} - \frac{\Omega_1 ln(1+\delta)}{\theta}\left[\frac{\nu \Delta_r}{(1+\delta)^{k+1}}\right]^2 + \Omega_3 = 0$$

Hence $\Omega_3 > 0$ and $k = 0$. Next, substituting $\Omega_1 = 1 + \lambda$ into equation (50), we have:

$$\Delta w_1 = \frac{\lambda \bar{q} \Delta \beta}{1+\lambda} \tag{66}$$

$$e_1 = \frac{\nu}{\theta}\left[\frac{\lambda \bar{q} \Delta\beta}{1+\lambda} + \frac{\Delta_r}{(1+\delta)}\right] \tag{67}$$

The binding IR constraint gives us the following solution for w_1:

$$w_1 = \frac{C^2}{8\theta} - \frac{\nu^2}{2\theta}\left[\frac{\lambda \bar{q} \Delta\beta}{1+\lambda} + \frac{\Delta_r}{(1+\delta)}\right]^2 \tag{68}$$

Using $w_1 > 0$, we have:

$$\frac{\lambda \bar{q} \Delta\beta}{1+\lambda} + \frac{\Delta_r}{(1+\delta)} < \frac{C}{2\nu} \tag{69}$$

CASE IV: $\Omega_1 > 0, \Omega_2 > 0, \Omega_4 = 0$

Here $w_1 = 0$ and $0 < \Omega_1 < 1+\lambda$. The latter implies that $\Delta w_1 < \frac{\lambda \bar{q} \Delta\beta}{1+\lambda} < \bar{q}\Delta\beta$. Let $\Omega_3 = 0$. Then the following must be true:

$$\frac{\nu^2 \lambda \bar{q} \Delta\beta \Delta_r ln(1+\delta)}{\theta(1+\delta)^{k+1}} + \frac{\Omega_1 ln(1+\delta)}{\theta}\left[\frac{\nu \Delta_r}{(1+\delta)^{k+1}}\right]^2 + \frac{\Omega_1 C_r^2 ln(1+\delta)}{(1+\delta)^{k+1}} = \frac{(1+\lambda-\Omega_1)\nu^2 \Delta w_1 \Delta_r ln(1+\delta)}{\theta(1+\delta)^{k+1}} \tag{70}$$

But this cannot be true since $\Delta w_1 < \frac{\lambda \bar{q} \Delta\beta}{1+\lambda}$. Hence $\Omega_3 > 0$ and $k = 0$. Further, since the IR constraint (45) is binding and $C_r = C$, we have that:

$$\Delta w_1 = \frac{C}{2\nu} - \frac{\Delta_r}{(1+\delta)}$$
$$e_1 = \frac{C}{2\theta}$$

Further, using (50) and $\frac{\lambda \bar{q} \Delta\beta}{2(1+\lambda)} - \frac{\Delta_r}{2(1+\delta)} < \Delta w_1 < \frac{\lambda \bar{q} \Delta\beta}{1+\lambda}$, we have the following conditions:

$$\frac{\lambda \bar{q} \Delta\beta}{2(1+\lambda)} + \frac{\Delta_r}{1+\delta} < \frac{C}{2\nu} < \frac{\Delta_r}{1+\delta} + \frac{\lambda \bar{q} \Delta\beta}{1+\lambda} \tag{71}$$
$$\frac{\Delta_r}{1+\delta} < \frac{\lambda \bar{q} \Delta\beta}{1+\lambda} \tag{72}$$

Furthermore, when $\frac{\Delta_r}{1+\delta} > \frac{\lambda \bar{q} \Delta\beta}{1+\lambda}$ then $\frac{\Delta_r}{1+\delta} > \frac{\lambda \bar{q} \Delta\beta}{2(1+\lambda)} + \frac{\Delta_r}{2(1+\delta)}$, this case is also true when the following is true:

$$\frac{\Delta_r}{1+\delta} < \frac{C}{2\nu} < \frac{\Delta_r}{1+\delta} + \frac{\lambda \bar{q} \Delta\beta}{1+\lambda} \tag{73}$$

$$\frac{\Delta_r}{1+\delta} > \frac{\lambda\bar{q}\Delta\beta}{1+\lambda} \tag{74}$$

CASE V: $\Omega_1 > 0, \Omega_2 > 0, \Omega_4 > 0$

In this case, $w_1 = \Delta w_1 = 0$ and the IR is binding. Similar to Case IV, $\Omega_3 > 0$ and $k = 0$. This can only be true when

$$\frac{\Delta_r}{(1+\delta)} = \frac{C}{2\nu}$$

Hence the solution will be a line when $\frac{\Delta_r}{(1+\delta)} > \frac{\lambda\bar{q}\Delta\beta}{1+\lambda}$.

.1. A linear example

CASE I:

Equation (103) gives us the expression for quantity produced by the inefficient type. To simplify we rewrite it as:

$$\bar{q} = k_1 + k_2 e_1 \tag{75}$$

where $k_1 = \frac{(1+\lambda)[m-\bar{\beta}] - \frac{\nu\lambda\Delta\beta}{1-\nu}}{(1+2\lambda)n}, k_2 = \frac{\frac{\nu\lambda\Delta\beta}{1-\nu}}{(1+2\lambda)n}$ in this case, $e_1 = \frac{\nu}{\theta}\left[\frac{\lambda\bar{q}\Delta\beta}{2(1+\lambda)} + \frac{\Delta_r}{2(1+\delta)}\right]$. Then the above expression can be rewritten solely in terms of exogenous parameters as:

$$\bar{q} = \frac{k_1}{B} + \frac{k_2\Delta_r\nu}{2\theta(1+\delta)B} \tag{76}$$

where $B = \left[1 - \frac{k_2\nu}{\theta}\left(\frac{\lambda\Delta\beta}{2(1+\lambda)}\right)\right]$. Similarly, the necessary conditions can also be expressed solely in terms of exogenous parameters. We begin with the following:

$$\begin{aligned} \frac{\lambda\bar{q}\Delta\beta}{2(1+\lambda)} + \frac{\Delta_r}{2(1+\delta)} &> \frac{C}{2\nu} \\ \implies \frac{\lambda\Delta\beta k_1}{2(1+\lambda)B} + \frac{\Delta_r}{2(1+\delta)}\left[1 + \frac{\lambda\Delta\beta\nu k_2}{\theta 2(1+\lambda)B}\right] &> \frac{C}{2\nu} \\ \implies \frac{\lambda\Delta\beta k_1}{2(1+\lambda)B} + \frac{\Delta_r}{2(1+\delta)B} &> \frac{C}{2\nu} \end{aligned} \tag{77}$$

The second necessary condition gives us:

$$\begin{aligned}
&\frac{\Delta_r}{1+\delta} < \frac{\lambda \bar{q} \Delta\beta}{1+\lambda} \\
&\frac{\Delta_r}{1+\delta} < \frac{\lambda k_1 \Delta\beta}{(1+\lambda)B - \frac{k_2 \nu (1+\lambda)\Delta\beta}{2\theta}} \\
\implies &\frac{\Delta_r}{1+\delta} < \frac{k_1 \Delta\beta}{1 - \frac{k_2 \nu \Delta\beta}{\theta}}
\end{aligned} \tag{78}$$

CASE II:

Here $e_1 = \frac{\nu \Delta_r}{\theta(1+\delta)}$. Therefore $\bar{q}$ becomes:

$$\bar{q} = k_1 + \frac{k_2 \nu \Delta_r}{\theta(1+\delta)}$$

The necessary conditions then become:

$$\begin{aligned}
&\frac{\Delta_r}{1+\delta} > \bar{q}\Delta\beta \\
\implies &\frac{\Delta_r}{1+\delta} > k_1 \Delta\beta + \frac{k_2 \nu \Delta_r \Delta\beta}{\theta(1+\delta)} \\
\implies &\frac{\Delta_r}{1+\delta} > \frac{k_1 \Delta\beta}{1 - \frac{k_2 \nu \Delta\beta}{\theta}}
\end{aligned}$$

and:

$$\frac{\Delta_r}{1+\delta} > \frac{C}{2\nu} \tag{79}$$

CASE III:

In this case:

$$e_1 = \frac{\nu}{\theta}\left[\frac{\lambda \bar{q} \Delta\beta}{1+\lambda} + \frac{\Delta_r}{(1+\delta)}\right] \tag{80}$$

Therefore,

$$\begin{aligned}
&\bar{q} = k_1 + \left[\frac{k_2 \nu \lambda \bar{q} \Delta\beta}{\theta(1+\lambda)} + \frac{k_2 \nu \Delta_r}{\theta(1+\delta)}\right] \\
\implies &\bar{q} = \frac{k_1}{A} + \frac{k_2 \nu \Delta_r}{\theta(1+\delta)A}
\end{aligned}$$

Where $A \equiv \left[1 - \frac{k_2 \lambda \nu \Delta\beta}{\theta(1+\lambda)}\right]$. Note that $1 > B > A$. The necessary condition then becomes:

$$\begin{aligned} \frac{\lambda \bar{q} \Delta\beta}{1+\lambda} + \frac{\Delta_r}{(1+\delta)} &< \frac{C}{2\nu} \\ \implies \frac{\lambda k_1 \Delta\beta}{A(1+\lambda)} + \frac{\lambda k_2 \nu \Delta_r \Delta\beta}{\theta(1+\lambda)(1+\delta)A} + \frac{\Delta_r}{(1+\delta)} &< \frac{C}{2\nu} \\ \implies \frac{\lambda k_1 \Delta\beta}{A(1+\lambda)} + \frac{\Delta_r}{A(1+\delta)} &< \frac{C}{2\nu} \end{aligned} \tag{81}$$

CASE IV:

As shown in the previous section $e_1 = \frac{C}{2\theta}$.

$$\bar{q} = k_1 + \frac{k_2 C}{2\theta}$$

There are two subcases here. We begin with the first set of conditions:

Case IVa

$$\begin{aligned} \frac{\lambda \bar{q} \Delta\beta}{2(1+\lambda)} + \frac{\Delta_r}{2(1+\delta)} < \frac{C}{2\nu} &< \frac{\Delta_r}{(1+\delta)} + \frac{\lambda \bar{q} \Delta\beta}{1+\lambda} \\ \implies \frac{\lambda \Delta\beta k_1}{2(1+\lambda)B} + \frac{\Delta_r}{2(1+\delta)B} < \frac{C}{2\nu} &< \frac{\Delta_r}{(1+\delta)A} + \frac{\lambda \Delta\beta k_1}{(1+\lambda)A} \end{aligned} \tag{82}$$

Along with

$$\begin{aligned} \frac{\Delta_r}{1+\delta} &< \frac{\lambda \bar{q} \Delta\beta}{1+\lambda} \\ \implies \frac{\Delta_r}{1+\delta} &< k_1 \Delta\beta + \frac{k_2 \Delta\beta \nu}{\theta} \left[\frac{C}{2\nu}\right] \end{aligned} \tag{83}$$

Case IVb

We can now focus on the second set of conditions for this case:

$$\begin{aligned} \frac{\Delta_r}{1+\delta} < \frac{C}{2\nu} &< \frac{\Delta_r}{1+\delta} + \frac{\lambda \bar{q} \Delta\beta}{1+\lambda} \\ \frac{\Delta_r}{1+\delta} < \frac{C}{2\nu} &< \frac{\Delta_r}{(1+\delta)A} + \frac{\lambda \Delta\beta k_1}{(1+\lambda)A} \end{aligned} \tag{84}$$

along with

$$\frac{\Delta_r}{1+\delta} > \frac{\lambda\bar{q}\Delta\beta}{1+\lambda}$$
$$\implies \frac{\Delta_r}{1+\delta} > \frac{\lambda}{1+\lambda}\left[k_1\Delta\beta + \frac{k_2\Delta\beta\nu}{\theta}\left[\frac{C}{2\nu}\right]\right] \tag{85}$$

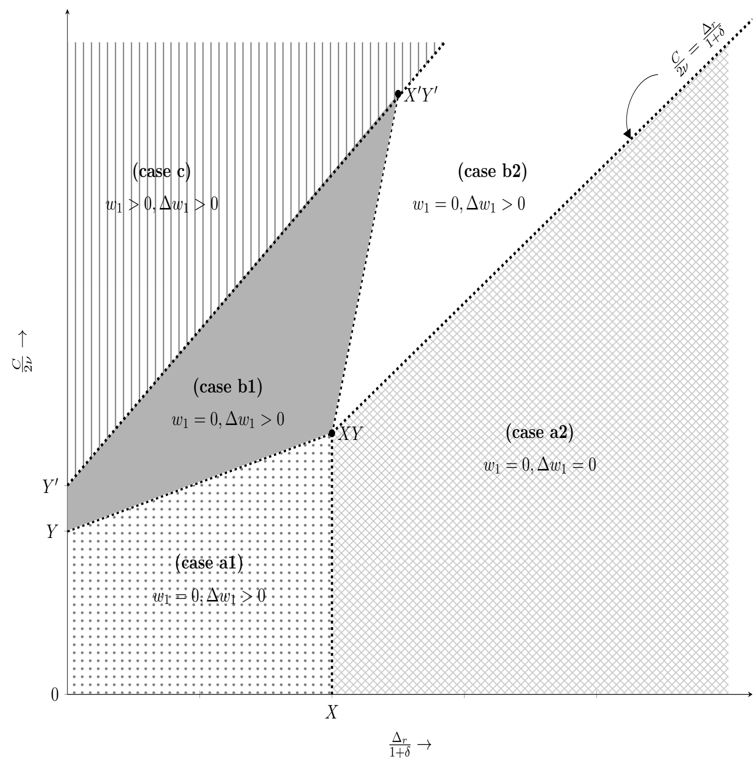


Fig. 9. Incentives from Proposition 2

where $X = \frac{k_1\Delta\beta}{1-\frac{k_2\nu\Delta\beta}{\theta}}$, $Y = \frac{\lambda\Delta\beta k_1}{(1+2\lambda)B}$, and $Y' = \frac{\lambda k_1\Delta\beta}{A(1+\lambda)}$.

Proof of Proposition 3

For elastic demand

$$EW = (1-\nu)W(\bar{q}) + \nu W(\underline{q}) - \big(1-e_1\big)\nu\lambda\bar{q}\Delta\beta - (1+\lambda)\big[w_1 + e_1\nu\Delta w_1\big] \tag{86}$$

Subject to:

$$w_1 + e_1\nu\Delta w_1 + \frac{C_r^2}{8\theta(1+\delta)^{k+1}} - \frac{\theta(e_1)^2}{2} \geq \frac{C^2}{8\theta}\left[\frac{2+\delta}{1+\delta}\right] \tag{87}$$

$$e_1 = \frac{\nu}{\theta}\Delta w_1 \tag{88}$$

$$w_1 \geq 0 \tag{89}$$

$$\Delta w_1 \geq \frac{\tau\bar{q}\Delta\beta}{(1+\delta)^{k+1}} \tag{90}$$

$$k \geq 0 \tag{91}$$

Setting up the Lagrangian:

$$\mathcal{L} = (1-\nu)W(\bar{q}) + \nu W(\underline{q}) - \left(1 - \frac{\nu\Delta w_1}{\theta}\right)\nu\lambda\bar{q}\Delta\beta - (1+\lambda)\left[w_1 + \frac{(\nu\Delta w_1)^2}{\theta}\right]$$
$$+ \Omega_1\left[w_1 + \frac{C_r^2}{8\theta(1+\delta)^{k+1}} + \frac{(\nu\Delta w_1)^2}{2\theta} - \frac{C^2}{8\theta}\left[\frac{2+\delta}{1+\delta}\right]\right] + \Omega_2 w_1$$
$$+ \Omega_3\left[\Delta w_1 - \frac{\tau\bar{q}\Delta\beta}{(1+\delta)^{k+1}}\right] + \Omega_4 k$$

We have the following KKT conditions:

$$\Omega_1 + \Omega_2 = 1 + \lambda \tag{92}$$

$$\lambda\bar{q}\Delta\beta - 2(1+\lambda)\Delta w_1 + \Omega_1\Delta w_1 + \frac{\Omega_3\theta}{\nu^2} = 0 \tag{93}$$

$$-\frac{\Omega_1 C_r^2 ln(1+\delta)}{8\theta(1+\delta)^{k+1}} + \frac{\Omega_3 ln(1+\delta)\tau\bar{q}\Delta\beta}{(1+\delta)^{k+1}} + \Omega_4 = 0 \tag{94}$$

$$S'(\underline{q}) + \lambda[P'(\underline{q})\underline{q} + P(\underline{q})] = (1+\lambda)\underline{\beta} \tag{95}$$

$$S'(\bar{q}) + \lambda[P'(\bar{q})\bar{q} + P(\bar{q})] = (1+\lambda)\bar{\beta} + \frac{(1-e_1)\nu\lambda\Delta\beta}{1-\nu} + \frac{\Omega_3\tau\Delta\beta}{(1+\delta)^{k+1}(1-\nu)} \tag{96}$$

$$\Omega_1\left[w_1 + \frac{C_r^2}{8\theta(1+\delta)^{k+1}} + \frac{(\nu\Delta w_1)^2}{2\theta} - \frac{C^2}{8\theta}\left[\frac{2+\delta}{1+\delta}\right]\right] = 0 \tag{97}$$

$$\Omega_2 w_1 = 0 \tag{98}$$

$$\Omega_3\left[\Delta w_1 - \frac{\tau\bar{q}\Delta\beta}{(1+\delta)^{k+1}}\right] = 0 \tag{99}$$

$$\Omega_4 k = 0 \tag{100}$$

We can first solve for the Lerner indices and quantities (by assuming a downward sloping demand function):

$$L_{\underline{q}} = \frac{\underline{p} - \underline{\beta}}{\underline{p}} = \frac{\lambda}{1+\lambda}\frac{1}{\eta_{\underline{q}}} \tag{101}$$

$$L_{\bar{q}} = \frac{\bar{p} - \bar{\beta}}{\bar{p}} = \frac{\lambda}{1+\lambda}\frac{1}{\eta_{\bar{q}}} + \frac{(1-e_1)\nu\lambda\Delta\beta}{\bar{p}(1+\lambda)(1-\nu)} + \frac{\Omega_3\tau\Delta\beta}{\bar{p}(1+\lambda)(1-\nu)(1+\delta)^{k+1}} \tag{102}$$

where $\underline{p} = P(\underline{q}) = S'(\underline{q}), \eta_{\underline{q}} = -\frac{\underline{p}}{\underline{q}}\frac{1}{P'(\underline{q})}$ and $\bar{p} = P(\bar{q}) = S'(\bar{q}), \eta_{\bar{q}} = -\frac{\bar{p}}{\bar{q}}\frac{1}{P'(\bar{q})}$. To solve for quantities, we use $P(q) = m - nq$ and $S'(q) = P(q)$ in equations (52) and (53) to obtain:

$$\underline{q} = \frac{(1+\lambda)[m-\underline{\beta}]}{(1+2\lambda)n}$$

$$\bar{q} = \frac{(1+\lambda)[m-\bar{\beta}] - \frac{\nu\lambda\Delta\beta}{1-\nu} + \frac{e_1\nu\lambda\Delta\beta}{1-\nu} - \frac{\Omega_3\tau\Delta\beta}{(1+\delta)^{k+1}(1-\nu)}}{(1+2\lambda)n} \tag{103}$$

We begin working through each case.

CASE 1: $\Omega_1 = 0, \Omega_2 > 0, \Omega_3 = 0, \Omega_4 = 0$

In this case, $w_1 = 0$ and:

$$\Delta w_1 = \frac{\lambda\bar{q}\Delta\beta}{2(1+\lambda)} \tag{104}$$

$$e_1 = \frac{\nu\lambda\bar{q}\Delta\beta}{2\theta(1+\lambda)} \tag{105}$$

Further, since $\Omega_3 = 0$, from equation (165), we obtain:

$$\frac{\lambda}{2(1+\lambda)} > \frac{\tau}{(1+\delta)^{k+1}} \tag{106}$$

Therefore, the principal sets the cooling-off period large enough to ensure capture proofness. The necessary condition for this case is:

$$\left[\frac{\lambda\bar{q}\Delta\beta}{2(1+\lambda)}\right]^2 > \frac{C^2}{4\nu^2}\left[\frac{2+\delta}{1+\delta}\right] - \frac{C_r^2}{4\nu^2(1+\delta)^{k+1}} \tag{107}$$

where k is determined by:

$$k = \begin{cases} 0 & ,\lambda \geq \frac{2\tau}{1+\delta-2\tau} \\ \frac{ln\left[\frac{2(1+\lambda)\tau}{\lambda}\right]}{ln(1+\delta)} - 1 & ,\lambda < \frac{2\tau}{1+\delta-2\tau} \end{cases} \tag{108}$$

Computations using linear demand function: ($\nu = 0.5$, $\underline{\beta} = 0$,$n = 1$)

$$\bar{q} = \frac{(1+\lambda)m}{(1+2\lambda)} - \bar{\beta} + \frac{\lambda\bar{\beta}}{(1+2\lambda)}\left[\frac{\lambda\bar{q}\Delta\beta}{4\theta(1+\lambda)}\right] \tag{109}$$

$$= \frac{(1+\lambda)m}{(1+2\lambda)} - \bar{\beta} + \frac{(\lambda\bar{\beta})^2\bar{q}}{4\theta(1+2\lambda)(1+\lambda)} \tag{110}$$

$$\implies \bar{q} = \frac{\frac{(1+\lambda)m}{(1+2\lambda)} - \bar{\beta}}{1 - \frac{(\lambda\bar{\beta})^2}{4\theta(1+2\lambda)(1+\lambda)}} \tag{111}$$

CASE 2a: $\Omega_1 > 0, \Omega_2 = 0, \Omega_3 = 0, \Omega_4 > 0$

In this case, we have that:

$$\Delta w_1 = \frac{\lambda\bar{q}\Delta\beta}{(1+\lambda)} \tag{112}$$

$$e_1 = \frac{\nu\lambda\bar{q}\Delta\beta}{\theta(1+\lambda)} \tag{113}$$

$$w_1 = \frac{C^2}{8\theta}\left[\frac{2+\delta}{1+\delta}\right] - \frac{C_r^2}{8\theta(1+\delta)} - \frac{\nu^2}{2\theta}\left[\frac{\lambda\bar{q}\Delta\beta}{1+\lambda}\right]^2 \tag{114}$$

where the last equation follows from (163). Further, since $\Omega_3 = 0$, from equation (165), we obtain:

$$\frac{\lambda}{1+\lambda} > \frac{\tau}{1+\delta} \tag{115}$$

The necessary condition for this case is:

$$\left[\frac{\lambda\bar{q}\Delta\beta}{1+\lambda}\right]^2 < \frac{C^2}{4\nu^2}\left[\frac{2+\delta}{1+\delta}\right] - \frac{C_r^2}{4\nu^2(1+\delta)} \tag{116}$$

Computations using linear demand function:($\nu = 0.5$, $\underline{\beta} = 0$,$n = 1$)

$$\bar{q} = \frac{(1+\lambda)m}{(1+2\lambda)} - \bar{\beta} + \frac{\lambda\bar{\beta}}{(1+2\lambda)}\left[\frac{\lambda\bar{q}\Delta\beta}{2\theta(1+\lambda)}\right] \tag{117}$$

$$= \frac{(1+\lambda)m}{(1+2\lambda)} - \bar{\beta} + \frac{(\lambda\bar{\beta})^2\bar{q}}{2\theta(1+2\lambda)(1+\lambda)} \tag{118}$$

$$\implies \bar{q} = \frac{\frac{(1+\lambda)m}{(1+2\lambda)} - \bar{\beta}}{1 - \frac{(\lambda\bar{\beta})^2}{2\theta(1+2\lambda)(1+\lambda)}} \tag{119}$$

CASE 3a: $\Omega_1 > 0, \Omega_2 > 0, \Omega_3 = 0, \Omega_4 > 0$

In this case, we have that $w_1 = 0$ and :

$$\Delta w_1 = \sqrt{\frac{C^2}{4\nu^2}\left[\frac{2+\delta}{1+\delta}\right] - \frac{C_r^2}{4\nu^2(1+\delta)}} \tag{120}$$

$$e_1 = \frac{\nu}{\theta}\sqrt{\frac{C^2}{4\nu^2}\left[\frac{2+\delta}{1+\delta}\right] - \frac{C_r^2}{4\nu^2(1+\delta)}} \tag{121}$$

Further, since $\Omega_3 = 0$, from equation (165), we obtain:

$$\frac{C^2}{4\nu^2}\left[\frac{2+\delta}{1+\delta}\right] - \frac{C_r^2}{4\nu^2(1+\delta)} > \left[\frac{\tau\bar{q}\Delta\beta}{1+\delta}\right]^2 \tag{122}$$

The necessary condition for this case is:

$$\left[\frac{\lambda\bar{q}\Delta\beta}{2(1+\lambda)}\right]^2 < \frac{C^2}{4\nu^2}\left[\frac{2+\delta}{1+\delta}\right] - \frac{C_r^2}{4\nu^2(1+\delta)} < \left[\frac{\lambda\bar{q}\Delta\beta}{1+\lambda}\right]^2 \tag{123}$$

Computations using linear demand function:($\nu = 0.5$, $\underline{\beta} = 0$,$n = 1$, $\delta = 1$)

$$\bar{q} = \frac{(1+\lambda)m}{(1+2\lambda)} - \bar{\beta} + \frac{\lambda\bar{\beta}}{(1+2\lambda)}\left[\frac{1}{2\theta}\sqrt{\frac{3C^2}{2} - \frac{C_r^2}{2}}\right] \tag{124}$$

CASE 2c: $\Omega_1 > 0, \Omega_2 = 0, \Omega_3 > 0, \Omega_4 > 0$

In this case,

$$\Delta w_1 = \frac{\tau\bar{q}\Delta\beta}{1+\delta} \tag{125}$$

$$e_1 = \frac{\nu\tau\bar{q}\Delta\beta}{\theta(1+\delta)} \tag{126}$$

$$w_1 = \frac{C^2}{8\theta}\left[\frac{2+\delta}{1+\delta}\right] - \frac{C_r^2}{8\theta(1+\delta)} - \frac{\nu^2}{2\theta}\left[\frac{\tau\bar{q}\Delta\beta}{1+\delta}\right]^2 \tag{127}$$

where $\Omega_3 = \frac{(1+\lambda)C_r^2}{8\theta\tau\bar{q}\Delta\beta} - \frac{\Omega_4(1+\delta)}{\tau\bar{q}\Delta\beta ln(1+\delta)}$. The necessary conditions for this case is:

$$\left[\frac{\tau\bar{q}\Delta\beta}{1+\delta}\right]^2 < \frac{C^2}{4\nu^2}\left[\frac{2+\delta}{1+\delta}\right] - \frac{C_r^2}{4\nu^2(1+\delta)} \tag{128}$$

$$\frac{\tau}{1+\delta} > \frac{\lambda}{1+\lambda} \tag{129}$$

$$\frac{\lambda\bar{q}\Delta\beta}{1+\lambda} + \frac{C_r^2}{8\nu^2\tau\bar{q}\Delta\beta} > \frac{\tau\bar{q}\Delta\beta}{1+\delta} \tag{130}$$

CASE 3b: $\Omega_1 > 0, \Omega_2 > 0, \Omega_3 > 0, \Omega_4 = 0$

Here $w_1 = 0$ and the IR constraint is binding:

$$\Delta w_1 = \frac{\tau\bar{q}\Delta\beta}{(1+\delta)^{k+1}} \tag{131}$$

The cooling-off period is determined by:

$$\left[\frac{\tau\bar{q}\Delta\beta}{(1+\delta)^{k+1}}\right]^2 = \frac{C^2}{4\nu^2}\left[\frac{2+\delta}{1+\delta}\right] - \frac{C_r^2}{4\nu^2(1+\delta)^{k+1}} \tag{132}$$

$\Omega_3 = \frac{2(1+\lambda)\bar{q}\Delta\beta}{\theta}\left[\frac{\frac{\tau}{(1+\delta)^{k+1}} - \frac{\lambda}{2(1+\lambda)}}{\frac{1}{\nu^2} + \frac{8\tau\bar{q}\Delta\beta}{C_r^2}}\right]$. This case lies in the region:

$$\frac{\tau}{(1+\delta)^{k+1}} > \frac{\lambda}{2(1+\lambda)} \tag{133}$$

$$\left[\frac{\tau\bar{q}\Delta\beta}{1+\delta}\right]^2 > \frac{C^2}{4\nu^2}\left[\frac{2+\delta}{1+\delta}\right] - \frac{C_r^2}{4\nu^2(1+\delta)} \tag{134}$$

$$\frac{\lambda\bar{q}\Delta\beta}{1+\lambda} + \frac{C_r^2}{8\nu^2\tau\bar{q}\Delta\beta} > \frac{\tau\bar{q}\Delta\beta}{(1+\delta)^{k+1}} \tag{135}$$

CASE 2b: $\Omega_1 > 0, \Omega_2 = 0, \Omega_3 > 0, \Omega_4 = 0$

In this case,

$$\Delta w_1 = \frac{\tau\bar{q}\Delta\beta}{(1+\delta)^{k+1}} \tag{136}$$

$$e_1 = \frac{\nu\tau\bar{q}\Delta\beta}{\theta(1+\delta)^{k+1}} \tag{137}$$

$$w_1 = \frac{C^2}{8\theta}\left[\frac{2+\delta}{1+\delta}\right] - \frac{C_r^2}{8\theta(1+\delta)^{k+1}} - \frac{\nu^2}{2\theta}\left[\frac{\tau\bar{q}\Delta\beta}{(1+\delta)^{k+1}}\right]^2 \tag{138}$$

Where the cooling-off period is determined by the following equation:

$$\frac{\lambda\bar{q}\Delta\beta}{1+\lambda} + \frac{C_r^2}{8\nu^2\tau\bar{q}\Delta\beta} = \frac{\tau\bar{q}\Delta\beta}{(1+\delta)^{k+1}} \tag{139}$$

$\Omega_3 = \frac{(1+\lambda)C_r^2}{8\theta\tau\bar{q}\Delta\beta}$. The necessary conditions for this case are:

$$\frac{\tau\bar{q}\Delta\beta}{(1+\delta)^{k+1}} > \frac{\lambda\bar{q}\Delta\beta}{(1+\lambda)} \tag{140}$$

$$\frac{\tau}{(1+\delta)^{k+1}} > \frac{\lambda}{1+\lambda} \tag{141}$$

$$\left[\frac{\tau\bar{q}\Delta\beta}{(1+\delta)^{k+1}}\right]^2 < \frac{C^2}{4\nu^2}\left[\frac{2+\delta}{1+\delta}\right] - \frac{C_r^2}{4\nu^2(1+\delta)^{k+1}} \tag{142}$$

$$k_1^* = \begin{cases} 0 & ,\lambda \geq \frac{2\tau}{1+\delta-2\tau} \\ \frac{ln\left[\frac{2\tau(1+\lambda)}{\lambda}\right]}{ln(1+\delta)} - 1 & ,\lambda < \frac{2\tau}{1+\delta-2\tau} \end{cases} \tag{143}$$

$$k_2^* = \begin{cases} 0 & ,\frac{C}{2\nu}\sqrt{\frac{2+\delta}{1+\delta}} \geq \frac{\tau\bar{q}\Delta\beta}{1+\delta} \\ \frac{ln\left[\frac{\tau\bar{q}\Delta\beta}{\frac{C}{2\nu}\sqrt{\frac{2+\delta}{1+\delta}}}\right]}{ln(1+\delta)} - 1 & ,\frac{C}{2\nu}\sqrt{\frac{2+\delta}{1+\delta}} < \frac{\tau\bar{q}\Delta\beta}{1+\delta} \end{cases} \tag{144}$$

$$k_3^* = \begin{cases} 0 & ,\lambda \geq \frac{\tau}{1+\delta-\tau} \\ \frac{ln\left[\frac{\tau(1+\lambda)}{\lambda}\right]}{ln(1+\delta)} - 1 & ,\lambda < \frac{\tau}{1+\delta-\tau} \end{cases} \tag{145}$$

Proof of Proposition 4

The proof has two parts.

1. First, we need to show that Cases 3a and 3b cannot overlap.

   Suppose the two cases do overlap. Then there must exist a λ at which cases 3a and 3b overlap such that

$$\Delta w_1 = \sqrt{R(0)} = \frac{\tau \bar{q}_{3b} \Delta\beta}{2^{k+1}} \tag{146}$$

   where $\bar{q}_{3b}$ refers to the optimal quantity produced by the high cost firm in Case 3b and $R(k) = \frac{3C^2}{2} - \frac{C_r^2}{2^{k+1}}$. But this violates equation (132), which states that:

$$\left[\frac{\tau \bar{q}_{3b} \Delta\beta}{2^{k+1}}\right]^2 = R(k_1) > R(0) \tag{147}$$

   Therefore, the two cases cannot overlap.

2. Second, we need to show that both cases 3a and 3b lie in the region left of case 1.

   To start with we look at case 3a and case 1. Let $\bar{q}_{3a} > \bar{q}_1$. Therefore, we have the following:

$$R(0) > \left[\frac{\tau \bar{q}_{3a} \Delta\beta}{2}\right]^2 > \left[\frac{\tau \bar{q}_1 \Delta\beta}{2}\right]^2 \tag{148}$$

   where q_1 is the optimal quantity produced by the high cost firm in case 1. When $\lambda = \lambda'$ is large enough to satisfy:

$$\left[\frac{\lambda' \bar{q}_1 \Delta\beta}{2(1+\lambda')}\right]^2 > R(k_1) > R(0) \tag{149}$$

   Where λ' denotes all the values of λ lying within the region of case 1.

   Now, one of the necessary conditions for case 3a is:

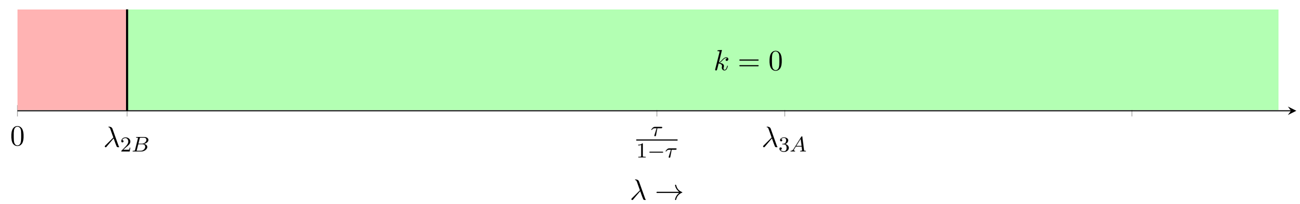
$$\left[\frac{\lambda \bar{q}_{3a} \Delta\beta}{2(1+\lambda)}\right]^2 < R(0) < \left[\frac{\lambda \bar{q}_{3a} \Delta\beta}{(1+\lambda)}\right]^2 \tag{150}$$

   where $\bar{q}_{3a}$ is the optimal inefficient quantity in case 3a. For case 3a and case 1 to be true, it must be that:

$$\left[\frac{\lambda' \bar{q}_1 \Delta\beta}{2(1+\lambda')}\right]^2 > \left[\frac{\lambda \bar{q}_{3a} \Delta\beta}{2(1+\lambda)}\right]^2 \tag{151}$$

   When $\bar{q}_{3a} > \bar{q}_1$ this can only be true when $\lambda' > \lambda$ and when case 3a lies to the left of case 1.

Also note that in this case, $\left[\frac{\lambda'\bar{q}_1\Delta\beta}{2(1+\lambda')}\right]^2 > \left[\frac{\tau\bar{q}_1\Delta\beta}{2}\right]^2$. This implies $k = 0$. On the other hand, when $\bar{q}_{3a} < \bar{q}_1$, it can be shown that there is no λ for which case 3a exists. The following diagram illustrates the cases:



In the diagram, λ_{3A} is the interface between cases 3a and 1. To demonstrate that are no gaps as we go from Case 3a to case 1, note that there exists a λ such that $\bar{q}_{3a} = \bar{q}_1 = \bar{q}'$.[12] Now when Cases 3a and 1 overlap, λ_{3A} is given by:

$$\left[\frac{\lambda_{3A}}{1+\lambda_{3A}}\right]^2 = 4 \times \frac{R(0)}{(\bar{q}'\Delta\beta)^2} \tag{153}$$

Now, consider cases 3b and 1. One of the necessary conditions for case 1 is:

$$\frac{\lambda}{2(1+\lambda)} > \frac{\tau}{2^{k_1+1}} \tag{154}$$

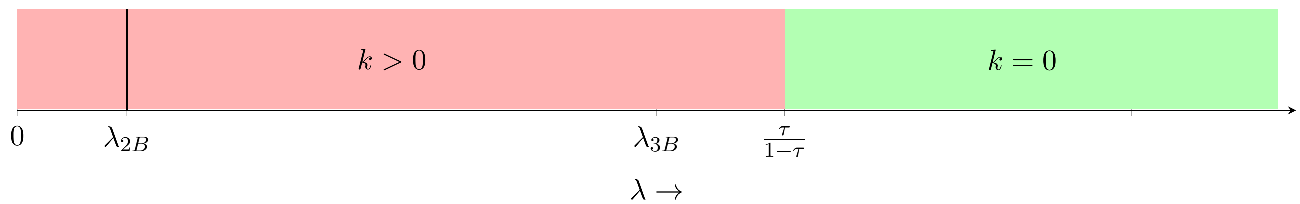
Compare this with the following condition from case 3b:

$$\frac{\lambda}{2(1+\lambda)} < \frac{\tau}{2^{k_{3b}+1}} \tag{155}$$

Any overlap would lead to a contradiction. If $k_1 > k_{3b}$, then $R(k_1) > R(k_{3b})$. Case 1 implies that $\frac{\lambda\bar{q}\Delta\beta}{2(1+\lambda)} > R(k_1)$ and an overlap implies $\frac{\lambda\bar{q}\Delta\beta}{2(1+\lambda)} = R(k_{3b})$ which leads to the contradiction that $R(k_{3b}) > R(k_1)$. Therefore, $k_{3b} > k_1$. It is clear then that case 3b can only lie to the left of case 1 giving rise to the following diagram:

[12]When $\nu = 0.5, \underline{\beta} = 0$, $n = 1$, and $\delta = 1$ such a λ is given by:

$$\frac{\lambda\Delta\beta}{1+\lambda} = \frac{\sqrt{\frac{3C^2}{2} - \frac{C_r^2}{2}}}{\frac{(1+\lambda)m}{1+2\lambda} - \bar{\beta} + \frac{\lambda\bar{\beta}}{(1+\lambda)}\left[\frac{1}{2\theta}\sqrt{\frac{3C^2}{2} - \frac{C_r^2}{2}}\right]} \tag{152}$$



In the diagram, λ_{3B} is the interface between cases 3b and 1. To demonstrate that there are no gaps as we go from case 3b to 1, we need to find a λ such that:

$$\frac{\tau}{2^{k'+1}} = \frac{\lambda}{2(1+\lambda)} \tag{156}$$

where $k'' = k_{3b} = k_1 = \frac{ln\left[\frac{2(1+\lambda)\tau}{\lambda}\right]}{ln2} - 1$ and $\bar{q}_{3b} = \bar{q}_1 = \bar{q}''$.

$$\frac{\lambda_{3B}\bar{q}''\Delta\beta}{2(1+\lambda_{3B})} = \frac{\tau\bar{q}''\Delta\beta}{2^{k''+1}} = \frac{3C^2}{2} - \frac{C_r^2}{2^{k+1}} \tag{157}$$

$$\implies \frac{\lambda_{3B}\bar{q}''\Delta\beta}{2(1+\lambda_{3B})} = \frac{3C^2}{2} - \frac{C_r^2\lambda_{3B}}{2(1+\lambda_{3B})\tau} \tag{158}$$

$$\implies \frac{\lambda_{3B}}{1+\lambda_{3B}} = \frac{\frac{3C^2}{2}}{\frac{\bar{q}''\Delta\beta}{2} + \frac{C_r^2}{2\tau}} \tag{159}$$

Proof of Corollary 3

We first present the entire optimization problem with the assumption that $\bar{q} = \underline{q} = Q$, that is, for **inelastic demand**. The second statement of the proof follows from the solution to the principal's capture-proofness optimization problem. Setting up the Lagrangian:

$$\begin{aligned}\mathcal{L} = W(Q) - \left(1 - \frac{\nu\Delta w_1}{\theta}\right)\nu\lambda Q\Delta\beta - (1+\lambda)\left[w_1 + \frac{(\nu\Delta w_1)^2}{\theta}\right] \\ + \Omega_1\left[w_1 + \frac{C_r^2}{8\theta(1+\delta)^{k+1}} + \frac{(\nu\Delta w_1)^2}{2\theta} - \frac{C^2}{8\theta}\left[\frac{2+\delta}{1+\delta}\right]\right] + \Omega_2 w_1 \\ + \Omega_3\left[\Delta w_1 - \frac{\tau Q\Delta\beta}{(1+\delta)^{k+1}}\right] + \Omega_4 k\end{aligned}$$

We have the following KKT conditions:

$$\Omega_1 + \Omega_2 = 1 + \lambda \tag{160}$$

$$\lambda Q\Delta\beta - 2(1+\lambda)\Delta w_1 + \Omega_1 \Delta w_1 + \frac{\Omega_3 \theta}{\nu^2} = 0 \tag{161}$$

$$-\frac{\Omega_1 C_r^2 ln(1+\delta)}{8\theta(1+\delta)^{k+1}} + \frac{\Omega_3 ln(1+\delta)\tau Q\Delta\beta}{(1+\delta)^{k+1}} + \Omega_4 = 0 \tag{162}$$

$$\Omega_1 \left[w_1 + \frac{C_r^2}{8\theta(1+\delta)^{k+1}} + \frac{(\nu\Delta w_1)^2}{2\theta} - \frac{C^2}{8\theta}\left[\frac{2+\delta}{1+\delta}\right]\right] = 0 \tag{163}$$

$$\Omega_2 w_1 = 0 \tag{164}$$

$$\Omega_3 \left[\Delta w_1 - \frac{\tau Q\Delta\beta}{(1+\delta)^{k+1}}\right] = 0 \tag{165}$$

$$\Omega_4 k = 0 \tag{166}$$

We begin working through each case by assuming $\nu = 0.5, \delta = 1$.

CASE 1: $\Omega_1 = 0, \Omega_2 > 0, \Omega_3 = 0, \Omega_4 = 0$

In this case, $w_1 = 0$ and:

$$\Delta w_1 = \frac{\lambda Q\Delta\beta}{2(1+\lambda)} \tag{167}$$

$$e_1 = \frac{\lambda Q\Delta\beta}{4\theta(1+\lambda)} \tag{168}$$

Further, since $\Omega_3 = 0$, from equation (165), we obtain:

$$\frac{\lambda}{2(1+\lambda)} > \frac{\tau}{2^{k+1}} \tag{169}$$

Therefore, the principal sets the cooling-off period large enough to ensure capture proofness. The necessary condition for this case is:

$$\left[\frac{\lambda Q\Delta\beta}{2(1+\lambda)}\right]^2 > \frac{3C^2}{2} - \frac{C_r^2}{2^{k+1}} \tag{170}$$

where k is determined by:

$$k = \begin{cases} 0 & \lambda \geq \frac{\tau}{1-\tau} \\ \frac{ln\left[\frac{(1+\lambda)\tau}{\lambda}\right]}{ln2} & \lambda < \frac{\tau}{1-\tau} \end{cases} \tag{171}$$

CASE 2a: $\Omega_1 > 0, \Omega_2 = 0, \Omega_3 = 0, \Omega_4 > 0$

In this case, we have that:

$$\Delta w_1 = \frac{\lambda Q \Delta\beta}{(1+\lambda)} \tag{172}$$

$$e_1 = \frac{\lambda Q \Delta\beta}{2\theta(1+\lambda)} \tag{173}$$

$$w_1 = \frac{3C^2}{16\theta} - \frac{C_r^2}{16\theta} - \frac{1}{8\theta}\left[\frac{\lambda Q \Delta\beta}{1+\lambda}\right]^2 \tag{174}$$

where the last equation follows from (163). Further, since $\Omega_3 = 0$, from equation (165), we obtain:

$$\frac{\lambda Q \Delta\beta}{1+\lambda} > \frac{\tau Q \Delta\beta}{2} \tag{175}$$

The necessary condition for this case is:

$$\left[\frac{\lambda Q \Delta\beta}{1+\lambda}\right]^2 < \frac{3C^2}{2} - \frac{C_r^2}{2} \tag{176}$$

CASE 3a: $\Omega_1 > 0, \Omega_2 > 0, \Omega_3 = 0, \Omega_4 > 0$

In this case, we have that $w_1 = 0$ and :

$$\Delta w_1 = \sqrt{\frac{3C^2}{2} - \frac{C_r^2}{2}} \tag{177}$$

$$e_1 = \frac{1}{2\theta}\sqrt{\frac{3C^2}{2} - \frac{C_r^2}{2}} \tag{178}$$

Further, since $\Omega_3 = 0$, from equation (165), we obtain:

$$\frac{3C^2}{2} - \frac{C_r^2}{2} > \left[\frac{\tau Q \Delta\beta}{2}\right]^2 \tag{179}$$

The necessary condition for this case is:

$$\left[\frac{\lambda Q \Delta\beta}{2(1+\lambda)}\right]^2 < \frac{3C^2}{2} - \frac{C_r^2}{2} < \left[\frac{\lambda Q \Delta\beta}{(1+\lambda)}\right]^2 \tag{180}$$

CASE 2c: $\Omega_1 > 0, \Omega_2 = 0, \Omega_3 > 0, \Omega_4 > 0$

In this case,

$$\Delta w_1 = \frac{\tau Q \Delta\beta}{2} \tag{181}$$

$$e_1 = \frac{\tau Q \Delta\beta}{4\theta} \tag{182}$$

$$w_1 = \frac{3C^2}{16\theta} - \frac{C_r^2}{16\theta} - \frac{1}{8\theta}\left[\frac{\tau Q \Delta\beta}{2}\right]^2 \tag{183}$$

In this case, $\Omega_3 = \frac{(1+\lambda)C_r^2}{8\theta\tau Q\Delta\beta} - \frac{2\Omega_4}{ln2\tau Q\Delta\beta}$ The necessary conditions for this case is:

$$\left[\frac{\tau Q \Delta\beta}{2}\right]^2 < \frac{3C^2}{2} - \frac{C_r^2}{2} \tag{184}$$

$$\frac{\tau Q \Delta\beta}{2} > \frac{\lambda Q \Delta\beta}{(1+\lambda)} \tag{185}$$

$$\frac{\lambda Q \Delta\beta}{1+\lambda} + \frac{C_r^2}{2\tau Q \Delta\beta} > \frac{\tau Q \Delta\beta}{2} \tag{186}$$

CASE 2b: $\Omega_1 > 0, \Omega_2 = 0, \Omega_3 > 0, \Omega_4 = 0$

In this case,

$$\Delta w_1 = \frac{\tau Q \Delta\beta}{2^{k+1}} \tag{187}$$

$$e_1 = \frac{\tau Q \Delta\beta}{2\theta 2^{k+1}} \tag{188}$$

$$w_1 = \frac{3C^2}{16\theta} - \frac{C_r^2}{8\theta 2^{k+1}} - \frac{\nu^2}{2\theta}\left[\frac{\tau Q \Delta\beta}{2^{k+1}}\right]^2 \tag{189}$$

Where the cooling-off period is determined by the following equation:

$$\frac{\lambda Q \Delta\beta}{1+\lambda} + \frac{C_r^2}{2\tau Q \Delta\beta} = \frac{\tau Q \Delta\beta}{2^{k+1}} \tag{190}$$

This condition also implies that:

$$\frac{\lambda Q \Delta\beta}{1+\lambda} + \frac{C_r^2}{2\tau Q \Delta\beta} < \frac{\tau Q \Delta\beta}{2} \tag{191}$$

$\Omega_3 = \frac{(1+\lambda)C_r^2}{8\theta\tau Q\Delta\beta}$. The necessary conditions for this case are:

$$\frac{\tau Q\Delta\beta}{2^{k+1}} > \frac{\lambda Q\Delta\beta}{(1+\lambda)} \quad (192)$$

$$\frac{\lambda Q\Delta\beta}{1+\lambda} + \frac{C_r^2}{2\tau Q\Delta\beta} < \frac{\tau Q\Delta\beta}{2} \quad (193)$$

$$\left[\frac{\tau Q\Delta\beta}{2^{k+1}}\right]^2 < \frac{3C^2}{2} - \frac{C_r^2}{2^{k+1}} \quad (194)$$

CASE 3b: $\Omega_1 > 0, \Omega_2 > 0, \Omega_3 > 0, \Omega_4 = 0$

Here $w_1 = 0$ and the IR constraint is binding:

$$\Delta w_1 = \frac{\tau Q\Delta\beta}{2^{k+1}} \quad (195)$$

The cooling-off period is determined by:

$$\left[\frac{\tau Q\Delta\beta}{2^{k+1}}\right]^2 = \frac{3C^2}{2} - \frac{C_r^2}{2^{k+1}} \quad (196)$$

This case lies in the region:

$$\frac{\tau Q\Delta\beta}{2^{k+1}} > \frac{\lambda Q\Delta\beta}{2(1+\lambda)} \quad (197)$$

$$\left[\frac{\tau Q\Delta\beta}{2}\right]^2 > \frac{3C^2}{2} - \frac{C_r^2}{2} \quad (198)$$

$$\frac{\lambda Q\Delta\beta}{1+\lambda} + \frac{C_r^2}{2\tau Q\Delta\beta} > \frac{\tau Q\Delta\beta}{2^{k+1}} \quad (199)$$

This gives rise to the graph presented in figure 3 below.

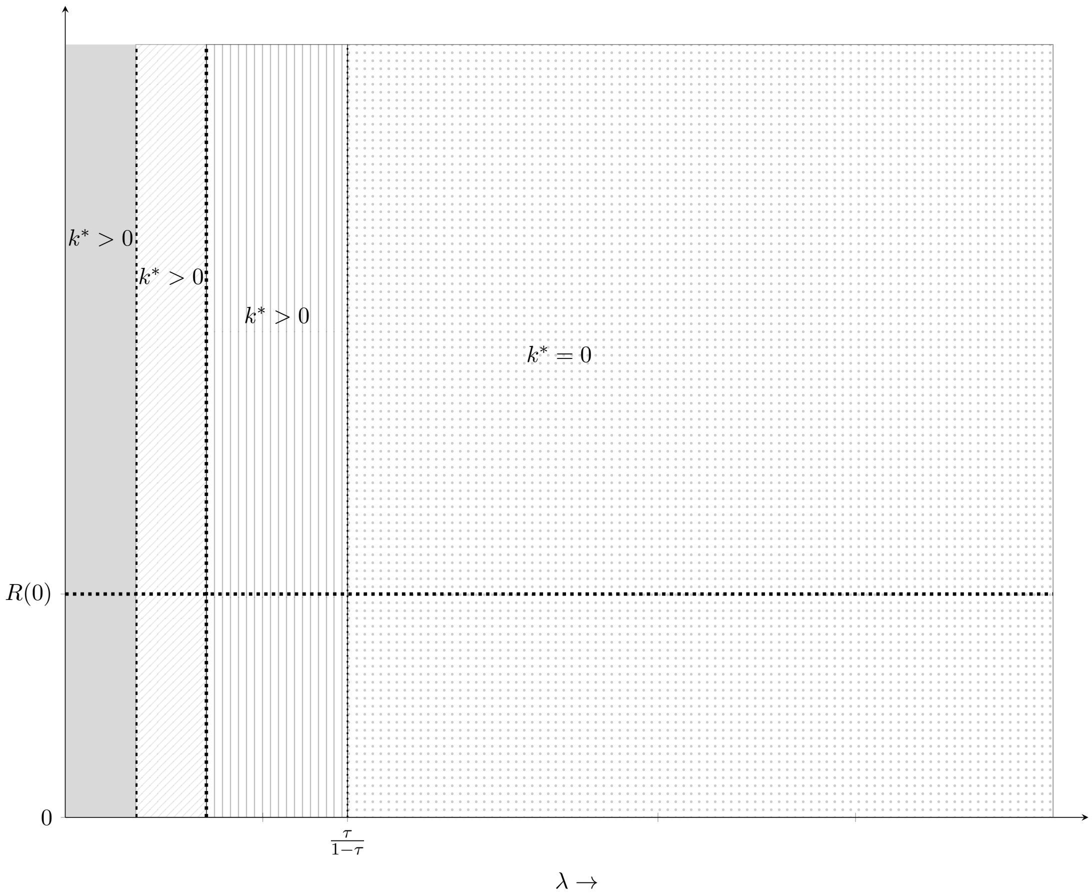


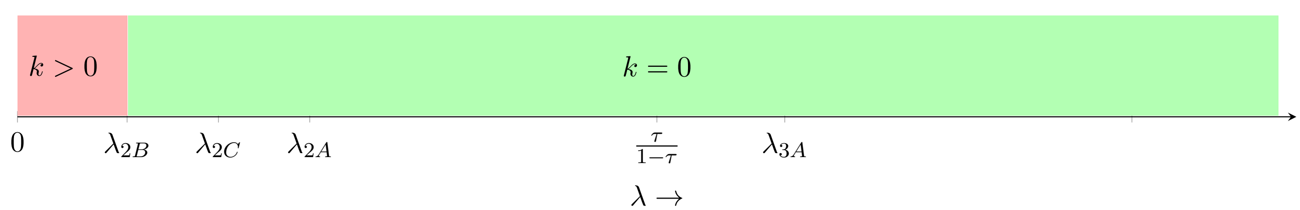
Fig. 10. Cooling-off period when $\left[\frac{\tau Q \Delta\beta}{2}\right]^2 \gg \frac{3C^2}{2} - \frac{C_r^2}{2}$.

The proof analogous to Proposition 4 for fixed Q

The proof is presented based on the following condition.

1. Let $\left[\frac{\tau Q \Delta\beta}{2}\right]^2 < \frac{3C^2}{2} - \frac{C_r^2}{2}$.

   Under this condition, cases 1, 2a, 2b, 2c, and 3a are valid. The limit points for each case are represented on the line below in terms of λ:



Where λ_{2B} is the interface between Cases 2b and 2c. It is determined by using inequalities

(193) and (186) such that:

$$\frac{\lambda_{2B} Q\Delta\beta}{1+\lambda_{2B}} + \frac{C_r^2}{2\tau Q\Delta\beta} = \frac{\tau Q\Delta\beta}{2} \implies \lambda_{2B} = \max\left\{0, \frac{\frac{\tau}{2} - \frac{C_r^2}{2\tau(Q\Delta\beta)^2}}{1-\frac{\tau}{2}+\frac{C_r^2}{2\tau(Q\Delta\beta)^2}}\right\} \tag{200}$$

Next, λ_{2C} is the interface between cases 2c and 2a. It is determined by the inequalities (175) and (185) such that:

$$\frac{\lambda_{2C} Q\Delta\beta}{1+\lambda_{2C}} = \frac{\tau Q\Delta\beta}{2} \implies \lambda_{2C} = \frac{\tau}{2-\tau} \tag{201}$$

Next, λ_{2A} is the interface between Cases 2a and 3a. It is determined by the inequalities (176) and (180), such that

$$\left[\frac{\lambda_{2A}}{1+\lambda_{2A}}\right]^2 = \frac{3C^2}{2(Q\Delta\beta)^2} - \frac{C_r^2}{2(Q\Delta\beta)^2} \implies \lambda_{2A} = \frac{\sqrt{R(0)}}{1-\sqrt{R(0)}} \tag{202}$$

where $R(0) \equiv \frac{3C^2}{2(Q\Delta\beta)^2} - \frac{C_r^2}{2(Q\Delta\beta)^2}$. Further, λ_{3A} is the interface between Cases 3a and 1. Note that for case 1 to be valid, it must be true that $\left[\frac{\lambda Q\Delta\beta}{2(1+\lambda)}\right]^2 > \frac{3C^2}{2} - \frac{C_r^2}{2} > \left[\frac{\tau Q\Delta\beta}{2}\right]^2$. The outer inequality implies that $\lambda > \frac{\tau}{1-\tau}$ and that $k=0$. Also, $\lambda_{3A} \geq \frac{\tau}{1-\tau}$ and it is determined by the inequalities (170) and (180), such that:

$$\left[\frac{\lambda_{3A}}{1+\lambda_{3A}}\right]^2 = 4 \times \left[\frac{3C^2}{2(Q\Delta\beta)^2} - \frac{C_r^2}{2(Q\Delta\beta)^2}\right] \implies \lambda_{3A} = \frac{4\sqrt{R(0)}}{1-4\sqrt{R(0)}} \tag{203}$$

It is clear that $\lambda_{2B} < \lambda_{2C} < \lambda_{2A} < \lambda_{3A}$.

The above bounds show that when λ is small, the unconstrained solutions are unable to satisfy the capture proofness constraint. Therefore, the capture proofness constraint only binds in cases 2b and 2c. Given $\left[\frac{\tau Q\Delta\beta}{2}\right]^2 < \frac{3C^2}{2} - \frac{C_r^2}{2}$, case 2b is the only case where $k > 0$, which is true when $\lambda < \frac{2\tau - \frac{C_r^2}{2\tau(Q\Delta\beta)^2}}{1-2\tau+\frac{C_r^2}{2\tau(Q\Delta\beta)^2}}$. Similarly, case 2c ($k=0$) is true when $\lambda > \frac{2\tau - \frac{C_r^2}{2\tau(Q\Delta\beta)^2}}{1-2\tau+\frac{C_r^2}{2\tau(Q\Delta\beta)^2}}$. Therefore, $\tilde{\lambda} = \lambda_{2B} = \max\left\{0, \frac{2\tau - \frac{C_r^2}{2\tau(Q\Delta\beta)^2}}{1-2\tau+\frac{C_r^2}{2\tau(Q\Delta\beta)^2}}\right\}$, where $\tilde{\lambda}$ is the interface between $k > 0$ and $k = 0$.

To show that k^* is decreasing in λ when $\left[\frac{\tau Q\Delta\beta}{2}\right]^2 < \frac{3C^2}{2} - \frac{C_r^2}{2}$, note that the optimal cooling-off period is given by:

$$k^* = \begin{cases} \frac{ln\left[\frac{1}{\frac{\lambda}{(1+\lambda)\tau}+\frac{C_r^2}{2(\tau Q\Delta\beta)^2}}\right]}{ln2} - 1 & , 0 \leq \lambda < \lambda_{2B} \\ 0 & , \lambda > \lambda_{2B} \end{cases}$$

To analyze the behavior of k^* with respect to λ, we compute $\frac{\partial k^*}{\partial \lambda}$:

$$\frac{\partial k^*}{\partial \lambda} = \begin{cases} -\frac{1}{ln2}\left[\frac{1}{\frac{\lambda}{(1+\lambda)\tau}+\frac{C_r^2}{2(\tau Q\Delta\beta)^2}}\right]\frac{1}{\tau(1+\lambda)^2} & , 0 \leq \lambda < \lambda_{2B} \\ 0 & , \lambda > \lambda_{2B} \end{cases}$$

In this case, when $k^* > 0$, we have that $\frac{\partial k^*}{\partial \lambda} < 0$. Also, $k^* > (=)0$ when $\lambda < (>)\lambda_{2B}$. Therefore, k^* is decreasing in λ. This is represented in the diagram below:

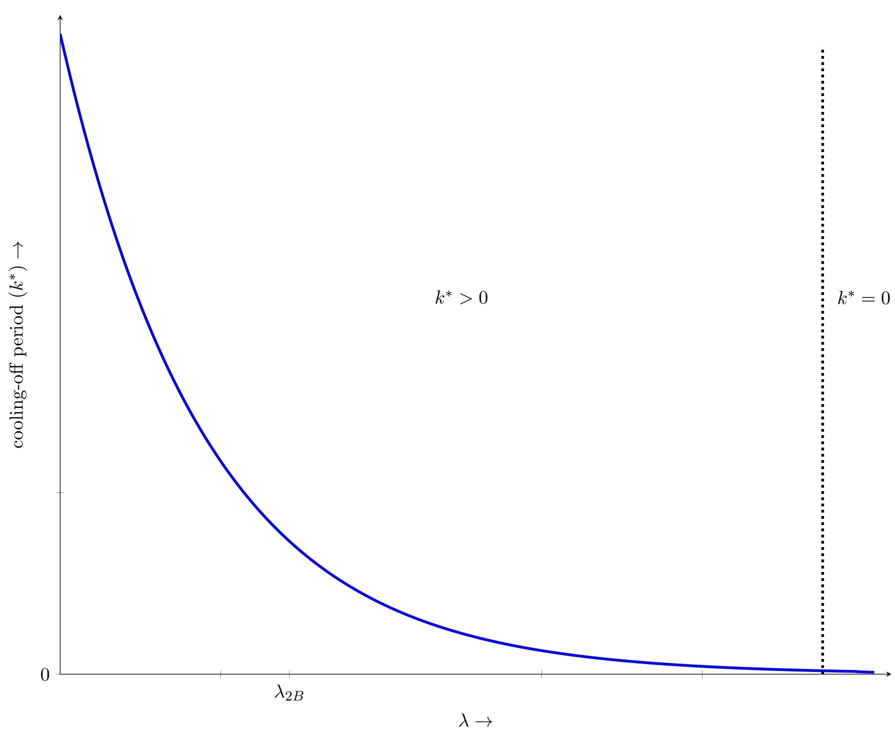
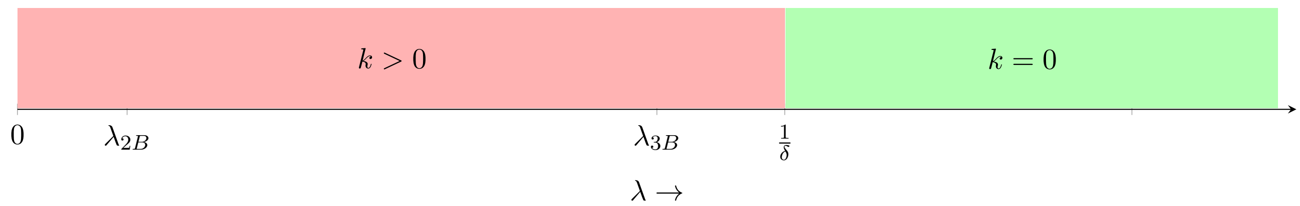


Fig. 11. Cooling-off period as a function of λ when $\left[\frac{\tau Q\Delta\beta}{2}\right]^2 < \frac{3C^2}{2} - \frac{C_r^2}{2}$

2. Now let $\left[\frac{\tau Q\Delta\beta}{2}\right]^2 > \frac{3C^2}{2} - \frac{C_r^2}{2}$.

   Under this condition, only cases 1, 2b, and 3b can hold. The limit points for these cases are shown below:



Where λ_{2B} is the interface between cases 2b and 3b. It depends on the inequality (194) and equations (196) and (190) such that:

$$\frac{\lambda_{2B}Q\Delta\beta}{1+\lambda_{2B}} + \frac{C_r^2}{2\tau Q\Delta\beta} = \frac{\tau Q\Delta\beta}{\Lambda} \implies \lambda_{2B} = \max\left\{0, \frac{\frac{\tau}{\Lambda} - \frac{C_r^2}{2\tau(Q\Delta\beta)^2}}{1 - \frac{\tau}{\Lambda} + \frac{C_r^2}{2\tau(Q\Delta\beta)^2}}\right\} \tag{204}$$

where $\Lambda = 2^{k+1} = \frac{C_r^2 + \sqrt{C_r^4 + 6C^2(\tau Q\Delta\beta)^2}}{3C^2}$. Next, λ_{3B} is the interface between cases 3b and 1 and is determined by the inequalities (170) and (197) and equation (196) such that:

$$\left[\frac{\tau Q\Delta\beta}{2^{k+1}}\right]^2 = \left[\frac{\lambda_{3B}Q\Delta\beta}{2(1+\lambda_{3B})}\right]^2 = \frac{3C^2}{2} - \frac{C_r^2}{2^{k+1}} \tag{205}$$

To determine λ_{3B} (when $\lambda_{3B} < \frac{\tau}{1-\tau}$), we solve the following equation (using $2^{k+1} = \frac{\lambda}{\tau(1+\lambda)}$):

$$\left[\frac{\lambda_{3B}Q\Delta\beta}{2(1+\lambda_{3B})}\right]^2 = \frac{3C^2}{2} - \frac{C_r^2}{2^{k+1}} \implies \frac{\lambda_{3B}}{1+\lambda_{3B}} = \frac{\frac{-4C_r^2}{\tau(Q\Delta\beta)^2} + \sqrt{\left[\frac{4C_r^2}{\tau(Q\Delta\beta)^2}\right]^2 + \frac{24C^2}{(Q\Delta\beta)^2}}}{2} \tag{206}$$

Since $\lambda_{3B} \leq \frac{\tau}{1-\tau}$, we will always have $k > (=)0$ when $\lambda < (\geq)\frac{\tau}{1-\tau}$. This is because in both cases 2b and 3b, $k > 0$. Further, Case 1 can take two values: $k > 0$ when $\lambda < \frac{\tau}{1-\tau}$ and $k = 0$ when $\lambda \geq 0$. Therefore, for all $\lambda < \frac{\tau}{1-\tau}$, it is optimal to have a positive cooling-off period and for all $\lambda > \frac{\tau}{1-\tau}$ there is no cooling-off period where $\tilde{\lambda} = \frac{\tau}{1-\tau}$.

To show that the optimal cooling-off period, k^*, is decreasing in λ, note that the optimal cooling-off period when $\left[\frac{\tau Q\Delta\beta}{2}\right]^2 > \frac{3C^2}{2} - \frac{C_r^2}{2}$ is given by:

$$k^* = \begin{cases} \frac{ln\left[\frac{1}{\frac{\lambda}{(1+\lambda)\tau}+\frac{C_r^2}{2(\tau Q\Delta\beta)^2}}\right]}{ln2} - 1 & ,0 \leq \lambda < \lambda_{2B} \\ \frac{ln\left[\frac{C_r^2+\sqrt{C_r^4+6C^2(\tau Q\Delta\beta)^2}}{3C^2}\right]}{ln2} - 1 & ,\lambda_{2B} < \lambda < \lambda_{3B} \\ \frac{ln\left[\frac{\tau(1+\lambda)}{\lambda}\right]}{ln2} & ,\lambda_{3B} < \lambda < \frac{\tau}{1-\tau} \\ 0 & ,\lambda \geq \frac{\tau}{1-\tau} \end{cases}$$

Further, when we compute $\frac{\partial k^*}{\partial \lambda}$, we obtain:

$$\frac{\partial k^*}{\partial \lambda} = \begin{cases} -\frac{1}{ln2}\left[\frac{1}{\frac{\lambda}{(1+\lambda)\tau}+\frac{C_r^2}{2(\tau Q\Delta\beta)^2}}\right]\frac{1}{\tau(1+\lambda)^2} & ,0 \leq \lambda < \lambda_{2B} \\ 0 & ,\lambda_{2B} < \lambda < \lambda_{3B} \\ -\frac{1}{ln2}\left[\frac{1}{\lambda(1+\lambda)}\right] & ,\lambda_{3B} < \lambda < \frac{\tau}{1-\tau} \\ 0 & ,\lambda \geq \frac{\tau}{1-\tau} \end{cases}$$

It is clear that k^* is decreasing when $0 \leq \lambda < \lambda_{2B}$ and $\lambda_{3B} < \lambda < \frac{\tau}{1-\tau}$. To show that k^* decreases as we transition from case 2b to 3b, let k^*_{2B} be the optimal cooling-off period when $0 \leq \lambda < \lambda_{2B}$ and k^*_{3B} be the optimal cooling-off period be the optimal cooling-off period when $\lambda_{2B} < \lambda < \lambda_{3B}$. To show that $k^*_{2B} > k^*_{3B}$, we refer to necessary conditions for cases 2b and 3b respectively. From conditions (194) and (196), we have that:

$$\left[\frac{\tau Q\Delta\beta}{2^{(k^*_{2B}+1)}}\right]^2 < \frac{3C^2}{2} - \frac{C_r^2}{2^{(k^*_{2B}+1)}}$$
$$\left[\frac{\tau Q\Delta\beta}{2^{(k^*_{3B}+1)}}\right]^2 = \frac{3C^2}{2} - \frac{C_r^2}{2^{(k^*_{3B}+1)}}$$

A decrease in the cooling-off period makes the RHS smaller and LHS larger in both the above conditions. Therefore, given that all other parameters are exogenous, it must be that $k^*_{2B} > k^*_{3B}$. Similarly, to show that k^* decreases as we transition from case 3b to 1, let k^*_1 be the optimal cooling-off period when $\lambda_{3B} < \lambda < \frac{\tau}{1-\tau}$. To show that $k^*_{3B} > k^*_1$ when $\lambda_{3B} < \lambda < \frac{\tau}{1-\tau}$, we use conditions (170), (197), and (196). At $\lambda = \lambda_{3B}$ it must be true that

$$\left[\frac{\lambda_{3B}Q\Delta\beta}{2(1+\lambda_{3B})}\right]^2 = \frac{3C^2}{2} - \frac{C_r^2}{2^{k_1+1}}$$
$$\frac{3C^2}{2} - \frac{C_r^2}{2^{k_{3B}+1}} = \left[\frac{\lambda_{3B}Q\Delta\beta}{2(1+\lambda_{3B})}\right]^2$$

Therefore, at $\lambda = \lambda_{3B}$, $k^*_{3B} = k^*_1$, and k^*_1 decreases in λ. This implies k^*_{3B} the maximum value that k^*_1 can reach and $k^*_{3B} > k^*_1$ when $\lambda > \lambda_{3B}$. Further, $k^* > (=)0$ when $\lambda < (>)\frac{\tau}{1-\tau}$. Therefore, k^* is decreasing in λ. This is represented in the diagram below:

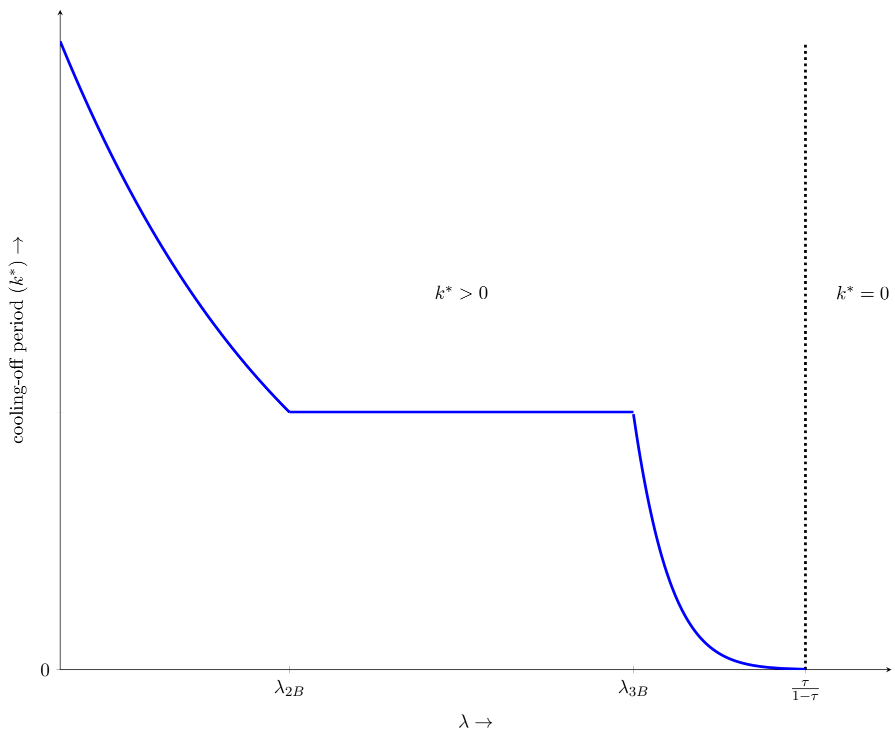


Fig. 12. cooling-off period as a function of λ when $\left[\frac{\tau Q\Delta\beta}{2}\right]^2 > \frac{3C^2}{2} - \frac{C_r^2}{2}$

Proof of Lemma 5.1

The proof of this lemma follows directly from the proof of Proposition 3. First note that when

$\left[\frac{\tau Q\Delta\beta}{2}\right]^2 > \frac{3C^2}{2} - \frac{C_r^2}{2}$, k^* is given by:

$$k^* = \begin{cases} \dfrac{ln\left[\dfrac{1}{\frac{\lambda}{\tau(1+\lambda)}+\frac{C_r^2}{2(\tau Q\Delta\beta)^2}}\right]}{ln2} - 1 & ,0 \leq \lambda < \lambda_{2B} \\ \dfrac{ln\left[\dfrac{C_r^2+\sqrt{C_r^4+6C^2(\tau Q\Delta\beta)^2}}{3C^2}\right]}{ln2} - 1 & ,\lambda_{2B} < \lambda < \lambda_{3B} \\ \dfrac{ln\left[\frac{\tau(1+\lambda)}{\lambda}\right]}{ln2} & ,\lambda_{3B} < \lambda < \frac{1}{\delta} \\ 0 & ,\lambda \geq \frac{1}{\delta} \end{cases}$$

An increase in $\Delta\beta$ or Q increases the numerator and therefore increases k^*. Similarly, an increase in τ decreases the numerator and therefore decreases k^*. The same reasoning holds for $\left[\frac{\tau Q\Delta\beta}{2}\right]^2 < \frac{3C^2}{2} - \frac{C_r^2}{2}$.

Appendix B

Countries	Senior civil servants	Civil servants
Australia	1 year (1.5 for ministers)	1 year
Austria	<1 year	<1 year
Belgium	0	0
Canada	2 years (Ministers)	1 year
Chile	6 months	6 months
Czech Republic	1 year	6 months
Denmark	0	0
Estonia	1 year (only for board positions)	1 year (only for board positions)
Finland	0	0
France	3 years	3 years
Germany	3-5 years	3-5 years
Greece	0	0
Hungary	0	0
Iceland	6 months	6 months
Ireland	1 year (for lobbying positions)	1 year (for lobbying positions)
Israel	1 year	1 year
Italy	3-4 years	3-4 years
Japan	0	0
Korea	3 years	3 years
Netherlands	2 years (only for defense ministry)	0
New Zealand	0	0
Norway	6 months	6 months
Poland	1 year	1 year
Portugal	3 years (with several exceptions)	3 years (with several exceptions)
Slovak Republic	0	0
Slovenia	2 years (for lobbying positions)	2 years (for lobbying positions)
Spain	2 years	2 years

Table 1: Cooling-off periods across the world

Countries	**Senior civil servants**	**Civil servants**
Sweden	0	0
Switzerland	1 year	1 year
Turkey	3 year	3 years
United Kingdom	2 years	2 years
United States	2 years	1 year
Brazil	6 months	0
Colombia	2 years	2 years
Latvia	2 years	2 years
Russia	2 years	2 years
China	3 years	2 years
Thailand	2 years	2 years
Kazakhstan	0	0
India	1 year	0
Sri Lanka	0	0
Cambodia	0	0
Vietnam	1-2 years	1-2 years
Philipines	1 year	1 year
Pakistan	0	0
Nigeria	0	0
South Africa	0	0
Indonesia	0	0
Malaysia	0	0
Bangladesh	0	0
Mexico	1 year	1 year
Bolivia	0	0
Argentina	3 years	3 years
Costa Rica	0	0
El Salvador	0	0
Honduras	0	0
Peru	0	0
Uruguay	0	0
Tajikistan	0	0
Malta	0	0
Cyprus	2 years	2 years
Iran	0	0
Ghana	0	0
Botswana	0	0
Namibia	0	0
Zimbabwe	0	0
Ethiopia	0	0
Sudan	0	0
Papua New Guinea	0	0
Armenia	1 year	1 year
Iraq	0	0
Chad	0	0
Afghanistan	0	0
Angola	0	0
Malawi	0	0

Table 2: Cooling-off periods across the world

Corruption risks in Italian public procurement: The impact of emergencies

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Abstract

We combine the EM-DAT dataset on disasters with administrative data on public tenders from 2007 to 2020 to study five disasters in Italy and their impact on procurement locally. Using a matching estimator, we show that disasters lead to a 16.1% increase in non-publication of tender calls, 10.5% increase in awards through non-open procedures, and 19.6% increase in the usage of too-short advertisement periods in disaster-affected areas. There is also a positive but insignificant change in the share of tenders with a single bidder. Overall, while our results show that there is an increased use of altered procedures which indicate a heightened corruption risk, it is difficult to quantify the extent of increased risk because there are also legitimate reasons for officials to deviate from non-emergency procurement rules, such as ensuring rapid disaster response.

1. Introduction

A well-functioning procurement system allows public authorities to buy the necessary levels of goods and services from private firms at the optimal combination of price and quality. This so-called 'value for money' standard ensures the efficient utilization of tax revenues and resource rents to fulfill the needs of citizens in important sectors like energy, transport, waste management, healthcare, and education. Therefore, government contracting is a key area of governance[1] and citizens rely on officials to implement the right decisions on their behalf.

However, the large network of competing interests involved in a procurement system may leave it vulnerable to corruption. Officials willing to receive illicit gains may abuse their discretionary powers to award contracts at inflated prices. They may also award contracts to friends, family members, or those that offer the highest bribes. Private firms also have the incentive to bribe officials and receive lucrative contracts in exchange. While discretionary power may be required in many cases to allow flexibility,[2] it has also been highlighted as one of the necessary conditions for corruption (Rose-Ackerman 1975, Aidt 2003). Corruption in procurement processes ultimately leads to the society paying inflated prices and/or receiving poor quality of goods and services. Eventually, it may also lead to significant environmental damage and hamper economic development (Rose-Ackerman & Palifka 2016). The question of how officials use their discretion becomes even more important in the event of a natural disaster.

Natural disasters pose serious challenges to societies due to the immediate loss of life and property. Disaster response may call for substantial amounts of public spending. Essential goods and services, like medicines and food, need to be procured immediately for the sake of mitigating damages and for commencing the subsequent recovery processes. Following non-emergency procurement rules, which favor open competition and 'value for money' in terms of price and quantity, may result in delays in delivering much needed relief to disaster-affected areas. Therefore, procurement rules usually allow for certain relaxations in procedures during such emergencies. These emergency clauses grant more discretionary powers to public officials to deviate from the otherwise strict procurement principles and fast-track processes to fulfill local needs.

[1] In the EU, government contracting represents 14% of the GDP. See `https://ec.europa.eu/growth/single-market/public-procurement_en`

[2] Coviello et al. (2018) and Decarolis et al. (2020) document that discretion may not always introduce inefficiencies and may, in fact, reduce transactions costs by reducing delays in acquisitions.

While there is a well-founded need to have emergency clauses in procurement rules, there may also be a heightened risk of corruption. Along with greater discretionary powers embedded in emergency clauses, affected areas also attract a large amount of funds for disaster-relief. These allow officials in-charge, who want to derive benefits for themselves, an even greater opportunity to do so. In a system already affected by corruption, therefore, the occurrence of disasters may further heighten corruption risks (Atkinson & Sapat 2012). Those benefiting from corruption may also want to prolong the emergency so that they may continue to receive illicit gains. Indeed, as Schultz & Søreide (2008) highlight, a lack of consensus on what constitutes an emergency and how long it should last may motivate officials to continue to abuse the discretionary powers given by emergency clauses for illegal rent-seeking.

On the other hand, such corruption risks may not necessarily materialize. Officials may refuse to distort decisions in exchange for bribes due to the importance of saving lives. Their decisions are also not without oversight and any acts of corruption may be brought to light through ex-post investigations by auditors, aid donors,[3] or other branches of government. Finally, officials might also be careful because of the desire to avoid a corruption scandal.

In this study, for a set of five disasters in Italy, we investigate whether there is an increase in corruption risks due to natural disasters. We combine the data on natural disasters with administrative data on public procurement tenders in Italy and conduct a contract-level analysis. Several indicators from different stages of the procurement process are used as proxies for corruption risks. These are: (a) non-publication of tender calls online, (b) single bidding, (c) non-open procedures in awarding contracts, and (d) too-short advertisement periods. To understand how disasters affect these dependent variables, we carry out an unmatched and a matched before-after analysis of disaster-affected areas. The unmatched logistic regression is conducted in the three-year before-and-after time window around disasters. This analysis shows that there is an 11.9% increase in the probability of non-publication of tender calls after disasters. Similarly, the probability of single bidding also increases by 7.92%. In addition, these increases are 4.29% for the probability of non-open procedures and 17.8% in the probability of too-short advertisement period.

For the full sample, ranging from 2007 to 2020, the matched comparison shows a 16.1% increase

[3] Lambert & de La Maisonneuve (2007) is an example of an ex-post investigation. The authors investigate the use of relief-aid after the 2004 Indian Ocean Tsunami.

in non-publication of call of tender and a 6.5% increase in the share of tenders with single bidder due to emergencies. We also find that emergencies led to a 10.5% increase in the contract awards through non-open procedures and a 19.6% increase in the share of tenders with a too-short advertisement period.

The advantages of our approach are: first, the exact timing of natural disasters is exogenous and allows us to conduct a causal analysis. Second, conducting a comparison within the disaster-affected areas ensures that the before-after comparison controls for institutional quality. Third, disasters are likely to affect the procurement process through both changes in behavior (direct effect) and changes in the spending composition (indirect effect). The latter implies that a disaster-affected municipality would procure some goods or services in greater quantities after a disaster which might be inherently more susceptible to corruption risks. This would also increase the overall corruption risks. Conducting a matched comparison controls for such changes in spending composition and isolates the direct effect of behavioral changes due to disaster because we compare similar contracts before and after the shock.

Our results show that the emergencies may have effects on procurement procedures and single bidding which reflect a heightened risk of corruption. Our results must, however, be interpreted with caution. First, due to the emergency, deviations from non-emergency principles might be necessary and allowed under emergency clauses. Officials may alter procedures to reduce delays in acquisitions and not necessarily to favor a particular supplier in exchange for a bribe. Second, officials may also face the pressure to use disaster-relief funds quickly and may prefer to contract with fewer suppliers (Schultz & Søreide 2008). This may contribute to increased single bidding. Both of these factors will be captured as heightened corruption risks in an analysis of procurement procedures and probability of single bidding after a disaster. Further, to capture the overall changes in the government contract process, we analyse the effect of emergencies starting from several years before to several years after the disaster. This approach may also not fully capture the extent of corruption risks since officials may also need to legitimately prolong the use of emergency clauses to deal with particularly severe disasters.

We have selected Italy as a case for several reasons: first, the Italian government has recently taken steps to increase efficiency in the procurement process. These include the inclusion of the public procurement authority into the anti-corruption agency and the introduction of laws which harmonize procurement with EU standards.[4] Second, while Italian public procurement has been extensively studied, there has been little work on disasters and their effect on Italian government contracting. Third, the availability of a rich micro-level data-set allows us to concretely investigate our research question.

We rely on the assumption that corruption risks in procurement are higher when there is a lack of competition or when non-transparent procedures are used (Søreide 2002). First, single bidding is a corruption risk because an official may try to limit competition by designing tenders to suit a specific supplier, possibly in exchange for a bribe. This has been used as an indicator for corruption risk in several empirical studies including Klašnja (2015) and Charron et al. (2017). Further, non-publication of tender calls limits competition by restricting how widely a tender is advertised (Coviello & Mariniello 2014, Fazekas & Kocsis 2020). Fazekas & Kocsis (2020) show that, for EU27 countries (excluding Malta) and Norway, non-publication of tender calls leads to a 12 to 18% increase in the probability of single bidding depending upon model specification. Non-open procedures limit competition by restricting open entry. Contract awards through negotiation without publication and similar non-open procedures reduce transparency and may indicate an attempt to favor certain suppliers (Decarolis 2014, Chong et al. 2016, Auriol et al. 2016). Fazekas & Kocsis (2020) show that non-open procedures lead to 14.1%-18.8% increase in the probability of single bidding. Finally, too-short advertisement periods may also be designed to distort competition to suit one supplier because too-short periods may give competitors too little time to prepare bids (Piga 2011). Fazekas & Kocsis (2020) examine the effect of a too-short or too-long advertisement period and show that an extreme advertisement period raises the probability of single bidding by 1% compared with normal advertisement periods.

[4] EU directives 2004/18/EC and 2007/17/EC culminated into the Italian Legistalive Decree 163/2006, and ten years later EU directives 23/2014/EU, 24/2014/EU, and no. 25/2014/EU culminated into Italian Legislative decree 50/2016. For a more detailed review of public procurement in Italy, see Decarolis & Giorgiantonio (2015).

2. Italy and the empirical context

2.1. EM-DAT data on disasters

The Emergency Events Database (EM-DAT)[5] is maintained by the Centre for Research on the Epidemiology of Disasters (CRED) which has data on 22,000 disasters from all over the world starting from 1900. For each disaster, the database provides detailed information about the type of disaster, the start and end date, the region (up to city level) affected, the origin, associated disasters,[6] the magnitude, the number of people affected (injured and dead), and the damage caused. Since this data set contains information on very small scale disasters with very little damage, we need to select disasters which have are sufficiently large to have an impact on the procurement process. The selection criteria for disasters used in this study are described below.

2.1.1. Selection of disasters

We select those disasters from the EM-DAT data set which have (a) a fixed location on land, (b) a fixed start and end date, (c) are geophysical or hydrological in nature, (d) caused more that 10 deaths, and (e) occurred between 2008 and 2020.[7] After applying this selection criteria, the following five disasters which lie in mutually exclusive regions remain (the regions where they occurred are depicted in Figure 1):

1. **Floods in Messina Province** which occurred on the 1st of October, 2009. The flood mainly affected Giampilieri, Taormina, Scaletta Zanclea, Molino towns in Sicily and killed a total of 35 people. The floods caused an estimated total damage of US $20 million.
2. **Earthquake in Modena Province** which occurred on the 29th of May, 2012. The earthquake had a magnitude of 6 on the Richter scale and caused 17 deaths. According to the EM-DAT dataset, the earthquake caused total insured damage of US $1.3 billion. Others estimated the total damage to be around US $4 billion (Dirani 2012).
3. **Floods in Sassari Province** which occured on the 18th of November, 2013. The floods mainly affected the Olbia and Arzachena cities and led to 18 deaths. The floods caused total

[5] Available at: `https://www.emdat.be/`

[6] These are disasters that are caused by other disasters. For example, an earthquake may trigger an avalanche or a tsunami.

[7] These criteria rule out migrant boat accidents, heat waves, famine, industrial accidents, and other small scale disasters.

damage of US $780 million.

4. **Earthquake in Rieti and Ascoli Piceno Provinces** which occurred on the 24th of August, 2016. The earthquake had a magnitude of 6 on the Richter scale and led to 296 deaths. The earthquake caused total damage worth US $5 billion.

5. **Avalanche in Pescara Province** which occured on the 18th of January, 2017 and led to 29 deaths due to the destruction of a hotel. The avalanche was triggered by a set of earthquakes in the same area which themselves did not cause any deaths. The total damage caused by the avalanche was US $6 million.

Fig. 1. *Map of Italy Depicting the Affected and Unaffected areas*

2.2. Italian public procurement

Italian public procurement roughly accounts for 10% of the Italian GDP (European Commission 2016) and is carried out under the auspices of the *Autorità Nazionale Anticorruzione* (ANAC) which is the Italian anti-corruption body. A further level of oversight is maintained by Italy's Court of Audit.

The Italian government has stipulated strict rules regarding the procedures to be followed through the tendering process and for awarding contracts. In general, all contracts that have a value of more than 1 million euros need to go through the full open tendering process. Contracts below this threshold can be awarded through non-open procedures like direct award or a negotiated procedure. In the case of emergencies or in cases where previous open procedures received no bids, the rules allow the use of non-open procedures, even for contracts above the 1 million euro threshold.

In the past few years, there have been cases of corruption in the Italian procurement system. In 2012, 22% (68) of corruption convictions came from the procurement-related corruption (ANAC 2012). Between 2016-2019, 152 cases of procurement corruption came to light (ANAC 2019). Several reforms have been implemented to reduce the risk of corruption. For example, a national anti-corruption law was passed in 2012 which led to the national Anti-Corruption Plan 2013-2016. The 2012 Anti-Corruption law also makes it obligatory to make public all data related to award of public contracts. The formation of the Public Procurement Observatory to track financial flows is another anti-corruption step undertaken by the Italian authorities.

2.2.1. Data on Italian public procurement

For the public procurement data, we rely on the administrative data collected under the DIGIWHIST project.[8] The data consists of Italian public contracts between a supplier and a buyer (public authority) published on Tenders Electronic Daily (TED; which is the dedicated portal for European public procurement) from 2007 to 2020. For each contract, the data contains information regarding the procedure followed for awarding the contracts, the location of the buyer (NUTS3 code and city name), the type and name of the buyer, the CPV code, the size of the contract, the number of bidders, dates of first call, last call and the date of contract award. We drop all the

[8] DIGIWHIST refers to the Digital Whistleblower Project. More information is available at: `http://digiwhist.eu/about-digiwhist/`. The data can be freely downloaded from `https://opentender.eu/start`

contracts without location information or relevant dates.

All the contracts that lie in the NUTS3 code[9] (or city when NUTS3 code is missing) of an area affected by the five disasters discussed above are included in the analysis. The total number of such contracts is 11,128. Tables 1, 2, and 3 respectively show disaster-wise year-wise, and sector-wise composition of our sample:

Group	Number of Contracts
Disaster 1	2915
Disaster 2	2366
Disaster 3	2106
Disaster 4	615
Disaster 5	3126
Total	11128

Table 1: *The total number of contracts in each group from 2007-2020*

Year	Number of Contracts
2007	6
2008	254
2009	409
2010	388
2011	1402
2012	731
2013	1227
2014	988
2015	1260
2016	1171
2017	1274
2018	773
2019	952
2020	254
Total	11128

Table 2: *The yearly composition of contracts in disaster-affected areas*

[9]NUTS refers to Nomenclature of Territorial Units for Statistics. For Italy, the NUTS3 code allots a unique alphanumeric code to each of the 107 Italian provinces.

Type of Procurement	Number of Contracts
Medical equipment, pharmaceuticals, and personal care	7180
Financial and insurance services	722
Health and social work services	565
Sewerage, refuse, cleaning, and env. services	551
Repair and maintenance	222
Transport services (excluding waste transport)	206
Other	1682
Total	11128

Table 3: *The total number of contracts by main sector of the product (CPV)*

3. Causal identification of the impact of disasters

We exploit the exogeneity of the exact timing of hydrological and geophysical disasters to conduct a causal analysis where the treatment is the occurrence of the disaster. There may be certain areas where disasters occur frequently (for example, in zones of high seismic activity earthquakes may strike frequently), but since it is difficult to know exactly when an earthquake or flood will occur, the exact timing can be assumed to be randomly assigned. Secondly, even though the occurrence of floods may be known a few days in advance, through flood or heavy rain forecasts, it is unlikely to influence our results since public procurement operates on much longer time-frames during non-emergency periods. A contract may be awarded after weeks and months of preparation and tendering. We conduct both an unmatched and a matched analysis before and after the treatment.

All the contracts that had call-for-tender dates prior to the disaster are part of the treated group, while all those that had call-for-tender dates after the disaster are part of the control group. This is because any new procedural rules only apply to tenders that are yet to begin, and not to those tenders which are already underway at the time of the disaster, but lead to contract award after that. In cases where the call-for-tender dates are missing, we consider the publication date of the first contract award announcement.

Despite their exogeneity, we expect disasters to have a range of effects, not all of which directly impact corruption risks. In our analysis, we would like to isolate the direct effect of behavioral change due to disasters. This is difficult to do with an unmatched comparison. The unmatched comparison will capture both the direct effect of behavioral changes and the indirect effect of changes in spending composition due to disasters. The latter may give rise to risks because the new requirements may be susceptible to greater corruption risks. To control for the indirect effect of such changes in spending composition, we also conduct a matched before-and-after treatment analysis.

For the matched analysis, we match contracts in the treated group with those that are in the untreated group to find a suitable control group. For this purpose, we use Coarsened Exact Matching (CEM) (Iacus et al. 2012) at the contract level.[10] According to Iacus et al. (2009), the procedure does exact matching by temporarily coarsening covariates and minimizing imbalance between treatment and control groups. CEM is advantageous since it relies on fewer assumptions about common support than other procedures. We match the contracts from the treated group based on the following covariates:

1. Buyer Type (national, regional, public body, utilities, or others)
2. Main sector of the product purchased (CPV)
3. The Contract Value (natural logarithm of amount in euros)
4. Buyer Organization (pre-treatment average of the corruption risks)
5. Contract Month

We work on the assumption that the matching procedure generates a control group which is second-best since we cannot observe the same contract before and after disasters. Our approach is based on the work of Dávid-Barrett & Fazekas (2020) who argue for matching on these covariates because they are measured at the contract level and are more relevant for causal estimation. An advantage of focusing only on disaster-affected areas is that we are able to control such unobserved institutional quality. In particular, analyzing the same areas ensures that the range of buyers is limited. In the matched comparison, however, we do this explicitly by restricting the analysis to only those buyers that are present in the sample both before and after the disaster.

There are also drawbacks of our approach. First, the NUTS3 region of contract implementation might be broader than the actual disaster impact zone. Since the public procurement data does not

[10]The CEM code was written in R with the help of the R library due to Iacus et al. (2009).

go below the NUTS3 level, it is difficult to remove this drawback. Second, similar to Dávid-Barrett & Fazekas (2020), when using the pre-treatment average of the dependent variable for matching, we may get matches across buyers. Third, since the disasters are of varying magnitudes, not all of them will have the same impact on public procurement.

Our approach is based on Fazekas et al. (2016) and Fazekas & Kocsis (2020), who also use an objective set of indicators of corruption risk as dependent variables. This approach has been described as the "red flag approach" where unnecessary deviations from open and transparent procurement practices are used as indicators of higher corruption risk (Klašnja 2015, Charron et al. 2017, Decarolis & Giorgiantonio 2020). Table 4 provides an overview of the dependent variables included in the analysis:

Indicator	**Corruption Risk**	**Interpretation**
non-publication of tender call	Non publication of tender calls may limit advertisement and consequently restrict the number of firms involved in the bidding phase.	$tendercall = 1$, no call published $tendercall = 0$, call published
single bidder	Single bidding could be because the contract is narrowly defined to suit one firm. Alternatively, it could be due to the presence of a bidding cartel where the winner is pre-determined.	$singlebid = 1$, only one bidder $singlebid = 0$, multiple bidders
non-open procedure type	Non-open procedures reduce transparency. These may be used to favor certain suppliers.	$proceduretype = 1$, non-open procedure $proceduretype = 0$, open procedure
too-short advertisement period	A too-short advertisement period could be because the procedure is skewed in favor of one particular firm. The information about the tender is only available for a short while and it does not give competitors sufficient time to prepare bids.	$advertperiod = 1$, too-short advertisement period $advertperiod = 0$, normal advertisement period

Table 4: *Dependent variables and the associated corruption risks*

Note that in our analysis non-open procedure types include: Restricted, Restricted with publication, Negotiated without publication, Competitive dialog, Outright award, Negotiated, Innovation Partnership.

3.1. Empirical expectations

Since there is a need to fulfill demands rapidly in disaster-affected areas, we expect procurement officials to use emergency clauses and deviate from non-emergency periods. While this may be essential in times of crises, it may also allow officials to abuse their discretionary powers to earn illegal rents. Such officials may also try to prolong emergencies to keep profiting from emergency-related relaxation in procurement rules. We, therefore, expect natural disasters to lead to higher corruption risks. Note that from our data it is impossible to pin-point corruption, hence we refer to corruption risks.

4. Results: Unmatched comparisons

In this section, we discuss the unmatched comparisons of the treated and control groups with respect to all our dependent variables. Figures 2-5 (in the appendix) demonstrate the share of treated contracts for a 3-year time window before and after disasters. To confirm whether exogenous disasters lead to lasting changes in the shares across groups, we first conduct a simple t-test analysis for all the dependent variables in Table 5.

Window size	**No Tender Call** *(after - before)*	**Single bidding** *(after - before)*	**Non-open Procedure** *(after - before)*	**Too-short Advert period** *(after - before)*
3 years	-0.05	0.002	0.0341	0.2826***
	(-0.62)	(0.64)	(0.973)	(4.429)
2 years	0.04	-0.02	0.078	0.16
	(0.29)	(-0.437)	(1.04)	(1.31)
1 years	-0.08	-0.05	0.115	-0.058
	(-1.51)	(-0.396)	(0.94)	(-0.51)
Note:	*p <0.1; **p <0.05; ***p <0.01			

Table 5: *t-test results for the quarterly share of treated contracts awarded through risky procedures by dependent variable (t-value in the brackets)*

If there is an increase in the corruption risk following disasters, we would expect a sharp change (and possibly long-lasting) in the shares of awarded contracts with red flags. We do not observe such changes for all the dependent variables used in the analysis. Barring too-short advertisement period in the three-year time window, none of the t-tests show any significant changes. However, we note that the shares of contracts awarded without calls published online or through non-open procedures are positive but insignificant even up to three years following a disaster. Figure 4 (in the appendix) shows that there is an immediate increase in the use of non-open procedures in the quarter following a disaster. This is unsurprising since officials ought to use discretionary powers in emergency times. However, the changes are not significant at the one-year, two-year, or three-year time frames.

The inconclusive t-test results might be confounded by changing spending composition such as higher spending on construction projects or healthcare supplies critical for crisis response. By implication, to further understand the effects of natural disasters, we conduct regression analysis to control for such confounding factors. In particular, we run the following logistic regression for the binary dependent variables:

$$log_e\left(\frac{Pr[DV_i = 1]}{1 - Pr[DV_i = 1]}\right) = \beta_0 + \beta_1 \times Disaster_i + \alpha_i + \epsilon_i \tag{1}$$

where DV_i refers to the various dependent variables and $Disaster_i$ is the time dummy which is 0 before the disaster and 1 after the disaster. α_i refers to the control variables. Note that for all the binary dependent variables, a higher value indicates increased corruption risk. The control variables used in the analysis are listed in Table 6.

Table 6 demonstrates the results of the unmatched analysis within a three-year time window before and after a disaster.[11] The three-year time window is relevant because we are interested in the effect of disasters on the procurement process in general. Shorter time-windows are much more likely to only capture the immediate acquisition to fulfil emergency-related needs due to emergency clauses in Italian procurement rules. As noted in the introduction, this does not rule out the fact the emergencies may be legitimately prolonged to deal with severe damage.

The average marginal effects of logistic regression models in Table 6 provide evidence that disasters may have a significant impact on procurement procedures and outcomes in the three-

[11] Six years in total.

	Binary Logistic Regression			
	No Tender Call	**Single bidding**	**Non-open Procedure**	**Too-short Advertisement Period**
Treatment (3-years)	0.119***	0.0792***	0.0429***	0.178***
	(0.011)	(0.030)	(0.0079)	(0.010)
Control Variables–				
Contract Value (log)	Y	Y	Y	Y
CPV (Medical or not)	Y	Y	Y	Y
Contract Year	Y	Y	Y	Y
Contract Month	Y	Y	Y	Y
Buyer Type (Regional or not)	Y	Y	Y	Y
$N(total)$	4,214	1,588	4,214	4,213
$N(after\ disaster)$	1,734	1,065	1,734	1,734
Cox & Snell's R^2	0.26	0.18	0.19	0.29
Note:	$^*p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$			

Table 6: *The table reports the average marginal effects from the binary logistic regression of treatment dummy on all the dependent variables. (std. errors in the brackets)*

year time window. The estimates suggest that emergencies lead to an average increase of 11.9% in the probability of non-publication of tender calls. Similarly, there is a 7.92% higher single bid probability. In addition, there is a 4.29% higher probability of contract award through non-open procedures. Finally, there is a 17.8% increase in the probability of too-short advertisement period.

The results highlight increased probabilities of altered procedures and single bidding after disasters. However, the unmatched analysis does not isolate the effect of change in behavior due to disasters. Recall that the shock due to disasters can affect procurement practices through (a) changes in the spending composition and (b) changes in behavior. The coefficients of the unmatched comparison capture both. The matched analysis, presented in the next section, allows us to control for risks that arise because of changes in spending composition and isolate the effect of behavioral changes due to disasters.

5. Results: Matched comparisons

We follow the matching procedure outlined in Section 5 to generate a matched-control group. The matched-control group has the same buyers as the treated group. This explicitly controls for institutional quality and allows us to compare contracting by similar entities before and after disasters. The latter controls for corruption risks stemming from new kinds of goods and services (which may be inherently more susceptible to corruption risks) that municipalities may require after disasters. Following the matching, we conduct simple t-test before and after disasters to find that causal impact of the disasters. Since, the procurement data runs from 2007 to 2020 and the final disaster in the analysis occurs in 2017, we have at least three years of post-disaster data for all disasters when we conduct the matched comparison.

Table 7 below presents the results of the matched comparison. In terms of limited advertisement of tenders, we find that there is a 16.1% increase in non-call for tender publication as a result of emergencies. Further, there is a 10.5% increase in the contract awards through non-open procedures. For too-short advertisement periods, we find that emergencies result in an increase of 19.6% due to emergencies. The matched analysis shows that the disasters result in an increase of 6.5 % in the share of tenders with single bidder, though the change is insignificant.

Taken together, the results of this section indicate that emergencies increase in the use of procedures which are susceptible to corruption risks even when we include contracts that were awarded several years after the disaster. However, these results should not be considered as exact measures of increases in corruption risks. Disaster-affected areas need rapid acquisitions and procedures may be altered to facilitate them.

	(after - before)			
	No Tender Call	**Single bidding**	**Non-open Procedure**	**Too-short Advertisement Period**
Treatment (full sample)	0.161***	0.065	0.105***	0.196***
	(3.025)	(1.037)	(3.375)	(6.119)
Matching Variables–				
Contract Value (log)	Y	Y	Y	Y
Main Sector CPV	Y	Y	Y	Y
Contract Month	Y	Y	Y	Y
Buyer Type	Y	Y	Y	Y
Buyer prior DV avg.	Y	Y	Y	Y
$N(total)$	518	174	544	600
$N(after\ disaster)$	98	68	115	172
Note:	$^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$			

Table 7: *The table reports the results of the matched t-test of contracts before and after disaster (t-value in the brackets)*

6. Discussion and conclusions

In this study, we investigate whether there is an increase in corruption risks in the public procurement process due to natural disasters by combining public procurement data from Italy with data on five natural disasters. The results of the matched analysis show that disasters lead to an increased use of procedures and outcomes which limit competition and reduce transparency. Our results shed light on how procurement officials might use their discretionary powers to alter procedures and outcomes in the years following a disaster.

While our results show that disasters may increase the risks that officials may engage in rent-seeking, because they have opportunity to abuse their extended discretionary authority, this analysis of procedures and outcomes may not provide a complete picture of the extent of increase in corruption risks. Discretionary powers may help reduce delays in procurement (Coviello et al. 2018, Decarolis et al. 2020) and effective disaster-response calls for quick acquisitions of necessities and the 'value for money' standard may need to be relaxed. The pressure to use relief-aid quickly may also result in higher single bidding (Schultz & Søreide 2008). Furthermore, it is difficult to define what is an adequate time-period during which emergency-related procurement is allowed. While there is a risk that officials may prolong the state-of-emergency to continue to receive illicit gains, officials may also need discretionary powers to legitimately prolong the period of emergency-related procurement since some disasters could have particularly severe long-run effects.

In spite of this, our work presents some policy implications. First, besides emergency clauses, policymakers should ensure that there is a clear framework for disaster procurement which clarifies the legitimate uses of discretionary power under emergency clauses. The rules should clarify what kind of goods and services can be procured through emergency clauses. Second, there must be criteria, albeit flexible, for how an emergency is defined and a road map for returning to normalcy. Third, as Schultz & Søreide (2008) suggest, having 'real-time evaluations', which are quick assessments of disaster responses. These need to be carried out while relief efforts are underway. Such evaluations can help to flag any potential abuse of powers during the response effort and also aid in returning to normalcy. Fourth, ensuring ex-post evaluations take place which (a) focus on implementation and not necessary procedures and (b) have the power to sanction offenders.

In general, policymakers face the tough task of balancing the benefits of discretionary authority with the risks of corruption. This challenge becomes even more acute during emergencies. Striking the right balance is important as incorrect decisions could cost lives or result in huge losses due to, for example, prolonged abuse of emergency clauses. Further work may focus on contract implementation to study the welfare effects of emergency-related procurement.

References

Aidt, T. S. (2003), 'Economic analysis of corruption: A survey', *The Economic Journal* **113**(491), F632–F652.

ANAC (2012), Rapporto sul primo anno di attuazione della legge n. 190/2012, Technical report, Autorità Nazionale Anticorruzione.

ANAC (2019), La corruzione in italia: Numeri, luoghi e contropartite del malaffare, Technical report, Autorità Nazionale Anticorruzione.

Atkinson, C. L. & Sapat, A. K. (2012), 'After Katrina: Comparisons of post-disaster public procurement approaches and outcomes in the New Orleans area', *Journal of Public Procurement* **12**(3), 356–385.

Auriol, E., Straub, S. & Flochel, T. (2016), 'Public procurement and rent-seeking: The case of Paraguay', *World Development* **77**, 395–407.

Charron, N., Dahlström, C., Fazekas, M. & Lapuente, V. (2017), 'Careers, connections, and corruption risks: Investigating the impact of bureaucratic meritocracy on public procurement processes', *The Journal of Politics* **79**(1), 89–104.

Chong, E., Klien, M. & Saussier, S. (2016), The use and abuse of discretionary procurement procedures: Evidence from the European Union, Working Paper Chaire EPPP.

Coviello, D., Guglielmo, A. & Spagnolo, G. (2018), 'The effect of discretion on procurement performance', *Management Science* **64**(2), 715–738.

Coviello, D. & Mariniello, M. (2014), 'Publicity requirements in public procurement: Evidence from a regression discontinuity design', *Journal of Public Economics* **109**, 76–100.

Dávid-Barrett, E. & Fazekas, M. (2020), 'Anti-corruption in aid-funded procurement: Is corruption reduced or merely displaced?', *World Development* **132**, 105000.

Decarolis, F. (2014), 'Awarding price, contract performance, and bids screening: Evidence from procurement auctions', *American Economic Journal: Applied Economics* **6**(1), 108–32.

Decarolis, F., Fisman, R., Pinotti, P. & Vannutelli, S. (2020), Rules, discretion, and corruption in procurement: Evidence from Italian government contracting, Working Paper 28209, National Bureau of Economic Research.

Decarolis, F. & Giorgiantonio, C. (2015), 'Local public procurement regulations: The case of Italy', *International Review of Law and Economics* **43**, 209–226.

Decarolis, F. & Giorgiantonio, C. (2020), Corruption red flags in public procurement: new evidence from Italian calls for tenders, Questioni di Economia e Finanza (Occasional Papers) 544, Bank of Italy, Economic Research and International Relations Area.

Dirani, D. (2012), 'Terremoto, l'allarme di confindustria: danni per oltre quattro miliardi, lo stato intervenga'. Il Sol 24 Ore (12.06.2012): `https://st.ilsole24ore.com/art/notizie/2012-06-06/terremoto-allarme-confindustria-danni-152403.shtml?uuid=AbLaUEoF`.

European Commission (2016), Public procurement – Study on administrative capacity in the EU: Italy country profile, Report: `https://ec.europa.eu/regional_policy/sources/policy/how/improving-investment/public-procurement/study/country_profile/it.pdf`.

Fazekas, M. & Kocsis, G. (2020), 'Uncovering high-level corruption: cross-national objective corruption risk indicators using public procurement data', *British Journal of Political Science* **50**(1), 155–164.

Fazekas, M., Tóth, I. J. & King, L. P. (2016), 'An objective corruption risk index using public procurement data', *European Journal on Criminal Policy and Research* **22**(3), 369–397.

Iacus, S., King, G. & Porro, G. (2009), 'cem: Software for coarsened exact matching', *Journal of Statistical Software* **30**(9), 1–27.

Iacus, S. M., King, G. & Porro, G. (2012), 'Causal inference without balance checking: Coarsened exact matching', *Political Analysis* **20**(1), 1–24.

Klašnja, M. (2015), 'Corruption and the incumbency disadvantage: Theory and evidence', *The Journal of Politics* **77**(4), 928–942.

Lambert, B. & de La Maisonneuve, C. P. (2007), *UNHCR's Response to the Tsunami Emergency in Indonesia and Sri Lanka, December 2004-November 2006: An Independent Evaluation*, Policy Development and Evaluation Service, United Nations High Commissioner.

Piga, G. (2011), A Fighting Chance Against Corruption in Public Procurement?, *in* S. Rose-Ackerman & T. Søreide, eds, 'International Handbook on the Economics of Corruption, Volume Two', Chapters, Edward Elgar Publishing, chapter 5.

Rose-Ackerman, S. (1975), 'The economics of corruption', *Journal of public economics* **4**(2), 187–203.

Rose-Ackerman, S. & Palifka, B. J. (2016), *Corruption and Government: Causes, Consequences, and Reform*, 2 edn, Cambridge University Press.

Schultz, J. & Søreide, T. (2008), 'Corruption in emergency procurement', *Disasters* **32**(4), 516–536.

Søreide, T. (2002), *Corruption in public procurement: Causes, consequences and cures*, Chr. Michelsen Intitute.

Appendix A. Figures

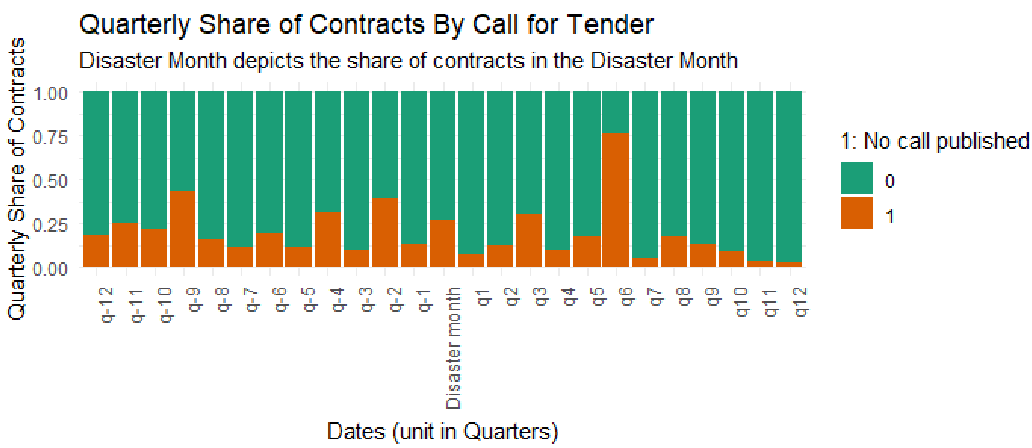

Fig. 2. Share of contracts with tender calls published or not

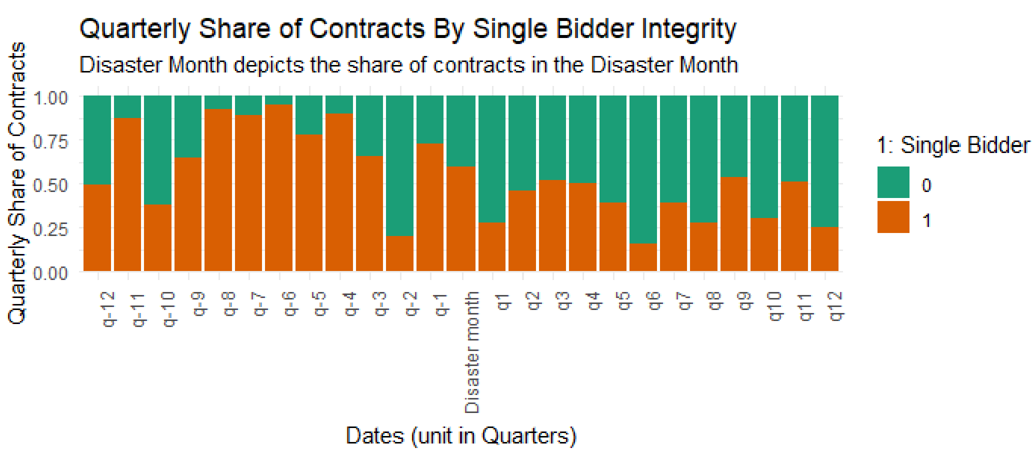

Fig. 3. Share of contracts with single bidders versus multiple bidders

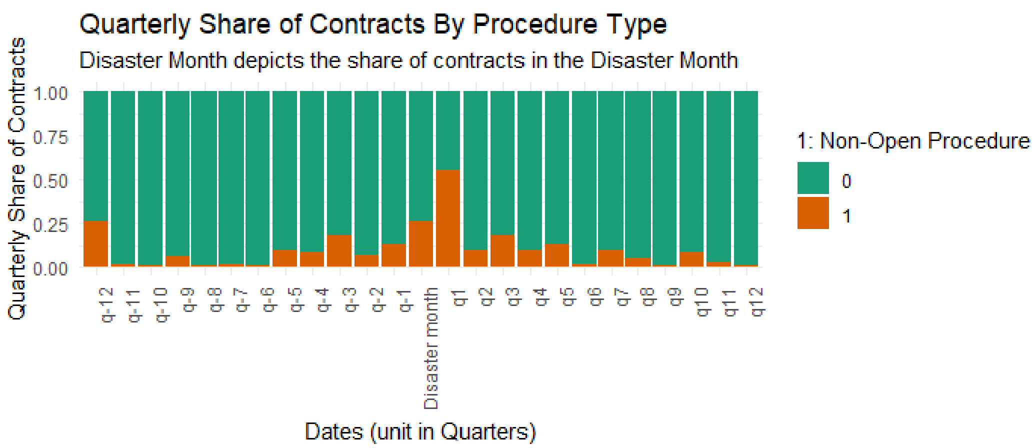

Fig. 4. Share of contracts with open versus non-open award procedures

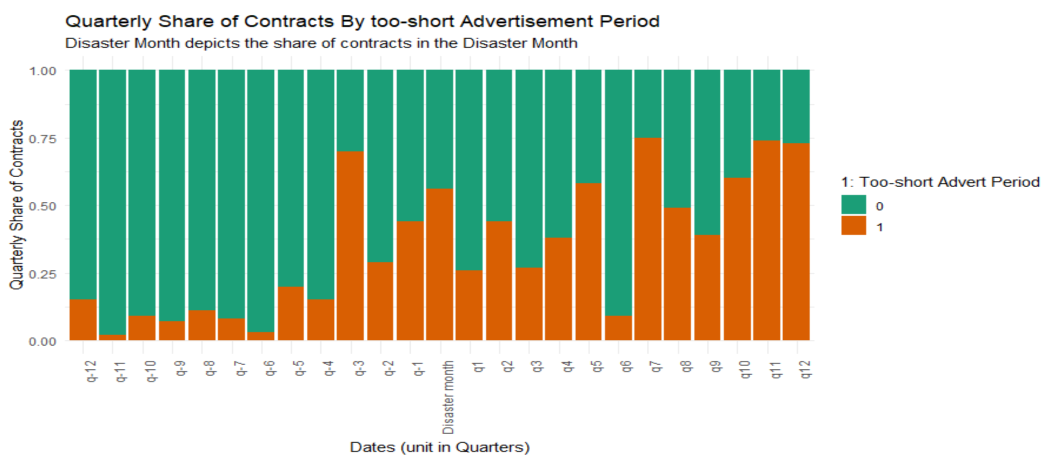

Fig. 5. Share of contracts with too-short versus normal advertisement period