Moral Hazard in Regulations with Loopholes*

(*Preliminary and Incomplete*)

Co-Pierre Georg†
University of Cape Town

Suraj Shekhar‡
University of Cape Town

November 2, 2018

Abstract

We study a static environment where two competing firms are subject to a regulation which increases their cost of production. The regulation has a loophole and the firms can exert private effort to find it. Any firm which finds the loophole can lower their cost of production. Given the loophole finding effort of a firm, the higher the strength of the regulation, the less likely it is that the firm finds the loophole. We demonstrate a new channel via which increasing the regulation strength could reduce welfare. We show that strengthening the regulation can make the reward for finding the loophole bigger. This could lead to higher loophole finding effort which offsets the impact of the regulation strengthening. We further show that even if regulation strength is determined by the firms' lobbying effort, this may still be welfare superior to the regime in which there is no regulation. This is because it is optimal for the firms to not induce very weak regulations. Our results are consistent with the empirical findings of Hu et al. (2017). *JEL codes - D82, L51.*

Keywords - Regulations, Loopholes, Moral Hazard, Lobbying, Competition

*Please do not cite without the permission of the authors.

†Email: cogeorg@gmail.com
‡Email: suraj.shekhar@uct.ac.za

"America's financial system has been highly innovative, but to a great degree innovation has recently been directed at circumventing laws and regulations..." - Joseph Stiglitz[1]

"...Complex rules have generated both the incentives and the means to exploit regulatory loopholes." - Andrew Haldane[2]

1 Introduction

Governments and regulators worldwide face the problem of coming up with good regulations. However, most regulations come with loopholes. In this paper, we use the word 'loophole' to describe a way to get around the regulation. This could be done legally, like in the case of *The Clean Air Act Amendments* of 1977 in the USA. It stated that only new factories and power plants would have to meet the tighter emissions standards imposed by the act. Existing plants would be regulated under the pre-existing standards unless they were 'substantially modified.' Unfortunately, the regulation did not precisely define what 'substantially modified' meant. Several old firms took advantage of this loophole. Alternatively, a firm could get around a regulation illegally, like in the case of Volkswagen who fitted their cars with pollution check beating software to get around the regulation of reducing pollution.

Obviously, the firm which finds a loophole in the regulation gets a competitive edge over its rivals. Thus, there could be significant incentives to find loopholes in regulations[3]. Regulators are aware that their regulations may have loopholes, and they constantly strive to make it difficult for firms to find the loopholes by strengthening regulations[4]. We take the 'strengthening' of regulations to refer to any act which makes it more difficult for any player to find the loophole in the regulation. Since regulations are usually put in place to curb something undesirable, it would appear intuitive that regulators should jump at any chance to reduce the

[1] Stiglitz (2009).

[2] Haldane (2013).

[3] In his 1977 paper (Kane (1977)), Edward Kane spoke about the 'regulatory dialectic', a phrase he used to describe the cycle of formulation of regulations, and the market's response to maintain/increase profits by finding and exploiting loopholes in the same.

[4] In the USA, the Great Depression spawned the Glass-Steagall Act (1933), which was about 37 pages. The recent financial crisis and subsequent recession has spawned the Dodd-Frank Act (2010). It runs to 848 pages. Once completed, Dodd-Frank might run to 30,000 pages of rule making.

number of loopholes in regulations. This brings us to our research question - If a regulator can strengthen a regulation at no cost, should she always do it?

We propose a new channel via which increasing the regulation strength could reduce welfare. We show that strengthening regulations can make the reward for finding loopholes bigger. This could lead to higher levels of loophole finding effort which undermines the strengthening of the regulation. The intuition is that when two firms compete with each other, the reward for finding the loophole in a regulation is highest when the other firm does not find the loophole. Thus, under some conditions, when regulation strength is increased, two opposing forces shape the firm's incentive to exert effort to find loopholes. One, the increase in regulation strength makes it less likely that a firm will find a loophole. This reduces the return from loophole finding effort. Two, the increase in regulation strength makes it more likely that if a firm finds the loophole, it may be the only firm which does so (that is, it becomes more likely that the other firm does not find the loophole). This increases the returns from loophole finding effort. We find conditions under which the latter effect dominates the former leading to the counter-intuitive result that - when regulation strength is increased, the probability that the regulation will be violated is also increased. Our theoretical results are consistent with the empirical findings of Hu et al. (2017) who find that as the permissible levels of Nitrogen Oxide emissions went down in Europe (between 2000-2014), the number of violations (as captured by an on the road sensor) went up.

We go on to show that an increase in competition can also increase the probability of one of the firms finding a loophole. In this way, the impact of an increase in regulation strength and the impact of increased competition is similar. If the latter can be affected by the regulator, then the regulator may think of regulatory strength and competition level as substitutes. Finally, we endogenize the regulation strength in the model by allowing the firms to put in lobbying effort which directly influences the level of regulation strength. We show that even though regulation strength is determined by the lobbying effort of firms, the society may be better of with influenced regulations as compared to no regulations. The key idea is that even though regulation strength is determined by lobbying effort, it is not in the interest of the firms to make regulation very weak (else the rival firm also has a high chance of finding the loophole). This

means that there is a high enough probability that no firm finds the loophole, and this benefits the society.

Our model shows that well intentioned regulations may produce undesirable effects if policy makers ignore how the relevant players will react to a change in regulation. Regulators often try to patch old regulations to make them 'stronger'. This could be because politicians want to score brownie points with their constituents, or because they truly believe that this is in public interest. However, we show that the mindless strengthening of old regulations can actually have the opposite of the desired effect. The policy implication of our result is that under some conditions, it is better to *reduce* the strength of the regulation (or remove the regulation entirely). Given how costly (both time and money) regulations are, any theory which prescribes lower regulations is important and must be examined carefully. Our result is in the spirit of the theory of the second best (see Lipsey and Lancaster (1956)).

The rest of the paper is structured as follows. Section 2 describes the relevant literature and section 3 describes our baseline model. Section 4 presents the analysis for our baseline model. In section 5, we introduce endogenous regulation strength determined by the lobbying efforts of the two firms. We find the equilibrium regulation strength under lobbying, and show the regime with lobby determined regulation strength can be better than one without regulations. Section 6 concludes the paper.

2 Literature

Our paper highlights a new channel via which stricter regulations can worsen welfare. We identify conditions under which stricter regulations increase the returns from circumventing the regulation in an environment where firms compete on prices.

Two papers that are somewhat close to ours is Branco and Villas-Boas (2015) and Hu et al. (2017). They are primarily interested in the impact of increasing competition on the effort made towards regulatory compliance, but they also consider the impact of stricter standards on compliance. They find conditions under which stricter regulatory standards can reduce welfare by reducing the incentives to be compliant. The idea is that stricter standards increase the

marginal cost of production and this can reduce the incentive to be compliant as it reduces profits/revenue. This is because the cost of being non-compliant is directly proportional to the profits since a firm found to be non-compliant loses all its profits. Thus, lower profits reduce the cost of non-compliance. These papers differ from our paper in several ways the most important of which are as follows. First, both Branco and Villas-Boas (2015) and Hu et al. (2017) consider quantity competition whereas we consider price competition in our model. We believe our model is more reflective of an environment where one firm can significantly corner a market by finding a regulatory loophole and undercutting all its rivals. The angle of competition is, in fact, completely missing from Hu et al. (2017) where the compliance effort of a rival firm has no impact on the incentive to exert compliance effort for a given firm. Secondly, we allow the firms to make their pricing decision after they learn of the success of the loophole finding effort. Thus, the pricing decision is made after a significant asymmetry is realized. We believe pricing decisions must be a function of the result of loophole finding effort. This aspect of our model is not present in Branco and Villas-Boas (2015).

There have been several papers which discuss other negative side effects of regulations. Going back to the work of Stigler and Posner in the 1970's (Stigler (1971), Posner et al. (1974)), where they postulate that the political process of regulation is typically captured by the industry. In this case, regulation not only fails to counter monopoly pricing, but is actually used to sustain it through state intervention. More recently, Glaeser and Shleifer (2001) and Cheng and Lai (2012) argue that regulations may work better when they impose a small cost only. The idea is that as regulations become more stringent, it may become efficient for firms to bribe, or to exert greater political pressure (via lobby groups for example) to reduce the impact of the regulation or worse, reverse the intended impact of the regulation.

It has also been demonstrated in the finance and economics literature that an increase in regulation strength can lead to more risk-taking behaviour by the players who seek to maximize short-run profits - Laffont (1995), Gonzalez (2005). Finally, increasing regulation strength can be welfare reducing if the incentives of the political agents/regulators are not aligned with those of the society. A case in point is New York's Martin Act, the state law that gives the state Attorney general broad powers to investigate and press charges against alleged financial fraud.

The purpose of the act was to deter and fight financial fraud. However, it has been argued that this law has been misused to gain political points[5].

3 Model

There are two firms, consumers distributed on the interval $[0,1]$, and one regulator in the game. This is a static model where all players are risk neutral.

The firms can produce one of two goods - High type good (H) and Low type good (L). Each consumer demands only one unit of output (irrespective of good type). The marginal cost of production for the high type good (c_h) is higher as compared to the marginal cost of production for the low type good (c_l). We assume that $0 < c_l < c_h < 1$. Additionally, while production of the high type good results in no social cost, the marginal cost of producing the L type good burdens each consumer with a cost of C, where C is a positive real number. The consumers are indifferent between the goods and get a utility u ($> c_h$) from consuming either. They choose based on the lowest price. Thus, if one firm charges a lower price for their good then all consumers purchase from this firm. The difference in the goods is reflected in the cost of producing them and by the cost they impose on the society.

The regulator cares about the aggregate utility of all consumers and can introduce regulations to ban the production of any type of good to increase social welfare (the case where the regulator maximizes the utility of all consumers plus the utility of the firms is discussed in section 4.3.2). However, these regulations have loopholes. This means that the firms can exert effort and go around the regulation if their loophole finding efforts were successful. Formally, the firms can exert costly effort $e \in [0,1]$ to find the loophole. Let $p(\in [0,1])$ denote the strength of the regulation (exogenously given), which refers to the probability of finding a loophole if full effort is exerted. More generally, if a firm exerts effort $e(\in [0,1])$, then the probability of the firm discovering the loophole is pe. The cost of effort e for firm i is $\frac{M_i e^2}{2}$ where M_i is a positive real number. M_i is common knowledge for all i. I assume that firm 1 is more capable

[5]"Attorney General Eric Schneiderman went after several large energy firms for allegedly over-optimistic financial comments on up-state gas 'fracking,' a charge conveniently aligned with his own anti-fracking stance." - See *Devil's bargain: Wall St. & the Martin act - New York Post August 30, 2011*

of finding loopholes by assuming that $M_1 < M_2$. We have quadratic costs simply to make sure that we have bounded interior solutions for optimal effort[6]. If a firm discovers a loophole, then the firm may produce any good it wants (including the banned one).

3.1 Timing

First, the firms learn p. Then, they simultaneously make the effort choice to discover loopholes. Subsequently, the firms learn which firms were successful at finding a loophole and which firms were not successful, and then they simultaneously decide which good to produce and at what price to sell them. Finally, the consumers decide which good to buy.

3.2 Strategies and Equilibrium

First, we define a feasible action set for the firms given the outcome of their loophole finding effort. Let the feasible set be denoted by F. If a firm's loophole finding effort is successful, $F = \{H, L\} \times \mathbb{R}^+$ where the first argument denotes the good choice and the second argument denotes the price choice. If a firm's loophole finding effort is unsuccessful, $F = X \times \mathbb{R}^+$ where X denotes the set of goods which are not banned by the regulator and the second argument denoted the price choice of the firm for its chosen good. The strategy for any firm is given by a function S which goes from the strength of regulation to loophole finding effort, and good and price choice. Thus, $S : [0,1] \to [0,1] \times F$. The equilibrium concept is Subgame Perfect Nash Equilibrium.

4 Analysis

4.1 Model without Regulator

Consider the model without the regulator first. In this case, no type of good is banned and therefore there is no need to exert effort to find loopholes. The action set for both firms is

[6]This will help in doing comparative statics which will add more intuition to our results. Other sufficiently convex functional forms would therefore also work.

$\{H, L\} \times \mathbb{R}$ i.e. both firms simply choose any type of good and price. The equilibrium concept is simply Nash Equilibrium.

Claim 1. *The unique Nash equilibrium in the static game without the regulator is one in which both firms choose the strategy* (L, c_l)

This is a trivial proof so we omit it. The consumers don't care about the type of good (since they don't internalize the cost to the society), and will purchase from the firm with the lowest prices. This forces both firms to produce only the low type good in equilibrium since it has a lower marginal cost of production which allows them to charge lower prices. Thus, in the game without regulators, both firms will split the consumers (any split of the consumers is permitted). Competition in this symmetric environment ensures that both firms get zero profits, and the total payoff for all consumers (including social cost) is $(u - c_l - C)$.

4.2 Game with Perfect Regulator

Next, consider the case of a perfect regulator. We call a regulator perfect if $p = 0$ i.e. there is no chance of any firm ever finding a loophole (possibly because the regulation is loophole free). In this case, there will be no loophole finding effort by the firms in equilibrium because they can never be successful. The perfect regulator observes that if it bans the L type good from being produced, then both firms will have to produce H type good. In a symmetric manner as before, in this case the payoff in any equilibrium will be as follows. Competition between symmetric firms would imply that both firms get a payoff of zero. The total payoff for all customers (including social cost) will be $(u - c_h)$.

Clearly, $C > (c_h - c_l) \Rightarrow u - c_h > u - c_l - C$. Thus, if the marginal social cost of producing the low type good is higher than the difference in the marginal costs of production of the two good types, then a perfect regulator maximizing consumer payoff will ban the low type good. Note that banning the L type good means that all customers will pay a higher price (c_h), but the loss in utility is made up by the gain from reduced social costs.

4.3 Game with Imperfect Regulator and loopholes

Consider the game where the regulator is imperfect i.e. $p > 0$. Let $C > c_h - c_l$. Suppose that the regulator bans the L type good and can costlessly choose any p in a fixed interval $[p_1, 1]$, where $p_1 > 0$. The lower bound to the regulator's choice set can be justified by the efforts of a lobby group trying to lower regulations, or through restrictions placed on the cost of regulation (it may be prohibitively expensive to draft and implement a perfect regulation). The question we are interested in is - are there any conditions under which the regulator will not prefer the highest feasible regulation strength - p_1? Given that perfect regulations are consumer utility maximizing (because $C > c_h - c_l$) and choosing p_1 is not more costly than choosing any other lower level of regulation strength, it may seem optimal to choose p_1. Furthermore, note that if there was only one firm in the market, it is trivial to show that choosing p_1 is optimal for the regulator. We consider a model with two competing firms, and we are interested in determining conditions under which choosing the highest feasible regulation strength is not optimal. Our contribution to the literature is a new explanation for why this is the case.

Consider the game where the regulator has chosen regulation strength p. First, we show that optimal loophole finding effort can be a non-monotone function of regulation strength. Let $Y = c_h - c_l$. Thus, Y denotes the difference between the marginal cost of production of the two goods.

Proposition 1. *Let e_i^* be the equilibrium loophole finding effort exerted by firm i. Furthermore, let p, Y, M_2 be such that $3M_2 < Y$, then there exists a p'' such that if $p \in (p'', 1]$ then in any subgame perfect equilibrium, $\frac{de_i^*}{dp} \leq 0 \; \forall i$.*

Proof. We will solve the game by backward induction. Consider the subgames beginning after we know the outcome of the loophole finding efforts. If both firms find a loophole or if neither finds a loophole then competition between symmetric firms will push their payoffs to zero (they will produce at marginal cost in the unique Nash equilibrium). Let us look at the subgame starting at the node where one firm finds a loophole but the other does not. Without loss of generality, suppose firm 1 finds a loophole and firm 2 does not. The strategy of a firm in this subgame simply consists of a tuple describing the good to produce and the price for this good.

Consider the following strategies in this subgame:

$$\text{Firm } 1 - (L, c_h)$$

$$\text{Firm } 2 - (H, c_h)$$

Lemma 1. *The above strategies constitute a Nash equilibrium of the subgame beginning after firm 1 finds a loophole but firm 2 does not. All customers buy from firm 1. Moreover, all Nash equilibria of the subgame are payoff equivalent to this one.*

Proof. It is easy to show that the above is a Nash equilibrium of the subgame. Firm 1 chooses the good with the lower cost of production and the price is chosen to maximize the payoff. Clearly, at any price strictly lower than c_h, firm 1 gets the entire market (firm 2 has not found the loophole so its cost of production is c_h, thereby making the equilibrium price charged by firm 2 at least as much) and this price is individually rational for firm 1 as long as it is greater than or equal to c_l. The payoff is maximized at the highest possible price - c_h. Firm 2 must produce only good H, and can choose any price greater than or equal to c_h in equilibria (to get non negative payoffs). However, this price choice will not change the payoff for any player as all customers will buy from firm 1 since it offers lower prices. Note that while the customers are indifferent between the two firms when they both charge the price c_h, there is no equilibrium in which some consumers buy from firm 2. This is because if this were the case then firm 1 could offer a slightly lower price and attract these customers. □

Thus, we have the following equilibrium payoffs in the subgame beginning after the effort outcome stage. The first argument represents firm 1's payoff and the second argument represents firm 2's payoff:

$$\text{Both firms find loophole} - (0,0)$$

$$\text{Firm 1 finds loophole, Firm 2 does not find loophole} - (c_h - c_l, 0) = (Y, 0)$$

$$\text{Firm 1 does not find loophole, Firm 2 finds loophole} - (0, c_h - c_l) = (0, Y)$$

$$\text{Neither firm find loophole} - (0,0)$$

Now, we solve the optimization problem at the beginning of the game. Both firms need to choose an effort. We know the equilibrium payoffs after the effort outcome stage. Suppose firm 1 puts in effort e_1^* in equilibrium and firm 2 puts in effort e_2^*. Firm 1's optimization problem:

$$\max_{x\in[0,1]} (xp)(1-e_2^*p)Y - \frac{M_1x^2}{2} \tag{1}$$

$$\Rightarrow x = e_1^* = \frac{p(1-e_2^*p)Y}{M_1} \tag{2}$$

Similarly, we get $e_2^* = \frac{p(1-e_1^*p)Y}{M_2}$. Solving for e_1^* and e_2^*, we get:

$$e_1^* = \frac{pY(p^2Y-M_2)}{(p^2Y)^2-M_1M_2} \tag{3}$$

$$e_2^* = \frac{pY(p^2Y-M_1)}{(p^2Y)^2-M_1M_2} \tag{4}$$

We know that $Y > M_2$ (the proposition demands $Y > 3M_2$), and it is clear that when p is high enough, then e_i^* is between zero and one. Also, note that the firm with the lower cost of effort (firm 1) puts in less effort in equilibrium ($e_1 < e_2$). Furthermore:

$$\frac{de_1^*}{dp} \leq 0$$

$$\Leftrightarrow ((p^2Y)^2 - M_1M_2)(3p^2Y^2 - YM_2) - 4p^4Y^3(p^2Y-M_2) \leq 0$$

$$\Leftrightarrow M_1M_2[M_2 - 3p^2Y] \leq (p^2Y)^2[p^2Y - 3M_2] \tag{5}$$

$$\Leftrightarrow M_1M_2[M_2 - 3Y] \leq Y^2[Y - 3M_2] \text{ ; } \textit{when } p \approx 1 \tag{6}$$

Now, the LHS is negative (since $Y > M_2$), so it is easy to check that 6 holds if $Y \geq 3M_2$ and $p \approx 1$. So we have that if $3M_2 < Y$ and p high enough, then $\frac{de_1}{dp} \leq 0$. Similarly, we can show that if $3M_1 < Y$ and p high enough, then $\frac{de_2}{dp} \leq 0$. Since $M_1 < M_2$, we can pick $3M_2 < Y$, and p large enough to get that $\frac{de_i}{dp} \leq 0 \; \forall i$. □

Corollary 1. *Optimal effort is non-monotone in regulation strength*

Proof. This follows from proposition 1 and from expression 5 where it is clear that $\frac{de_1^*}{dp} > 0$ when p is small. □

Why should optimal effort increase when regulation strength has also increased? The intuition is that when p is reduced (regulation strength increased), there are two effects. One, the increase in regulation strength makes it less likely that loophole finding effort is successful (at any fixed effort level). This reduces returns to effort. Two, it becomes more likely that if a firm finds the loophole, its competitor does not. This increases returns from effort as a firm can only get non zero profits when it finds the loophole but the other firm does not. When the regulation strength is low enough (p is high enough), and the cost of loophole effort is not very high compared to the reward ($Y > 3M_2$), the latter effect dominates the former. On the other hand, when regulation strength is high enough (p small enough), a further increase in regulation strength lowers the returns to effort to such an extent that optimal loophole finding effort falls, thereby reducing the probability that the loophole will be found by any firm.

4.3.1 Welfare

While the above result is interesting, the regulator is more concerned with how aggregate consumer utility changes with increasing regulation strength. It is possible that optimal loophole finding effort goes up when regulation strength $(1-p)$ falls, but the impact is not large enough to reduce aggregate consumer utility. In this section, we will determine conditions under which consumer welfare goes down when the regulation strength goes up. Let the total consumer payoff be denoted by W_{IPR}; where IPR stands for imperfect regulator. When neither firm finds the loophole, total consumer payoff is $(u-c_h)$, when one firm finds the loophole and the other firm does not, total consumer payoff is $(u-c_h-C)$, and finally, when both firms find the loophole, consumer payoff is $(u-c_l-C)$. Therefore, when the regulation strength is p and the corresponding equilibrium loophole finding efforts are given by e_1^*, e_2^*, we have:

$$W_{IPR} = (1-pe_1^*)(1-pe_2^*)(u-c_h) + pe_1^*(1-pe_2^*)(u-c_h-C) + pe_2^*(1-pe_1^*)(u-c_h-C) + \\ + pe_1^* pe_2^*(u-c_l-C)$$

Proposition 2. *Let $Y > M_2$. If $\frac{8M_1M_2}{M_1+M_2} < C < 1$, there exists a $\bar{Y}, \bar{p}$ such that if $Y \in (\bar{Y}, C)$ and $p \in (\bar{p}, 1)$, then $\frac{dW_{IPR}}{dp} > 0$*

Proof. We will show that the result holds when $Y \to C$ and $p \to 1$. The proposition would hold by continuity in Y, p. We know that:

$$W_{IPR} = (1-pe_1^*)(1-pe_2^*)(u-c_h) + pe_1^*(1-pe_2^*)(u-c_h-C) + pe_2^*(1-pe_1^*)(u-c_h-C)$$
$$+ pe_1^* pe_2^*(u-c_l-C)$$
$$\Leftrightarrow W_{IPR} = (u-c_h)(1-p^2e_1^*e_2^*) + (u-c_l)p^2e_1^*e_2^* - C[pe_1^* + pe_2^* - p^2e_1^*e_2^*]$$
$$\Leftrightarrow W_{IPR} = (u-c_h) + p^2e_1^*e_2^*Y - pC[e_1^* + e_2^* - pe_1^*e_2^*]$$
$$\Leftrightarrow W_{IPR} = (u-c_h) + e_1^*e_2^*p^2(Y+C) - pC[e_1^* + e_2^*]$$

substituting the optimal values of e_1, e_2 from equations 3,4 and simplifying :

$$W_{IPR} = (u-c_h) + \frac{(p^2Y)^2(p^2Y-M_1)(p^2Y-M_2)(Y+C)}{((p^2Y)^2-M_1M_2)^2} - \frac{p^2YC(2p^2Y-M_1-M_2)}{(p^2Y)^2-M_1M_2}$$

taking $x = p^2$, we get:

$$W_{IPR} = (u-c_h) + \frac{(xY)^2(xY-M_1)(xY-M_2)(Y+C)}{((xY)^2-M_1M_2)^2} - \frac{xYC(2xY-M_1-M_2)}{(xY)^2-M_1M_2}$$

taking $Y \to C$, we get:

$$W_{IPR} = (u-c_h) + C^2[\frac{2Cx^2(xC-M_1)(xC-M_2)}{((xC)^2-M_1M_2)^2} - \frac{x(2xC-M_1-M_2)}{(xC)^2-M_1M_2}]$$
$$\Leftrightarrow W_{IPR} = (u-c_h) + C^2[\frac{4x^2CM_1M_2 - (M_1+M_2)(x^3C^2+xM_1M_2)}{(x^2C^2-M_1M_2)^2}]$$

and

$$\frac{dW_{IPR}}{dx} \geq 0 \Leftrightarrow (x^2C^2-M_1M_2)^2[8xCM_1M_2 - (M_1+M_2)(3x^2C^2+M_1M_2)]$$
$$-4xC^2(x^2C^2-M_1M_2)[4x^2CM_1M_2 - (M_1+M_2)(x^3C^2+xM_1M_2)] \geq 0$$

when $x \to 1$, *we get* :

$$\frac{dW_{IPR}}{dx} \geq 0 \Leftrightarrow [C^2-M_1M_2][(M_1+M_2)(C^4+6C^2M_1M_2+M_1^2M_2^2) - 8CM_1M_2(C^2+M_1M_2)] \geq 0$$

$Y > M_2$ *and we know that* $C \geq Y$, *then* $C^2 - M_1M_2 \geq 0$, *and* :

$$\frac{dW_{IPR}}{dx} \geq 0 \Leftrightarrow C^3[C(M_1+M_2) - 8M_1M_2] + M_1M_2[C(6C(M_1+M_2) - 8M_1M_2) + M_1M_2(M_1+M_2)] \geq 0$$

Clearly, the above holds when $C > \frac{8M_1M_2}{M_1+M_2}$. Thus, a sufficient condition for welfare to go down with increasing regulation strength is that the initial regulation strength is low ($p \approx 1$), Y high, and the cost of loophole discovery for the society high enough $C > \frac{8M_1M_2}{M_1+M_2}$). Note that $C < 1$

is required to make the assumption $Y \to C$ possible, since $Y = c_h - c_l$ is always less than 1. Also note that the condition $C > \frac{8M_1M_2}{M_1+M_2}$ is easily satisfied as one of the firms becomes sufficiently better than the other firm at loophole finding (as $M_1 \to 0$). In subsection 4.3.2, we will consider a different utility function for the regulator and demonstrate another reason why the level of asymmetry between the firms is important when studying the impact of regulation strengthening on 'efficiency'. □

The idea is that if the prior regulation strength is weak, and the reward for finding loopholes is high, then a strengthening of regulation causes a large enough increase in loophole finding effort so as to compensate for the increased regulation strength. This causes a reduction in aggregate consumer utility (welfare) because the probability of the loophole being found is higher. This affects societal welfare by not only increasing the probability of social cost C (and the social cost of loophole discovery (C) is high enough because $C > \frac{8M_1M_2}{M_1+M_2}$), but also by increasing the price one would have to pay for the good (high probability of c_h as compared to c_l).

4.3.2 Other Welfare Criteria

In the analysis before, we have taken the regulator's utility function to mean the aggregate utility of all consumers. While this would be an apt welfare function for a benevolent regulator to optimize, it would be instructional to consider another welfare criteria which is more common in economic analysis. Thus, in this subsection, we will consider welfare to be the sum of payoffs of all players (firms and consumers). This welfare function will eliminate the effect of prices (since it cancels out across producers and consumers), and will focus on efficiency in terms of net surplus. This takes into account only two variables - the benefit to the consumers (sum of social cost and utility of consumption) and cost of production of the firm(s) (we ignore the cost of loophole finding effort here to show a strong result - even if there was no cost of effort, the welfare can still go down when regulation is strengthened[7]). Formally, the welfare

[7]This works because of proposition 1 because when M_1 is small (as required by proposition 3), $Y > 3M_1$ is satisfied.

is given by W where:

$$W = (1-pe_1^*)(1-pe_2^*)(u-c_h) + pe_1^*(1-pe_2^*)(u-c_l-C) + pe_2^*(1-pe_1^*)(u-c_l-C) + pe_1^*pe_2^*(u-c_l-C)$$
$$\Rightarrow W = (1-pe_1^*)(1-pe_2^*)(u-c_h) + [1-(1-pe_1^*)(1-pe_2^*)][u-c_l-C]$$
$$\Rightarrow W = (1-pe_1^*)(1-pe_2^*)(C-Y) + (u-c_l-C)$$

Next, we would like to understand the conditions under which this welfare is decreasing in regulation strength. The next proposition highlights this.

Proposition 3. *There exists an $\underline{M}, \bar{p}$ such that if $M_1 \in (0, \underline{M})$ and $p \in (\bar{p}, 1)$, then $\frac{dW}{dp} > 0$ whenever $\frac{3M_2}{2} \geq Y > M_2$.*

Proof. We will show the result when $M_1 \to 0, p \to 1$. The proof will follow by continuity in these variables. We have that:

$$W = (1-pe_1^*)(1-pe_2^*)(C-Y) + (u-c_l-C)$$
$$\Rightarrow \frac{dW}{dp} \geq 0 \Leftrightarrow \frac{d}{dp}((1-pe_1^*)(1-pe_2^*)) \geq 0 \ (because\ C > Y)$$

Thus, the change in welfare when there is a change in regulation strength only depends upon the change in the probability of the loophole not being found by any firm. If an increase in regulation strength (fall in p) causes the probability of the loophole being not found by any firm to fall (i.e. it is more likely that a firm finds the loophole), then the welfare will also decrease. So we need to check if:

$$\frac{d}{dp}((1-pe_1^*)(1-pe_2^*)) \geq 0$$
$$\Leftrightarrow \frac{d}{dp}\left(\frac{M_1M_2(p^2Y-M_1)(p^2Y-M_2)}{((p^2Y)^2-M_1M_2)^2}\right) \geq 0$$
$$\Leftrightarrow -2(p^2Y)^3 + 3(p^2Y)^2(M_1+M_2) - 6(p^2Y)M_1M_2 + M_1M_2(M_1+M_2) \geq 0$$

Taking $M_1 \to 0$ and $p \to 1$, we get :

$$\frac{d}{dp}((1-pe_1^*)(1-pe_2^*)) \geq 0 \Leftrightarrow 3M_2 \geq 2Y$$

Note that we need $Y > M_2$ (and p high) to guarantee interior solution for effort. □

Thus, when firms are sufficiently asymmetric and regulations are sufficiently lax, a strengthening of regulation can reduce welfare. The key idea here is that for welfare to go down upon regulation strengthening we require that there is an increase in loophole finding effort and it is sufficiently large so as to offset the impact of the strengthening of the regulation. Thus, we are interested in determining conditions under which the increase in loophole finding effort is very large. One reason due to which a firm may not increase effort too much when the regulation is strengthened is because the rival firm is also increasing effort which reduces the returns from the firm's loophole finding effort (remember the firms does not get positive profits if both firms find the loophole as it would leave them symmetric). Making the firms sufficiently asymmetric ($M_1 \to 0$ and $M_2 > \frac{2Y}{3}$) assuages this problem by incentivising firm 2 to increase effort sufficiently in response to a strengthening of regulations because it has to overcome its significant competitive disadvantage ($M_2 - M_1$), while keeping firm 1's efforts more or less unchanged (due to small M_1, its effort is close to 1 anyway).

4.3.3 Competition Effect

How does optimal loophole finding effort change as we increase competition? We will assume that competition is higher when the firms become more symmetric i.e. when M_1 becomes closer to M_2 (the better firm loses some of its competitive edge). For example, the Basel-I to Basel-II transition reduced competition since it made it easier for bigger banks to bypass regulations by making it possible for them to rate their assets internally via *Internal Ratings Based* approach (see Mariathasan and Merrouche (2014)). While the smaller banks could also do this in theory, it was too expensive for them.

It is easy to show that:

$$\frac{de_2^*}{dM_1} = \frac{p^3Y^2[M_2 - p^2Y]}{((p^2Y)^2 - M_1M_2)^2}$$
$$\frac{de_2^*}{dM_2} = \frac{pYM_1(p^2Y - M_1)}{((p^2Y)^2 - M_1M_2)^2}$$
$$\frac{de_1^*}{dM_1} = \frac{pYM_2(p^2Y - M_2)}{((p^2Y)^2 - M_1M_2)^2}$$
$$\frac{de_1^*}{dM_2} = \frac{p^3Y^2[M_1 - p^2Y]}{((p^2Y)^2 - M_1M_2)^2}$$

Clearly, when p is large enough, we have that $\frac{de_1^*}{dM_1} \geq 0$ and $\frac{de_1^*}{dM_2} \leq 0$. Similarly, $\frac{de_2^*}{dM_1} \leq 0$ and $\frac{de_2^*}{dM_2} \geq 0$. Thus, when the regulation strength is weak (high p), we have that when any firm's cost of loophole finding effort goes down, it actually exerts less effort in equilibrium whereas its rival puts in more effort in equilibrium. So, keeping M_1 fixed, if we reduce M_2 (increase competition), then we expect firm 1 to exert more effort and firm 2 to exert less loophole finding effort in equilibrium. Does the probability of loophole discovery go up? Let $p(loophole)$ denote the equilibrium probability that at least one firm will find a loophole.

Proposition 4. *If $Y > 2M_2$ then $\frac{dp(loophole)}{dM_2} < 0$*

Proof.

$$p(loophole) = 1 - Prob(no\ firm\ finds\ loophole)$$
$$= 1 - (1 - pe_1^*)(1 - pe_2^*)$$
$$\Rightarrow \frac{dp(loophole)}{dM_2} < 0 \Leftrightarrow \frac{de_2^*}{dM_2}(1 - pe_1^*) < -[\frac{de_1^*}{dM_2}(1 - pe_2^*)]$$
$$\Leftrightarrow M_2(p^2Y - M_1) - p^2Y(p^2Y - M_2) < 0$$
$$\Rightarrow \ when\ p \approx 1:$$
$$Y^2 + M_1M_2 - 2YM_2 > 0$$

Note that the LHS is increasing in Y (because $Y > M_2$) and the LHS is positive at $Y = 2M_2$. Thus, when p is large enough and $Y > 2M_2$, an increase in competition (lowering M_2 keeping M_1 fixed) increases the probability of one of the firms finding a loophole. □

In this way, the impact of an increase in regulation strength and the impact of increased competition is similar. If the latter can be affected by the regulator[8], then the regulator may think of regulatory strength and competition level as substitutes. On the other hand, when p is very large, and Y is close to its lower bound (M_2), we get that $Y^2 + M_1M_2 - 2YM_2 \to M_2(M_1 - M_2)(< 0)$. Thus, when regulation strength is low and the reward from loophole discovery is not too high, an increase in competition can reduce the probability of a loophole being found.

5 Lobbying

Hitherto, we have taken the regulation strength (p) as given. However, in several environments, the firms in an industry not only try to bypass regulation with loophole finding effort, they actively try to influence the regulation strength as well with lobbying effort. In this section, we modify our game to allow for the firms to exert lobbying effort to influence p. The modification to game structure is simple - we introduce a period 0 when both firms exert effort ($\in [0,1]$). The regulation strength is assumed to be a function of the total lobbying effort. In particular, if firm i exerts effort level e_i^L (superscript L indicates that this is lobbying effort), then the regulation strength is assumed to be $\frac{e_1^L + e_2^L}{2}$. Thus, the regulation strength is assumed to be decreasing in total lobbying effort. This is a natural assumption. The more lobbying effort an industry puts in collectively, the weaker we expect its governing regulations to be.

In this subsection, we consider the simple and tractable case of symmetric firms (in the cost of loophole finding effort). Thus, for this subsection $M_1 = M_2 = M$. In this case, optimal loophole effort in the symmetric equilibrium, given a regulation strength of p, is given by $e^* = \frac{p}{p^2 + \frac{M}{Y}}$. Before we make any further analysis, we make a simple assumption which makes sure that too much lobbying effort is definitely undesirable. In particular, we assume that if the two firms put in full lobbying effort then the welfare of the society is lower than what it would be in an environment without regulations. When the firms put in full lobbying effort, the regulation strength is at its weakest i.e. $p = 1$ (because $p = \frac{e_1^L + e_2^L}{2}$), and optimal effort

[8]One way to do this would be by increasing scrutiny on the firm with the lower marginal cost of loophole finding effort, so that the resulting marginal cost of finding loopholes is closer to that of the other firm.

$e^* = \frac{p}{p^2+\frac{M}{Y}} = \frac{Y}{Y+M}$. Thus, this assumption is formalized as:

welfare when lobbying effort is maximum $<$ welfare when there is no regulation

$$[(1-p^*e^*(p^*))^2](u-c_h)+2[pe^*(p^*)(1-p^*e^*(p^*))](u-c_h-C)+[(p^*e^*(p^*))^2](u-c_l-C) < u-c_l-C$$
$$\Leftrightarrow (1-\frac{Y}{Y+M})^2(u-c_h)+2[\frac{Y}{Y+M}(1-\frac{Y}{Y+M})](u-c_h-C)+[(\frac{Y}{Y+M})^2](u-c_l-C) < u-c_l-C$$
$$\Leftrightarrow C < Y+\frac{2Y^2}{M}$$

We assume $C < Y + \frac{2Y^2}{M}$ from here on. Next, we determine the regulation strength in a symmetric equilibrium.

Lemma 2. *The symmetric equilibrium regulation strength is given by* $p^* = \sqrt{\frac{M}{Y}}$

Proof. If the regulation strength is p, the ex-ante expected payoff of each firm is given by:

$$\begin{aligned} & pe^*(1-pe^*)Y - \frac{M(e^*)^2}{2} \\ &= \frac{p^2Y}{p^2+\frac{M}{Y}}(1-\frac{p^2}{p^2+\frac{M}{Y}}) - \frac{M}{2}(\frac{p}{p^2+\frac{M}{Y}})^2 \\ &= \frac{Mp^2}{2(p^2+\frac{M}{Y})^2} \end{aligned}$$

Now, in stage 0, when the firms choose the lobbying effort, if firm 2 chooses a lobbying effort of e_2^L and firm 1 chooses a lobbying effort of e_1^L, then the resultant regulation strength is given by $\frac{e_1^L+e_2^L}{2}$. Therefore, the maximization problem for firm 1 is:

$$\max_{x\in[0,1]} \frac{(\frac{x+e_2^L}{2})^2 M}{2((\frac{x+e_2^L}{2})^2+\frac{M}{Y}^2)}$$

Taking first order conditions and substituting $e_2^L = x$ to obtain the strategy choices for a symmetric equilibrium gives us optimal lobbying effort as $e_1^L = e_2^L = \sqrt{\frac{M}{Y}}$. This implies an equilibrium regulation strength of $\frac{\sqrt{\frac{M}{Y}}+\sqrt{\frac{M}{Y}}}{2} = \sqrt{\frac{M}{Y}} = p^*$. This gives each firm an expected ex-ante payoff of $(\frac{Y}{8})$ in equilibrium. □

There are two things to note immediately. One, the firms prefer to have some regulation.

This is obvious. Without any regulation, the firms necessarily get zero profits due to their symmetric nature. However, the introduction of imperfect regulations allows for the possibility of any firm separating from the other by finding a loophole and earning positive profits. The other interesting aspect of this result is that the firms do not want the weakest possible regulation strength. Notice that lobbying effort is costless, and yet, the firms choose an equilibrium effort level below the maximum effort level of 1. The intuition for this result is similar to the one for results before. The firms face a tradeoff when choosing lobbying effort. If they put in a lot of effort then the resulting regulation will be weak which will increase the probability of any firm finding the loophole. However, a weak regulation will also increase the probability of the other firm finding the loophole. The profits go to zero if both firms are successful in finding the loophole as they become completely symmetric. On the other hand, if they put in very little lobbying effort, the regulation is of very high strength which would make it very difficult for any firm to find a loophole. Once again, if neither firm finds a loophole, they will be symmetric and competition will drive their payoffs to zero. Thus, the optimal lobbying effort is interior.

Next, we show that the society may actually benefit from imperfect regulations even when they are biased due to the lobbying effort.

Proposition 5. *If $Y + \frac{2Y^2}{M} > C > 3Y$ then the welfare under the symmetric equilibrium under the lobbying model is greater than the symmetric equilibrium when there in no regulation.*

Proof. The welfare level when there is no regulation is $u - c_l - C$. When we allow for lobbying,

let the payoff for the society in the symmetric equilibrium be denoted by W_{sym_L} where:

$$W_{sym_L} = [(1-p^*e^*(p^*))^2](u-c_h) + 2[pe^*(p^*)(1-p^*e^*(p^*))](u-c_h-C) + [(p^*e^*(p^*))^2](u-c_l-C)$$

$$\Leftrightarrow W_{sym_L} = (u-c_h) - [1-(1-p^*e(p^*))^2]C + (p^*e^*(p^*))^2Y$$

$$\Leftrightarrow W_{sym_L} = (u-c_h-C) + (1-p^*e^*(p^*))^2C + (p^*e^*(p^*))^2Y$$

since the symmetric effort level $e^*(p) = \frac{p}{p^2+\frac{M}{Y}}$:

$$\Leftrightarrow W_{sym_L} = (u-c_h-C) + (1-p(\frac{p^*}{\frac{M}{Y}+(p^*)^2}))^2C + (p^*(\frac{p}{\frac{M}{Y}+(p^*)^2}))^2Y$$

$$\Leftrightarrow W_{sym_L} = (u-c_h-C) + (\frac{\frac{M}{Y}}{\frac{M}{Y}+(p^*)^2})^2C + (\frac{(p^*)^2}{\frac{M}{Y}+(p^*)^2})^2Y$$

In the symmetric equilibrium under lobbying, the equilibrium $p^* = \sqrt{\frac{M}{Y}}$, so:

$$\Leftrightarrow W_{sym_L} = u - c_h - C + \frac{C}{4} + \frac{Y}{4}$$

$$\Leftrightarrow W_{sym_L} = u - c_h - \frac{3C}{4} + \frac{c_h - c_l}{4}$$

$$\Leftrightarrow W_{sym_L} = u - \frac{3c_h}{4} - \frac{c_l}{4} - \frac{3C}{4} \tag{7}$$

Now, the welfare from the symmetric equilibrium with lobbying effort is higher if:

$$W_{sym_L} > u - c_l - C$$

$$\Leftrightarrow u - \frac{3c_h}{4} - \frac{c_l}{4} - \frac{3C}{4} > u - c_l - C$$

$$\Leftrightarrow C > 3(c_h - c_l) \; i.e. \; C > 3Y$$

This is the condition required by the proposition. □

The intuitive idea here is that there is a trade-off. With no regulation, society has to bear the entire social cost (C) of the low type good, but the competition means the price of the product is low (c_l). On the other hand, even though regulation strength is determined by lobbying effort, it is not in the interest of the firms to make regulation very weak (which would make the society's welfare lower than its welfare under no regulation by our assumption of $C < Y + \frac{2Y^2}{M}$). This means that there is high enough probability that no firm finds the loophole and society does not have to bear the social cost C, but the prices would be higher if any firm finds the loophole.

When $C > 3Y$, the lower probability of suffering the social cost under the lobbying with biased regulation regime (which stems from their own self interested desire to keep regulation from becoming too lax) compensates for the higher prices which may arise if a firm finds a loophole.

6 Conclusion

Our paper presents a very general model of regulations with competitive firms. We show that increasing the strength of regulations can increase the incentives to find loopholes in the regulation, and this is a new channel through which strengthening regulations may hurt welfare. In light of the fact that framing, amending and implementing regulations is costly, it is imperative that we understand exactly when we should be strengthening regulations. Politicians often want to make regulations stronger just to score brownie points with their constituents. We show that such acts may actually hurt their constituents. We go on to show that though lobby groups have the welfare of the firms in mind (and not the consumers), it is in their interest to not make regulations too lax. In fact, under some conditions, a regime with no regulation is actually worse for the consumers than one where regulation strength is determined by lobbying effort.

There are natural extensions of our paper which would be very interesting to study. For example, it is clear from our model that regulations with loopholes give competing symmetric firms a chance to earn higher profits by finding a loophole. What is the impact of this on long-run competition in the market? If a firm finds a loophole then it corners the market till the time the other firm also finds the loophole. Surely this kind of competitive advantage can cause the other firm to exit the market if it does not find the loophole quickly, thereby making the market less competitive. Additionally, it would be interesting to explore whether it is optimal for the regulator to make regulations stronger by decreasing p (making it harder for firms to find loopholes), or to increase monitoring of regulation compliance given a fixed level of regulation strength. We hope to study such questions in the future.

References

Acharya, V. V., Schnabl, P., and Suarez, G. (2013). Securitization without risk transfer. *Journal of Financial Economics*, 107(3):515–536.

Albrecht, J. A. (1998). Environmental regulation, comparative advantage and the porter hypothesis.

Allen, L. (2003). The Basel Capital Accords and International Mortgage Markets: A Survey of the Literature.

Anderson, S. P. . (1988). Equilibrium Existence in the Linear Model of Spatial Competition. *Economica*, 55(220):479–491.

Anderson, S. P. and Goeree, J. K. (1997). Location , Location , Location. *Journal of Economic Theory*, 127:102–127.

Baldwin, R., Cave, M., and Lodge, M. (2012). Understanding regulation: theory, strategy, and practice.

Benetton, M., Eckley, P., Garbarino, N., Kirwin, L., and Latsi, G. (2017). Staff Working Paper No. 639 Specialisation in mortgage risk under Basel II Specialisation in mortgage risk under Basel II.

Borrell, B. (2013). A big fight over little fish. *Nature*.

Branco, F. and Villas-Boas, J. M. (2015). Competitive vices. *Journal of Marketing Research*, 52(6):801–816.

Brunnermeier, M. K. and Oehmke, M. (2009). Complexity in financial markets. pages 1–12.

Cheng, C. C. and Lai, Y. B. (2012). Does a stricter enforcement policy protect the environment? A political economy perspective. *Resource and Energy Economics*, 34(4):431–441.

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

David Moss and Cisternino, J. (2009). New Perspectives on regulation.

Dixit, A. (1987). Strategic Behavior in Contests. *The American Economic Review*, 77(5):891–898.

dos Santos, J. C. (1996). Glass-steagall and the regulatory dialectic. *Federal Reserve Bank of Cleveland, Economic Commentary*.

Ehrenberg, R. G. and Bognanno, M. L. (1990). Do Tournaments Have Incentive Effects ? *Journal of Political Economy*, 98(6):1307–1324.

Emery, A. and Watson, M. (2004). Organizations and environmental crime: Legal and economic perspectives. *Managerial Auditing Journal*, 19(6):741–759.

Farboodi, M. and Veldkamp, L. (2016). Long Run Growth of Financial Technology. pages 1–37.

Frederic Mishkin (1996). Bank Consolidation: A central banker's perspective. *NBER working paper series*.

Glaeser, E. and Shleifer, A. (2001). A Reason for Quantity Regulation. *The American Economic Review - Papers and Proceedings of the Hundred Thirteenth Annual Meeting of the American Economic Association*, 91(2):431–435.

Glaeser, E. L., Shleifer, A., Djankov, S., Goldin, C., Hart, O., Johnson, S., Katz, L., Kaplow, L., Porta, R. L., Lopez-De-Silanes, F., Shavell, S., and Summers, L. (2003). The Rise of the Regulatory State. *Journal of Economic Literature*, 41(2):401–425.

Glode, V., Green, R. C., and Lowery, R. (2012). Financial Expertise as an Arms Race Source. *The Journal of Finance*, 67(5):1723–1759.

Gonzalez, F. (2005). Bank regulation and risk-taking incentives: An international comparison of bank risk. *Journal of Banking & Finance*, 29(5):1153–1184.

Häckner, J. and Herzing, M. (2017). The effectiveness of environmental inspections in oligopolistic markets. *Resource and Energy Economics*, 48:83–97.

Haldane, A. G. (2012). The dog and the frisbee. Speech at jackson hole symposium, Jackson Hole Symposium.

Haldane, A. G. (2013). Turning the red tape tide. Remarks at the international financial law review dinner, International Financial Law Review Dinner, London.

Heyes, A. (2000). Implementing Environmental Regulation: Enforcement and Compliance. *Journal of Regulatory Economics*, 17(2):107–129.

Hotelling, H. (1929). Stability in competition. *Economic Journal*, 39:41–57.

Hu, K., Chopra, S., and Chen, Y. (2017). The danger of tightening standards without appropriate monitoring effectiveness in a competitive market. *Working paper*.

Jackson, P., Furfine, C., Yoneyama, M., and Hancock, D. (1999). Basle Committee on Banking Supervision C Apital Requirements and Bank Behaviour :. *Basel Committee on banking Supervision working papers*, (1).

Jovanovic, B. and MacDonald, G. M. (1994). Competitive Diffusion. *Journal of Political Economy*, 102(1):24.

Kane, E. J. (1977). Good intentions and unintended evil: The case against selective credit allocation. *Journal of Money, Credit and Banking*, 9(1):55–69.

Kawai, K., Lang, R., and Li, H. (2017). Political Kludges. *Working Paper*.

Laffont, J.-J. (1995). Regulation, moral hazard and insurance of environmental risks. *Journal of Public Economics*, 58:319–336.

Laffont, J.-J. and Tirole, J. (1991). The Politics of Government Decision-Making: a Theory of Regulatory Capture. *Quarterly Journal of Economics*, 106(4):1089–1127.

Lerner, J. (2006). The new new financial thing: The origins of financial innovations. *Journal of Financial Economics*, 79(2):223–255.

Lipsey, R. G. and Lancaster, K. (1956). The general theory of second best. *The review of economic studies*, 24(1):11–32.

Mariathasan, M. and Merrouche, O. (2014). The manipulation of basel risk-weights. *Journal of Financial Intermediation*, 23(3):300–321.

McMillan, J. (2015). Banking in the digital age: the failure of financial regulation. *The Guardian*, pages 2015–2018.

Morrison, A. D. and White, L. (2013). Reputational contagion and optimal regulatory forbearance. *Journal of Financial Economics*, 110(3):642–658.

Peltzman, S. (1976). Toward a More General Theory of Regulation. *The Journal of Law & Economics*, 19(2):211–240.

Peltzman, S. (1977). The Gains and Losses from Industrial Concentration. *The Journal of Law & Economics*, 20(2):229–263.

Peltzman, S. (2007). W(h)ither Regulation? *Competition and Regulation in Network Industries*, 8(4):1559–1579.

Peltzman, S. (2010). Regulation and the Natural Progress of Opulence. *Economic Affairs*.

Porter, M. (1996). AmericaâĂŹs green strategy. *Business and the environment: a reader*, 33.

Porter, M. E. and Van der Linde, C. (1995). Toward a new conception of the environment-competitiveness relationship. *Journal of economic perspectives*, 9(4):97–118.

Posner, R. A. et al. (1974). Theories of economic regulation. *Bell Journal of Economics*, 5(2):335–358.

Prescott, E. C. and Visscher, M. (1977). Sequential Location among Firms with Foresight. *Bell Journal of Economics*, 8(2):378–393.

Sam Peltzman, M. E. . L. and Noll, R. G. . (1989). The Economic Theory of Regulation after a Decade of Deregulation. *Brookings Papers on Economic Activity. Microeconomics*, 1989(1989):1–59.

Sato, T. (2009). Tightening capital rules could increase risk-taking.

Shapiro, S. A. and Rabinowitz, R. S. (1997). Punishment versus cooperation in regulatory enforcement: A case study of Osha. *Administrative Law Review*, 49(4):713.

Shleifer, A. (2004). Understanding Regulation. *European Financial Management Association (EFMA) Meetings European Financial Management*, 11(4):439–451.

Short, J. L. and Toffel, M. W. (2010). Making Self-Regulation More Than Merely Symbolic: The Critical Role of the Legal Environment. *Administrative Science Quarterly*, 55(3):361–369.

Sloan, A. (2016). A Schlupfloch Here, a Schlupfloch There. Now It's Real Money. *Propublica*, pages 6–8.

Stigler, G. J. (1971). The Theory of Economic Regulation. *The Bell Journal of Economics and Management Science*, 2(1):3–21.

Stiglitz, J. (2009). Regulation and Failure. *New Perspectives on Regulation*, pages 11–23.

Thakor, A. V. (2012). Incentives to innovate and financial crises. *Journal of Financial Economics*, 103(1):130–148.