Warning Labels as Cheap Talk: Why Regulators Ban Products

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Abstract

The most frequently mentioned explanation for product bans is that regulators know more about product quality than consumers. A problem with this explanation, however, is that such regulators should prefer to just communicate the information implicit in their ban, perhaps via a "would have banned" label. We show, however, that since product labeling is cheap talk, any small market failure, such as a use-externality, will tempt regulators to lie about quality. If consumers suspect such lies, regulators can not communicate their ban information, and so will ban instead. We also show that when regulators expect market failures to lead to underconsumption of a product, and so would not ban it for informed consumers, regulators should want to commit to not banning this product for uninformed consumers.

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1 Introduction

Students of political economy have long been puzzled by the ubiquity of limits on the sale of products and services. Governments prohibit the sale of some products, require the purchase of other products, and mandate features on many other products. The range of such behavior is very wide, and includes large areas of health, finance, and law. By analogy with the limits parents often place on children, such choice limits are often called "paternalistic."

A wide variety of explanations have been offered to explain such choice limits, including regulatory capture, non-competitive markets, excessive signaling, self-control problems, externalities, and consumer irrationality. (These explanations are discussed in more detail section 1.2.) Most of these explanations describe why a regulator would expect unconstrained consumers to buy too much of a product, and hence why that regulator might prefer zero sales for a low-quality product.

These explanations probably explain many aspects of paternalistic behavior, but political debates about such policies seem to most often mention *informed regulators*, the idea that regulators are better informed than consumers about aspects of product quality. A serious criticism of this explanation, however, is that consumers would seem to be better off if regulators just communicated the information implicit in their choice limit. Instead of banning a drug, for example, the FDA might require a prominent "Not FDA Approved" label on that drug.

Responses to this criticism include suggestions that reading labels is too costly, and that consumers' beliefs are systemically biased. But these responses have serious problems of their own (also discussed in section 1.2).

This paper explores a different response. If citizens care only about the market consequences of regulatory warnings, then regulator product labeling becomes a cheap talk signaling game. In such a game, any small temptation to lie (if one would be believed) can induce large losses in information transfer (Crawford & Sobel, 1982). Furthermore, a regulator with any of the other reasons to limit choices, i.e., who expects informed consumers to over- or under- consume the product, is tempted to lie about quality to uninformed consumers. Perhaps regulators just *can not* communicate the information implicit in a product ban.

This paper describes a simple game-theoretic model of such a cheap talk explanation of product bans. In the model, a market chooses the quantity purchased of some product, and that quantity depends on consumers beliefs about the one-dimensional quality of that product. Those consumers may be *informed*, and know as much about quality as the regulator does, or may be *uninformed*, and know substantially less.

Also in the model is a regulator, who is empowered to require one of several warning labels on the product, and may also be empowered to ban the product. Due to market failures or regulatory capture, this regulator expects even informed consumers to either *over-consume* or *under-consume* the product. (The same model can be interpreted as applying to activities with varying risk and activity levels, to product or activity requirements instead of bans, and to relationships between parents and children.)

We obtain the following results:

- With informed consumers, regulators only ban when they expect over-consumption, and ban only a small fraction of products when the over-consumption amount is small.
- With uninformed consumers, regulators ban both when they expect over-consumption *and* when they expect under-consumption, and they can ban a large fraction of products even when the expected over- or under-consumption amount is small.
- Averaging over possible qualities, a regulator who expects under-consumption is better off when she *can not* ban the product, because consumers will then believe more severe warnings. Anyone whose ideal point lies between the regulator's ideal and what the unconstrained market would produce is also better off. Such agents would prefer a prior commitment to not ban.

Thus we can explain ubiquitous product and activity bans and requirements, by combining substantial regulator information advantages with any small amount of the other explanations commonly offered for limiting consumer choices. And we can see that in many situations, product bans may be a political commitment failure, a common form of political failure. In our model, if a regulator would not want to ban some type of product when consumers and regulators had the same information about quality, that regulator would want to commit to not banning such products even when she had better information.

In the remainder of this paper, we review the puzzle of product bans, review the explanations that have so far been offered for them, summarize the main features and results of our model, describe a specific example model in some detail, prove some general social welfare results, and finally discuss some applications.

On a technical level, this paper generalizes the "cheap talk" signaling game of Crawford and Sobel (1982), where a sender has a one-dimensional signal and a receiver makes a one-dimensional choice. This game is generalized by allowing the sender to choose a single extreme "forced" action instead of talking to the receiver.

1.1 The Puzzle of Paternalism

Social scientists have long been puzzled by the ubiquity of government-imposed limits on individual choices to sell or consume products and services.

Governments prohibit the sale of some products in any form, while for other products they prohibit the sale of versions which lack mandated features. For example, many drugs are completely banned, and cars are required to have seat belts. Governments also directly require the "purchase" of some products, such as education, Social Security and Medicare. The range of such behavior is very wide, and includes large areas of health, finance, and law.

Regarding health and safety, many products may not be sold without a variety of safety features. These products include cars, planes, and many appliances. Building codes constrain houses and other construction, and workplaces must meet further safety requirements. Food must meet various health standards, and most drugs and medical devices require prior regulatory approval. One may only buy medical services from licensed professionals, and health plans are required to offer certain services. Organ sales are prohibited.

In finance, broad and ancient prohibitions against gambling and usury have long prevented the sale of a wide variety of financial instruments. Over the centuries, limited exemptions from these laws have been granted to allow various investments, including banking, joint stock corporations, insurance, commodity futures and options, and lotteries. These exemptions come with many restrictions. For example, disclosure constraints are imposed on stocks, and prior regulatory approval is required to offer new commodity futures.

In law, individuals may only purchase legal advice from licensed professionals. Limits are also placed on the sorts of private contracts that will be enforced, even when the intent of the parties is clear (Trebilcock, 1993). For example, damage awards are limited both by bankruptcy law and by the actual damage experienced in a case. Also, individuals may not contract around tort and criminal law, even when no other parties seem to be involved.

In addition to choice limits in health, finance, and law, we see minimum wages imposed, and bans on the sale of babies, organs, sex, and pornography. Professional licensing, product requirements, and required purchases also limit consumer choice in education and child care.

These government restrictions on individual choices are often called "paternalism," by analogy with the limits parents frequently place on the activities of their children (New, 1999; Burrows, 1993). This analogy raises the further puzzle of why parents impose limits on their children's dating, drinking, and driving, for example, and why the law imposes extra limits on children (Melton, Koocher, & Saks, 1983).

1.2 Previous Explanations

A wide variety of explanations have been offered to account for this regulatory behavior.

One class of explanations involves non-competitive behavior by firms. For example, since a monopolist can prefer to offer an inefficient menu of product qualities (Mussa & Rosen, 1978), a regulator might improve social welfare by limiting which product qualities may be sold. Similarly, since two competing firms can reduce price competition by distinguishing their products, a regulator can improve social welfare by imposing a minimum quality standard, which increases price competition by reducing product variety (Ronnen, 1991).

Excessive product variety explanations of product bans, however, have trouble explaining why we see so few *maximum* quality limits, and limits on non-quality product dimensions. They also have trouble explaining the insensitivity of most quality regulation, such as drug approval, to the industrial organization of the relevant markets.

Further complications come from the fact that, with two firms, minimum quality standards can reduce social welfare by reducing incentives to innovate (Maxwell, 1998). Welfare can also be reduced if firms choose product quality prior to market entry (Constantatos & Perrakis, 1998), or if three firms compete (Scarpa, 1998). Minimum quality standards can deter the entry of new firms (Lutz, 2000), and can be used strategically in international trade (Boom, 1995).

A second class of explanations states that product bans can mitigate excessive signaling by preventing the product variation used to signal. For example, professional licensing laws may limit inefficient signaling via human capital investments (Shapiro, 1986), while limits on work hours may limit inefficient "rat race" signaling via work effort (Landers, Rebitzer, & Taylor, 1996). Harm from consumer risk signaling may be mitigated by limits on various insurance products (Rothschild & Stiglitz, 1976), product liability waivers (Ordover, 1979), and liquidated-damages contracts (Aghion & Hermalin, 1990).

Required health purchases, such as Medicare and required health plan features, may also limit consumer risk signaling (Diamond, 1992). Frank (1985) has even offered status-signaling mitigation as simultaneously explaining minimum wage laws, most health and safety rules and licensure, required purchases of savings and education, and bans on sales of children, sex, and organs. (Signaling arguments have also been given for taxes on status-signaling luxuries (Ireland, 1994) and progressive taxation in general (Andersson, 1996).)

Unfortunately, the empirical evidence that excessive-signaling is a real problem is sometimes very weak. For example, it is far from clear that insurers suffer from substantial adverse selection when they are free to price based on what they know (Cawley & Philipson, 1999; Hemenway, 1992; Browne & Doerpinghaus, 1993).

Product bans can also be understood as aiding people in dealing with problems of self-control (Rabin & O Donoghue, 1997; O'Donoghue & Rabin, 1999). For example, if people could not feasibly commit to abstaining from alcohol, gambling, or candy bars, they might prefer such products be banned from places where impulse shopping is most likely.

Choices that rational consumers make far enough in advance of a possible self-control or excessive signaling situation should suffer much less from control or signaling problems. Ex-ante, information becomes symmetric and time preferences become stable. Thus control and signaling explanations of product bans do not seem to explain why ex-ante consumer choices, made years in advance, are not exempted from consumer choice limits. Why can not a twenty year old, for example, opt out of the Medicare system?

All three of the explanations discussed so far, competition, signaling, and self-control, have the further problem that such concepts seem to be rarely mentioned in political discussions where these policies are presumably decided. Perhaps politicians are not aware of the real reason they ban products, or perhaps product bans are preserved for different reasons than they are enacted.

A concept that political discussions do mention more often is use-externalities; advocates suggest many externalities which their favored bans would mitigate. For example, building codes may lower the risk of fires spreading to neighboring properties. Required health care product features may reduce the spread of infectious disease. And required product safety features may lower the risk that injured people will use public health care.

Usury laws and bans on liquidated damages contracts may also limit the risk that poor people will require public assistance (Posner, 1995). Allegations of crime and public-assistance mediated externalities have been pivotal in securing public support for drug prohibitions (Miller, 1991; Johnson, Goldstein, Preble, Schmeidler, Lipton, & Spunt, 1985), including alcohol prohibition (Barker, 1905; Isaac, 1965).

Bans on the sale of sex, pornography, body parts, and children have also been said to mitigate the externality of "commodification" which markets are said to create in the presence of "incommensurable" values (Radin, 1996). Similarly, bans on prohibited literatures are said to mitigate the externalities of contagious bad ideas. Finally, meddling preferences, where voters have specific preferences over other people's consumption patterns, are a type of externality which can (perhaps too easily) explain a wide variety of regulatory intervention.

Externalities are surely part of the story for many product bans. But there are difficulties in explaining most product bans this way. For example, it is not clear why legal liability rules or special product taxes would not usually better deal with such externalities (Kaplow & Shavell, 1998; Burrows, 1993). Yes, a product ban can be thought of as a very high tax, and we do see taxes on products like cigarettes, but why are there are not more intermediate level taxes?

Also, product bans do not seem to be very sensitive to known variations in the magnitude of externalities. For example, neither drug regulation or health professional licensing seem to distinguish contagious from non-contagious illnesses. Building codes do not seem to distinguish fire-promoting risks from risks, such as structural defects, with mostly local consequences. It is also hard to understand what substantial externality could be behind required airline safety features, especially on flights which are mainly over the open ocean.

A further problem for the externality explanation is that we see few exemptions given to larger scale organizations that may internalize most of the externality. For example, a large housing complex internalizes much of the fire hazard externality, yet is not exempt from building codes.

Regulatory capture by special interests is another frequently mentioned relatively general explanation of most product bans. While this explanation has much intuitive appeal, it is hard to understand why rational voters would approve politicians who back such bans, if regulatory capture were the main story. Direct cash transfers seem to be a more efficient form of wealth redistribution, so the only obvious reason for using inefficient bans would be to disguise the transfer. But product bans could only disguise such transfers if these bans had an other substantial accepted purpose in the minds of voters (Coate & Morris, 1995). Thus while some degree of regulatory capture is surely present, it is hard to understand how it can be the main story.

Some empirical studies *have* suggested that professional licensing is best explained as due to regulators captured by professionals in search of higher incomes (Stigler, 1971; Maurizi, 1974). Many other studies, however, find this to be a relatively small effect when compared to "public interest" type explanations (Leffler, 1978; Lueck, Olsen, & Ransom, 1995; Lambert & McGuire, 1990; Jensen, 1992).

"Public interest" explanations of product bans tend to focus on informed regulators, regulators who have special information about product quality, and who use this information to protect consumers from buying bad products. Such explanations are relatively general, and seem to dominate the political discussion of product bans. Critics may question regulator's judgment regarding a particular quality, but they rarely question the basic concept of banning very low quality products. For example, the Florida statute requiring medical licensing begins by explaining that "it is difficult for the public to make an informed choice when selecting a physician" (Feinstein, 1985).

Such public interest justifications also seem to have very high levels of public support. For example, a 1976 Harris poll found that 85 and 83 percent of the public favors federal regulation of product safety and quality standards, respectively (Lipset & Schneider, 1979).

When regulators have special information which they cannot otherwise communicate to consumers, and when consumers cannot or will not get equivalent information from other sources, product bans *can* improve consumer welfare. For example, when regulators can observe product quality, they can help consumers by imposing a minimum quality standard (Leland, 1979).

Regulator information explanations of product bans can help explain why old and familiar dangers, such as rock climbing, river rafting, smoking, alcohol, and pornography, are banned less often than comparable and arguably less harmful new dangers. They can also explain why exemptions are granted for relatively well-informed actors. For example, corporations are allowed more freedom of contract than individuals, and rich investors are allowed more investment choices.

Regulator information explanations do not apply well to situations, such as prostitution and many workplace injures, where relevant parties seem well aware of the dangers. Another problem is that, due to excessive product differentiation, informing consumers about quality can sometimes lower, not raise, social welfare (Schlee, 1996; Bester, 1998).

A widely mentioned objection is that consumers have many private sources of information, including prices, the experiences of friends, and certification by self-regulating producers (Gehrig & Jost, 1995). But unless private information sources reveal everything that a regulator knows, regulators may still want to inform consumers about what they know.

A more serious objection is that consumers could do no worse, and often do better, if, rather than banning bad products, regulators instead communicated the same information by certifying good products or putting warning labels on bad ones (Higgs, 1995; Weiner, 1980). For example, Leffler (1978) notes that

> Under a costly information argument for intervention, certification is the preferred re-

sponse. Certification provides all the information of licensure while offering a wider choice set.

Confirming this intuition, most papers which suggest an advantage for product bans do not directly compare bans to certification of the ban information. Gale (1997) takes them to be equivalent, for example, and Shapiro (1986) compares bans with certification of more than the ban information. Shaked and Sutton (1981), who do directly compare bans and labels in comparing professional licensing and certification, find that permitting entry of rival para-professionals is welfare improving.

Attempts to inform consumers of product risks have increased over recent decades, but the results of these attempts have not encouraged regulators to consider eliminating product bans. While reductions in consumption did follow requirements for warning labels on saccharin and cigarettes, many other warning campaigns have been seen as clear failures. The failure of seat belt warnings, for example, led to laws requiring seat belt use (Magat & Viscusi, 1992). And even the saccharin warnings only reduced consumption by three to six percent (for Health, 1987).

One explanation offered for the disappointing effects of warning labels is that it is costly for customers to read labels, and so they do so poorly or not at all (Kelman, 1981). With perfect enforcement of bans, in contrast, it takes no effort to avoid banned products. So even though regulators are slowly getting better and designing easily understood labels, the argument goes, labels are far from being able to substitute for bans.

Label-reading costs do not seem to be an adequate explanation in many cases, however. For example, warning labels on seat belts and on alcohol do not seem to have effected general consumption, even though consumers seem to have read and understood the warning labels (Mayer, Smith, & Scammon, 1991).

Furthermore, many authors have suggested that labeling costs could be borne by the unapproved products, for example by requiring a large red "Not FDA approved" warning label on unapproved drugs (Gieringer, 1985; Pearson & Shaw, 1982; Weiner, 1980).

If watching for this label were still deemed too costly a burden for consumers, then "a case could probably be made for allowing establishment of certain stores, with warnings prominently posted, that sell only products that do not meet regulatory standards" (Kelman, 1981). One might even require that consumers pass a test, something like a driver's test, before they are allowed to buy from such a store. It seems hard to argue that it would be too costly for consumers to notice whether they were in such a store. Thus the fact that no such exceptions are allowed to product bans is a puzzle from the simple regulator information perspective.

An alternative explanation for the failure of information approaches is systematic biases in consumer beliefs. If consumers believe themselves to be well informed regarding product quality, they have no reason to listen to regulatory advice. And if regulators believe consumers estimates to be biased, regulators may prefer to ban a low quality product which consumers mistakenly estimate to be of high quality.

Perceived irrationality seems to explain many limits to choices placed on those labeled mentally-ill. Various limits to legal contracts have also been explained as due to "limits of cognition" such as framing, availability and representativeness biases (Eisenberg, 1995). Akerlof and Dickens (1982) suggest that required safety features may help consumers if cognitive dissonance makes them prefer to believe products are safe, rather than fear for their lives. Attention has focused in particular on consumer biases regarding low probability events (Spense, 1977). Viscusi (1995) instructs risk regulators to keep in mind that "individuals tend to overestimate the risks associated with lower-probability events ... [and to] underestimate the risks associated with higher-risk events."

Even Viscusi, however, fails to find empirical support that errors in risk estimates reflect consumer irrationality, rather than ignorance (Viscusi, 1992a). And unless people are less biased as voters than they are as consumers, it is hard to understand why they would favor politicians who promise future product bans. The same biases that would lead voters to buy too much of a bad product should lead them to expect to benefit from the option to buy such products. Hence we would expect them to favor politicians who promise to allow them that choice, at least if voters base their electoral choices primarily on *prospective* evaluations of the future consequences of candidate policy positions.

In many electoral models, however, "the chosen candidate . . . selects an action . . . , where this action is unobserved by the voter, and (stochastically) determines the voter's reward for that period." Because of this "the voter employs a simple retrospective voting rule: retain the current incumbent as long as rewards remain above a certain level" (Banks & Sundaram, 1993). Biased and retrospective-voting consumers could induce regulators to try to correct for their biases, and "take as societies objective the promotion of societal welfare based on the true risk levels, not the risk levels as they may be perceived by society more generally" (Viscusi et al., 1995), as many regulation theorists suggest.

This irrational retrospective citizen explanation, however, seems to have trouble explaining the strong prospective public support for product bans we observe (Kelman, 1981). And it is far from clear that consumers are systematically biased in an extreme enough way to explain observed banning behavior. For example, would consumers be biased and ignore regulator advice even after taking a class informing them of their bias, after passing a special test, and then being limited to buying such products in special stores?

1.3 A Cheap Talk Explanation

In the political contexts where product bans get made, the explanation mentioned most often is regulator information, and the main problem with this explanation is the absence of the apparently superior alternative of warning labels which convey the information implicit in a ban. This paper explores the idea that, in the absence of prior commitments, a small amount of any of the other mentioned product ban explanations is enough to make this alternative infeasible, because of the difficulties of communicating via cheap talk. Thus we may be able to robustly explain ubiquitous product and activity bans and requirements.

To illustrate the intuition behind this paper's model, consider a drug produced by a monopolist, and a regulator informed about this drug's (one-dimensional) quality. This regulator must choose what quality information to announce to consumers, and may be authorized to ban the drug. If consumers believed anything the regulator said, then a regulator concerned only about social welfare would want to lie and announce a higher-than-true quality estimate. (How much higher, we will call the regulator's "bias.") This quality over-estimate would increase demand, compensating for the reduced consumption caused by monopoly pricing.

If consumers anticipated such lies, however, then a regulator-labeling cheap talk equilibrium would consist of a set of quality intervals. A regulator who knows the true product quality can only tell consumers which interval this quality lies in, and cannot credibly communicate finer distinctions. Furthermore, the number of possible intervals shrinks as the temptation to lie increases.

If the regulator can not ban the product, and announces that the quality is in the lowest quality interval, consumers purchases will reflect an average over this quality interval. If the true quality happened to be near its lowest possible value, this regulator could regret not being able to ban the product, as future voters would then recall being unhappy with their product experience.

If, however, the regulator can ban the product, in addition to announcing a quality interval, then the signaling game is changed. Any product in the lowest quality interval is banned, and the boundaries of the higher quality intervals move. In equilibrium, not banning a product is taken by consumers as an endorsement of product quality, encouraging regulators to ban even more often.

Thus the regulator bans often.

This story can be generalized to apply to many other cases. For example, imagine five companies produce this drug, instead of only one. The market price would still be a bit higher than competitive, lowering quantity purchased. And the regulator would still correct for this by lying a bit about quality, if she were believed, and so she would only be able communicate a limited number of distinctions to skeptical consumers.

We can also tell a similar story about a regulator concerned about a use-externality, excessive signaling, or self-control problem, or a "captured" regulator who gives unequal welfare weights to the relevant parties. Unless the quantity sold that an informed market would produce is exactly the quantity the regulator would prefer, she has a temptation to lie about quality.

Note that instead of talking about product bans and warnings, we could flip the sign of our quality variable and talk about regulators requiring or praising products. Also, instead of talking about the quality and quantity of a purchased product, we could talk about the risk and level of some activity like driving. And instead of a regulator limiting consumer choice, we can talk about a parent limiting the choices of her child to drink, drive, or date.

Finally, if consumers can be divided into distinct groups with differing information or preferences regarding product quality, and if our regulator can selectively target these different groups with different labels and bans, note that we can consider these to be different products, to be modeled separately.

1.4 What Can Cheap Talk Explain?

This cheap talk explanation inherits many virtues from the simple regulator information model it modifies. First, it is relatively general, with a value for product bans that does not depend as much on situational details as it does with explanations like product variety and excessive signaling. Second, it inherits from the regulator information theory an explanation for the apparent regulatory focus on new harms, and the granting of exemptions for especially informed parties. Third, it fits comfortably with empirical work which prefers a large public interest component and a small regulatory capture component to product ban behavior.

Finally, it can also take most political discussion of product bans at face value, instead of suggesting that such discussion is mainly a smoke screen obscuring the real motives. Since consumers take a lack of a ban as a product endorsement, voters can naturally be upset at regulators who failed to ban bad products. Thus we can understand why voters re-elect politicians who support particular bans, and why regulators who are biased in favor of some product category still ban many products in this category.

Contrary to the simple regulator information model, this theory also explains why warning labels do not substitute for product bans, and why there are not various imagined exemptions, such as for consumers who take special tests and shop at special unapproved product stores. If consumers exempted from a ban would still take that fact as a product endorsement, the regulator will not want to exempt them.

Cheap talk can explain bans with fully rational consumers and regulators, and with costless labels. It can explain why rational consumers ignore fine label information, even for large purchases, and why consumers are disappointingly unresponsive to regulatory advice. This theory also fits comfortably with other product ban explanations, since it requires that other explanations of product bans be present to at least a small degree.

1.5 Welfare Comparisons

Voters may be happy with the behavior of a particular regulator relative to an equilibrium where regulators are authorized to ban products. After all, citizens who interpret the lack of a ban as a product endorsement would be understandably upset at a regulator who failed to ban a bad product. This does not mean, however, that citizens would not be on average even better off in an equilibrium where regulators are not authorized to ban products. Who benefits by allowing a regulator to ban products?

In the appendix, we consider a simple example of Cournot competition between producers of two competing products, where consumers are uncertain about the quality of one of the products. In this example, producers of the possibly-banned product always ex-ante prefer no bans and a small bias, as do regulators "biased" in favor of these producers. But producers of the competing product ex-ante prefer that bans be allowed, and given bans they prefer that regulators be biased as far as possible in their favor. Regulators also prefer bans be allowed when they are biased in favor of these competing producers.

If there is no market failure with respect to quantity consumed, then regulatory bias is due purely to capture. In this case, consumers agree with producers of the possibly-banned product that bans and bias are bad. Eliminating the possibility of product bans also aligns the interests of all parties ex-ante, to want to minimize the magnitude of regulator bias, by reducing market failures and regulatory capture.

In a moderately more general example of quadratic preferences, regulators still ex-ante prefer bans only when they are biased against the product. Someone seeking only social welfare agrees when regulator bias is due to market failure, but always prefer no bans if regulator bias is due purely to regulatory capture.

For more general results, consider the limiting case where consumers know as much as regulators about quality. If regulator bias is negative, so that the regulator thinks an unconstrained market leads to overconsumption of the product, the regulator will sometimes ban the product. If there is no regulatory capture, this raises social welfare, and this result will not change if consumers become only slightly more ignorant. Thus for negative bias, the power to ban can sometimes be good ex-ante.

Even when bias is purely due to capture, there are some cases where bans are good ex-ante, and others where they are bad. This is because banning a product is a more severe action than assigning it the lowest quality label in the no banning situation, so there are quality levels which a regulator is not willing to actually ban, but is willing to label as in the lowest quality interval without bans. So with negative bias, bans can allow more distinctions to be made.

When bias is positive, however, so that the regulator thinks an unconstrained market leads to underconsumption of the product, then bans do not allow more distinctions to be made. This allows us to say something more general about the ex-ante value of bans. Given some technically-convenient assumptions about the nature of preferences and bans, we find that *if*, given equally informed regulators and consumers, the socially optimal outcome is anywhere between what the regulator would prefer and what the market would do if left to itself, *then* not allowing bans is always ex-ante socially preferred to allowing bans, even for when consumers are ignorant.

Technically, we will assume one-dimensional types (e.g., quality levels) and actions (e.g., amount purchased) and consider Crawford and Sobel's (1982) cheap talk signaling game between a sender (e.g., a regulator) and a receiver (e.g., a market containing consumers), modified to allow the sender a single extreme "ban" action. We assume, with Crawford and Sobel, concavity and sorting in preferences, convex signal support, that at no type do the two "player's" preferences coincide, and that interval boundaries all move in the same direction. Finally, we assume the ban outcome is between these two no-ban-possible outcomes: when the sender declares that the signal was the worst possible, and when the receiver knows for sure that the signal is the worst possible.

Thus the power to ban products is in general not a good idea when regulators think that, with informed consumers, free markets would lead to underconsumption of the product. Similarly, activity bans are a bad idea when the regulator thinks unconstrained informed people will have too low an activity level.

Regulators will in equilibrium ban frequently, however, if they have not committed somehow to not ban. In such cases, product banning can be thought of as a commitment failure, similar to other political failures which have been attributed to commitment failures (Levy & Spiller, 1994). Such commitment failures may at times be overcome, as for example has been done with constitutional prohibitions on print media bans in the United States. With bans prohibited, customers will interpret warning labels differently, and believe more severe warnings, to society's ex-ante benefit.

Note that the ability of this cheap talk model of product bans to explain the phenomenon of product bans depends on the plausibility of a political commitment failure; where such failures are implausible, then this explanation also becomes implausible, at least for regulators with a positive bias.

Note also that we have implicitly assumed that a regulator can only choose between giving advice or banning (or requiring) a product. It remains be seen whether these results described here will be robust to allowing the regulator to tax or subsidize the product or activity, or to make costly signals, such as burning money (Austen-Smith & Banks, 2000).

2 A Quadratic Example

Section 3, titled "A General Banning Game," gives relatively general but abstract results regarding cheap talk games with bans. Before considering such general models, however, let us examine a simple concrete example where we can derive simple specific closed form expressions for equilibria.

Let us focus on some particular product, and let Q represent the private information a regulator has about the quality of this product. If consumers were unconstrained and knew what the regulator knows, then in an equilibrium of the product market, consumers would purchase some amount of that product. If such equilibria are unique and if the regulator's private information signal is also one-dimensional, we can identify these two numbers. That is, we can interpret the regulators signal Q as the amount of the product consumers would purchase if they knew what the regulator knows.

In fact, consumers do not know what the regulator knows, and so they purchase an amount $\hat{Q}$, where in general $\hat{Q} \neq Q$. When the product is banned, we assume we have $\hat{Q} = 0$.

In Appendix 6.1, we consider an extended example of Cournot competition between multiple producers of each of two competing products. There supply and demand is linear for both products, and the demand of one product is also linear in a quality parameter, about which consumers are uncertain. In that extended example, we find that the amount actually purchased is that same that would be purchased by a "market" actor, and actor with preferences that are quadratic in the difference between the amount purchased $\hat{Q}$ and the "market's" ideal amount Q. The regulator's preferences are also quadratic in these two terms, but the regulator's ideal amount is $Q + \beta(Q)$, where $\beta(Q)$ is the regulator's "bias" or temptation to lie. Social welfare is also quadratic, and can differ from the market preferences due to market failure, and can differ from the regulator's preferences due to regulatory capture.

Here we just directly assume two effective actors, a market m and regulator r, with utility

$$\begin{aligned} U_m &= -(\hat{Q} - Q)^2, \\ U_r &= -(\hat{Q} - Q - \beta(Q))^2. \end{aligned}$$

In this situation the market will, when free to do so, choose a quantity equal to it's expected value of the signal Q, as in

$$\hat{Q} = E[Q].$$

2.1 Alternative Theories of Bans

Before considering our cheap talk model for this quadratic preference case, let us consider some alternative theories of product bans.

First, consider regulators who are no better informed about product quality than consumers. Such a regulator will ban the product if $\beta(Q) < -Q/2$ (assuming $\beta'(Q) < 2$). In this case, a regulator's ideal point may differ from the market's ideal point for many reasons, including a lack of competition, externalities, signaling problems, consumer irrationality, or regulatory capture.

For example, consider the case of irrational consumers and completely uncaptured regulators. If regulators know that consumers are acting on $\hat{Q} = \alpha Q + \eta$, then regulators will ban the product when $Q < \eta/(2 - \alpha)$ (at least for $\alpha < 2$).

For simplicity we will from here on in our quadratic example discussion assume constant bias, $\beta(Q) = \beta$, and a uniform distribution over signal Q on $[0, 1]$. For symmetric information and these assumptions, the fraction of products banned is linear in the bias β, but the product is never banned if the regulator is biased in its favor, with $\beta > 0$.

Second, consider a prohibitively-costly-labels explanation of bans. Here the regulator can only communicate with consumers by banning the product (labels will not be read). The regulator bans the product if $Q < (1-4\beta)/3$. When bias is small, and for either sign, this is near 1/3, and bias doesn't much change the fraction of products banned.

2.2 Cheap Talk Labeling With Bans

Consider now a cheap talk theory. This is based on a cheap talk labeling game with product bans, which proceeds as follows. The regulator first sees her private quality signal Q, and then either bans the product (if given the authority) or announces a recommended quantity $\tilde{Q}$. If the product is not banned, the market then estimates its prefered quantity $\hat{Q} = E[Q|\tilde{Q}]$,and purchases this amount.

For this game, Bayes-Nash equilibria can be described by a simple partition of $[0,1]$, that is, a set of n intervals $[Q_i, Q_{i+1}]$ such that $Q_0 = 0$ and $Q_n = 1$, where a regulator who observes a $Q \in [Q_i, Q_{i+1}]$ can only communicate the fact that $Q \in [Q_i, Q_{i+1}]$. Consumers would not believe any more specific claims about Q. (For a more detailed justification, see section 3.)

If $Q \in [0, Q_1]$, the lowest quality interval, a regulator who is allowed to will ban the product, forcing $\hat{Q}_0 = 0$. Given a uniform distribution over Q, consumers who are told $Q \in [Q_i, Q_{i+1}]$ and have a choice will choose to buy an average amount $\hat{Q}_i = (Q_i + Q_{i+1})/2$. Finally, the Q_i are the points where the regulator is indifferent between the outcomes $\hat{Q}_{i-1}$ and $\hat{Q}_i$. Given the quadratic regulator preferences, Q_i solves

$$(Q_i + \beta) - \hat{Q}_{i-1} = \hat{Q}_i - (Q_i + \beta),$$

These equations can be solved to give closed form solutions[1], shown in Table 1. With no ban, there can be an equilibrium with n intervals for any integer $n \geq 1$ such that $1 \geq 2|\beta|n(n-1)$. For bans allowed with positive regulator bias ($\beta > 0$) the same expression holds. For bans allowed with negative regulator bias ($\beta < 0$), however, the condition is instead $1 \geq 2|\beta|(n-1)^2$. Thus for a negative bias, but not for a positive bias, allowing bans can increase the equilibrium "size," i.e., the number of intervals in the equilibrium.

[1]Closed form solutions for the case where bans are not allowed were given in Crawford and Sobel (1982).

no ban	$\beta > 0$	$Q_1 = \frac{1-2\beta n(n-1)}{n}$	$Q_i = iQ_1 + 2\beta i(i-1)$
ban	$\beta > 0$	$Q_1 = \frac{1-2\beta n(n-1)}{2n-1}$	$Q_i = (2i-1)Q_1 + 2\beta i(i-1)$
no ban	$\beta < 0$	$1 - Q_{n-1} = \frac{1+2\beta n(n-1)}{n}$	$1 - Q_{n-i} = (n-i)(1-Q_{n-1}) -$
ban	$\beta < 0$	$1 - Q_{n-1} = \frac{1+2\beta(n-1)^2}{n-1/2}$	$2\beta(n-i)(n-i+1)$

Table 1: Quadratic Equilibria Formula

The solutions with the maximal number of intervals n for any given bias level are graphed in Figure 1, for $n \in [1, 7]$. Quantity Q rises along the vertical axis, while bias varies along the horizontal axis. (To see the full solutions for lessor values of n, project the lines shown in Figure 1 toward the zero bias line.) Table 2 gives numerical values for some specific bias values.

Note that with bans allowed, product bans occur for regulators with both positive and negative bias, and given negative bias a large fraction of products are banned even with a very weak bias. For example, 10% of products are banned at a bias of $-.5\%$, and this banning fraction goes roughly as the square root of bias, at least for negative bias.

The convex closure of the banning region shown describes when products would be banned in the alternative pure no-labels-possible model. Thus labels allow bans to occur less often compared to this model. A line from where this ban region intersects the $Q = 1$ line to the $0, 0$ origin would be the upper bound of the ban region in the other alternative model, where regulators and consumers are equally informed. Thus without consumer ignorance, the fraction of banned products is smaller, and bans only happen for one sign of the relevant bias parameter.

2.3 Welfare

For the class of games we have considered in this section, with quadratic preferences and a uniform distribution over best quantity Q, it turns out that allowing bans never increases expected "market utility" in the following sense. For any equilibria of such a game with bans, there is an equilibria of the corresponding no-ban game with higher ex-ante market utility.

Thus if we assumed no market failure and took market utility as describing social welfare, we might conclude that allowing bans always lowers social welfare in the quadratic case. It turns out, however, that allowing bans can improve market welfare under quadratic preferences if we change the distribution over quality.

Imagine that instead of a uniform distribution $F'(Q) = 1$ over Q, we assume

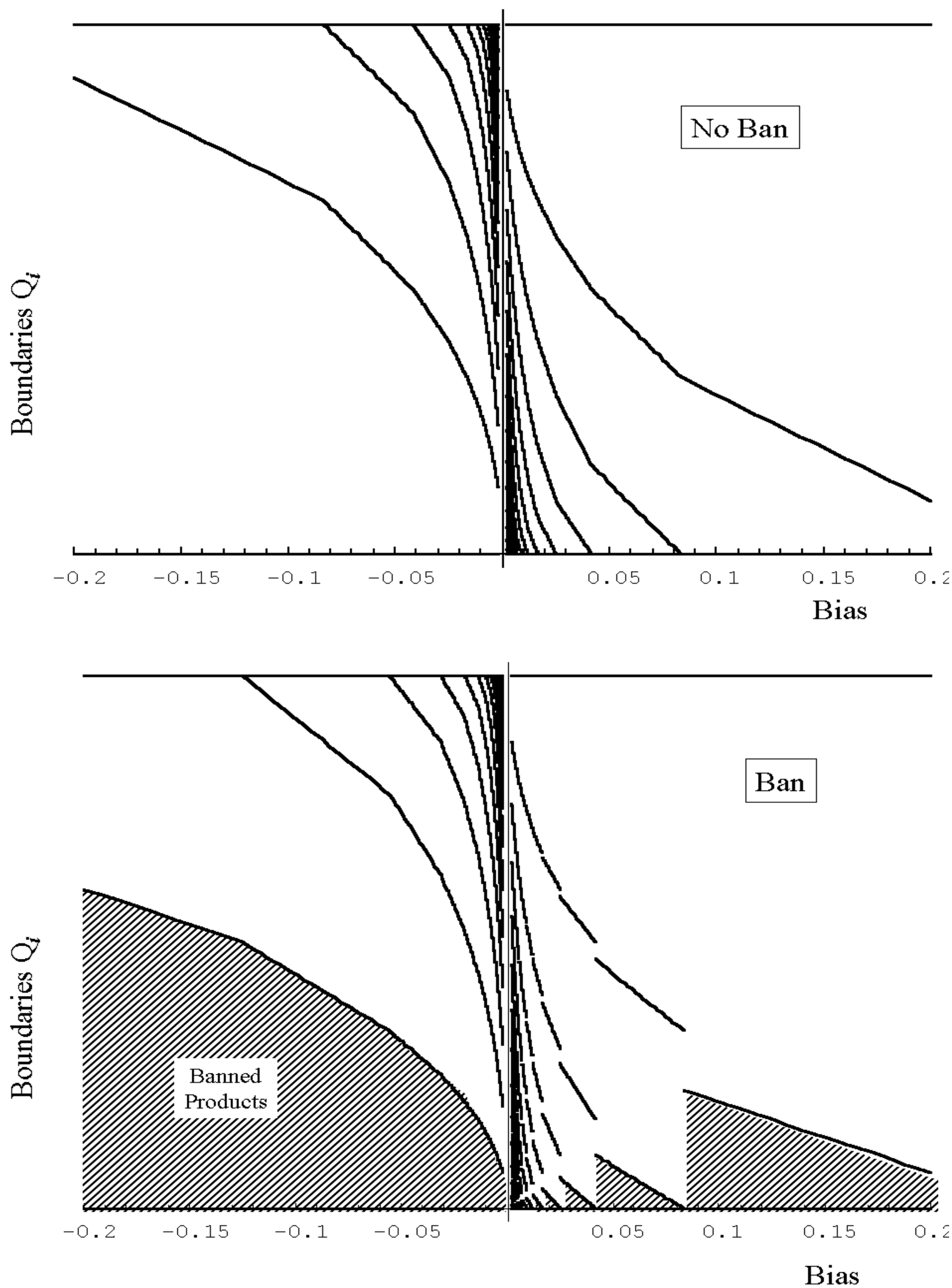

Figure 1: Quadratic Equilibria Boundaries vs. Bias

	Bias	max n	Boundaries Q_i for max n	$E[U_m]$	$E[U_r]$
no ban	-.5	1	0, 1	-83.3	-333.3
no ban	-.05	3	0, .53, .87, 1	-15.9	-18.4
no ban	-.005	10	0, .19, .36, .51, .64, .75, .84, .91, .96, .99, 1	-1.66	-1.68
no ban	.005	10	0, .01, .04, .09, .16, .25, .36, .49, .64, .81, 1	-1.66	-1.68
no ban	.05	3	0, .13, .47, 1	-15.9	-18.4
no ban	.5	1	0, 1	-83.3	-333.3
ban	-.5	1	0, 1 (all banned)	-333.3	-83.3
ban	-.05	4	0, .31, .74, .97, 1	-17.9	-15.5
ban	-.005	10	0, .1, .28, .44, .58, .7, .8, .88, .94, .98, 1	-1.68	-1.66
ban	.005	10	0, .005, .04, .09, .16, .25, .356, .49, .64, .81, 1	-1.68	-1.70
ban	.05	3	0, .08, .44, 1	-18.7	-21.5
ban	.5	1	0, 1 (nothing banned)	- 83.3	-333.3

Table 2: Quadratic Equilibria Examples

$$F'(Q) = \tfrac{1}{2}(1-Q)^{-1/2}.$$

This distribution is concentrated near $Q = 1$, but also has substantial weight over the whole $[0, 1]$ range. for $\beta \in [-.5, -.18]$ the game with a ban has a two interval ($n = 2$) solution, while the no-ban game only has a one interval ($n = 1$) solution. And for $\beta > -.24$, this two interval solution has a higher ex-ante market utility. Thus for $\beta \in [-.24, -.18]$, the game with bans allowed is better for ex-ante market utility. For example, if $\beta = .2$, then the two interval solution has $Q_1 = .64$ and $\hat{Q}_1 = .88$. In this equilibrium 40% of products (those for which $Q \in [0, .64]$) are banned.

It might be noted, however, that for a wide range of other bias values assuming this distribution, the ban game is ex-ante worse, and often by much larger margins. (Bans also sometimes raise ex-ante market utility for the distribution $F'(Q) \propto (1-Q)^{-1/4}$.)

3 A General Banning Game

3.1 The Model

The following is a more general model of a cheap talk labeling game, taken directly from the first published cheap talk signaling game paper of Crawford and Sobel (1982) (hereafter, C&S). We follow their notation where possible. (We will soon extend this game to include a single forced "ban" action.)

There are two players, a Sender (S) who observes private information $a \in [\underline{a}, \bar{a}] \subset \mathcal{R}$ (the real line), and a Receiver (R) who takes an action $y \in [\underline{y}, \overline{y}] \subset \mathcal{R}$. This is a signaling game in that before R takes action y, but after S learns information a, S sends a signal s to R about a. It is a "cheap talk" signaling game in that the player's twice continuously differentiable utility functions, $U^S(y,a)$ and $U^R(y,a)$, do not depend directly on the signal s. S's private information a is drawn from a differentiable c.d.f $F(a)$ with support $[\underline{a}, \bar{a}]$.

Sender S can be thought of as a regulator with special information $a = Q$ on product quality, and receiver R can be thought of as a market which chooses quantity purchased $y = \hat{Q}$ to maximize some effective objective. (For a competitive market, this objective would be total welfare.) Alternatively, S can be thought of as a "parent" who can either recommend a level of some "child" R's activity, such as driving, drugs, or dating, or can instead ban this activity entirely.

Instead of dealing directly with utilities $U(y,a)$, it will usually be more convenient to deal with marginal utilities $M(y,a) = U_1(y,a)$. Following C&S, we will assume *concavity*, $M_1 < 0$, and *sorting* (or single-crossing), $M_2 > 0$, everywhere. These imply strictly increasing and unique ideal points $\bar{y}(a) = \text{argmax}_y U(y,a)$. Furthermore, we w.l.o.g. assume[2] $M^R(y,y) = 0$, which implies $\bar{y}^R(a) = a$. Unless otherwise noted, we will also assume $[\underline{a}, \bar{a}] \subset [\underline{y}, \overline{y}]$. Finally, we will often want to assume that S's "bias" relative to R's preferences, $\bar{y}^S(a) - \bar{y}^R(a)$, has a constant sign, either positive from $M^S > M^R$ or negative from $M^S < M^R$.

In the game C&S considered, S first observes a and then sends signal s to R, who then chooses an action y. In this paper, we compare this basic labeling game with an extended labeling plus ban game, where S can choose to force a certain "ban" action x instead of sending a signal s to R. If S chooses x, the game ends immediately. Note that this extended game mixes cheap talk and costly signals within the same strategy space; the sender S chooses between "talking" and "doing."

3.2 Equilibria

Concavity ensures that R never uses mixed strategies, so R's strategy can be written as $y(s)$. S may use mixed strategies, so we write S's strategy as $q(s|a)$, a probability density of s given a, where $1 - \int q(s|a)da$ is the probability of x given a.

[2] If this is not true for $U(y,b)$, use $\tilde{U}(y,a) = U(y,a(b))$ with $a'(b) = -M_1^R(b,a(b))/M_2^R(b,a(b))$.

There will be some set of actions Y induced in any sequential equilibrium, and since talk is cheap and S has all private information, S essentially can choose any $y \in Y$. C&S's lemma one shows that this set of equilibrium actions is finite given $M^S > M^R$ or $M^S < M^R$, and their proof is valid without modification in our extended game.

Sorting and concavity ensure that the set of S types a who choose y_i are of the form $[a_i, a_{i+1}]$. (We needn't be very precise regarding the behavior of the measure-zero set of boundary types a_i.) When Y has n elements, we have $a_0 = \underline{a}$, $a_n = \bar{a}$.

When several signals s induce the same action y_i, R's expected utility must be the same given each of them, which follows if $q(s|a)$ is the same for each such s, given $a \in [a_i, a_{i+1}]$. Since the signal space will be partitioned into sets whose members are not meaningfully distinguished by the players, all that really matters about the space of possible signals s is its cardinality, which we will assume is large enough to not be a constraint. Following C&S, we ignore signals from here on, describing equilibria by $\vec{a} = (a_i)_{i=0}^{n}$ and $\vec{y} = (y_i)_{i=0}^{n-1}$.

C&S's theorem one shows that, for the basic game, there exists a N such that for every integer n in $[1, N]$, there exists a sequential equilibrium where $\vec{a}, \vec{y}$ satisfy equations $(\mathcal{E}_i^S)_{i=1}^{n-1}, (\mathcal{E}_i^R)_{i=0}^{n-1}$, where equation $\mathcal{E}_i^S(y_{i-1}, a_i, y_i)$ is

$$U^S(y_{i-1}, a_i) = U^S(y_i, a_i),$$

and equation $\mathcal{E}_i^R(a_i, y_i, a_{i+1})$ is

$$y_i = \bar{y}(a_i, a_{i+1}) = \text{argmax}_y \int_{a_i}^{a_{i+1}} U^R(y, a) dF(a).$$

Furthermore C&S show that every equilibrium is essentially equivalent to one of these.

These equations $\mathcal{E}_i^S, \mathcal{E}_i^R$ can be rewritten in terms of M as

$$\int_{y_{i-1}}^{y_i} M^S(y, a_i)\, dy = 0,$$

$$\int_{a_i}^{a_{i+1}} M^R(y_i, a)\, dF(a) = 0.$$

Alternatively, we can rewrite these equations $\mathcal{E}_i^S, \mathcal{E}_i^R$ as

$$U^S(y_{i-1}, a_i) = U^S(y_i, a_i),$$

$$I^R(y_i, a_i) = I^R(y_i, a_{i+1}),$$

where we have defined a pseudo-utility

$$I^R(y, a) = \int_y^a M^R(y, a')dF(a').$$

If x is too low or high, S may strictly prefer to never choose x. Such an equilibria of the extended game can be identified with an equilibria of the basic game with no forced act x.

For an equilibria of the extended game where the forced act x is chosen by S with positive probability, the only change to these equilibrium equations is that for some $i = \hat{\imath}$, the equation $\mathcal{E}_i^R(a_i, y_i, a_{i+1})$ is replaced by $y_i = x$. In this case there is no longer any direct dependence between $a_{\hat{\imath}}$ and $a_{\hat{\imath}+1}$. Thus for *interior* forced acts $\hat{\imath} \notin \{0, n\}$, the equilibrium equations are *divided* into disjoint sets, sets where i is above and below the $\hat{\imath}$ where $y_{\hat{\imath}} = x$.

For every equilibria of the basic game there is for some x an equilibria of the extended game with the same $\vec{a}, \vec{y}$. This is because if we set $x = y_i$ for any y_i in the basic game, S won't want to change his strategy, and hence neither will R. Thus we may w.l.o.g. analyze only equilibria of the extended game where x is chosen with positive probability.

C&S's proof of their theorem one (which proves existence) applies to our extended game as well, if we simply replace equation $\mathcal{E}_i^R$ with $y_i = x$. We again have a set of continuous non-linear difference equations with the same sort of properties. The only significant difference is that these equations may be divided. So $n = 1$ is possible only if either all or no S types a prefer the forced act x. Thus the following lemma applies.

Lemma 1 *Given a forced act x, there exists a $\hat{N}(x)$ such that for every $n \in [\underline{N}, \hat{N}(x)]$, for $\underline{N} \in \{1, 2\}$, there is a Bayes-Nash equilibrium (which is also sequential) satisfying $(\mathcal{E}_i^R)_0^{n-1}, (\mathcal{E}_i^S)_1^{n-1}$, except that for some i, $\mathcal{E}_i^R$ may be replaced by $y_i = x$.*

3.3 Comparing Welfare

To simplify their analysis C&S invoked a *monotonicity* assumption equivalent to $da_i/dx > 0$ for all $i \in [1, n-1]$, which implies $dy_i/dx > 0$ for all $i \in [0, n-1]$, and also implies that in the basic game there is a unique equilibrium for each size n. C&S's lemma three proves this, and their proof applies here. The only modification is that interior forced acts can induce some non-uniqueness; an $n = 7$ solution, for example, might have 3 parts on one side and 4 parts on the other, or these numbers might be reversed.

C&S showed that a sufficient condition for monotonicity is (something slightly weaker than) $M_1^R + M_2^R \leq 0$ and $M_1^S + M_2^S \geq 0$. An alternative and perhaps more intuitive sufficient condition for monotonicity is available, however.

Lemma 2 *Monotonicity is implied by I^R having steeper isoquants than U^S in (y, a) space, i.e., by*

$$\frac{I_1^R}{I_2^R} \leq \frac{U_1^S}{U_2^S}.$$

(Non-trivial proofs are in the Appendix.) Note that all isoquants of both I^R and U^S are in the $(+, +)$ direction.

Let us now collect together all of C&S's assumption we plan to use and call them *C&S's standard 1D cheap talk* assumptions. These assumptions are: $[\underline{a}, \bar{a}] \subset [\underline{y}, \bar{y}]$, concavity $M_1 < 0$ and sorting $M_2 > 0$ in preferences, monotonicity $da_i/dx > 0$, and either $M^S > M^R$ or $M^S < M^R$. We will from here on make these standard assumptions unless we state otherwise.

Let us also define a *mixed* agent T to be one for which $M^T = \theta M^R + (1-\theta)M^S$ for some function $\theta(y, a) \in [0, 1]$. A mixed agent has a marginal utility intermediate between the sender S and receiver R. (Both S and R are mixed agents.) Finally, let us define z_n to be the y_0 in the n step equilibrium of the basic game. z_n is the lowest act the receiver would voluntarily take.

Given monotonicity and a positive sender bias, we can show that both the sender and receiver, or any mixed agent in between, ex-ante prefers an n step equilibrium of the basic game to an n step equilibrium of the extended game where $z_n \geq x = y_0$. Such a forced act is the lowest act taken in equilibrium, and is no higher than the lowest act taken when no forced act is possible.

Lemma 3 *Given $M^S \geq M^R$, any mixed agent prefers an n step equilibrium of the basic game to an n step equilibrium of the extended game where $z_n \geq x = y_0$. The preference is strict if the* *equilibria are distinct.*

We can also show that one can't get any more equilibrium steps by introducing a lowest-taken forced act x that is within the range of the actions the receiver might take if she were fully informed.

Lemma 4 *Given $M^S > M^R$, for any n step equilibrium of the extended game where $\underline{a} \le x = y_0$, there exists an n step equilibrium of the basic game.*

Putting together lemmas 3 and 4, we can conclude that for $M^S > M^R$ and $y_0 = x \in [\underline{a}, z_n]$, a mixed agent ex-ante prefers the basic game.

Theorem 1 *Given C&S's standard 1D cheap talk assumptions, and $M^S > M^R$, for any n step equilibria of the extended game where $y_0 = x \in [\underline{a}, z_n]$, there exists an n step equilibrium of the basic game which any mixed agent ex-ante prefers. This preference is strict if the equilibria are distinct.*

Since both S and R are mixed agents, an immediate corollary is that both S and R ex-ante prefer the basic game in this situation.

One of the standard 1D cheap talk assumptions is that $\underline{y} \le \underline{a}$, which implies says that there is a distinct best action $\bar{y}(a)$ for the receiver for any true signal a. In the product quality domain this is equivalent to saying that quality cannot be negative; there is only one fully-known quality level where none of the product would be purchased.

We can also extend the result of theorem 1 to the case where, while holding $\underline{a}$ fixed, we allow $\underline{y}$ to vary up into the range where $\underline{y} > \underline{a}$. This allows for negative product quality.

Let us define $\hat{z}_\infty = \max(\underline{y}, \underline{a})$, the lowest action the receiver would take given full information. Let us also define $\hat{z}_n = \max(\underline{y}, z_n)$, where z_n is as before, the y_0 of the n step equilibria of the basic game where $\underline{y} \le \underline{a}$. Then $\hat{z}_n$ must be the y_0 of the n step equilibria of the basic game, assuming it exists, for any value of $\underline{y}$. (For $\underline{y} \le z_n$ the equilibria is not changed, and for $\underline{y} > z_n$, monotonicity requires $y_0 = \underline{y}$.) Using these definitions, we can express a more general result.

Theorem 2 *Given C&S's standard 1D cheap talk assumptions, except that we allow $\underline{y} \ge \underline{a}$, and given $M^S > M^R$, for any n step equilibria of the extended game where $y_0 = x \in [\hat{z}_\infty, \hat{z}_n]$, there exists* *an n step equilibrium of the basic game which any mixed agent ex-ante prefers. This preference is strict if the equilibria are distinct.*

4 Applications

These general results translate to the domain of product bans as follows. Assume that if any positive amount of the product is purchased, consumers will purchase more of it when they expect it to be of a higher quality. Assume that the regulator has private information about product quality, but that if consumers knew what regulators know, the regulator would prefer consumers to buy more of the product than they actually would. And assume that the socially ideal product quantity is somewhere between these two amounts.

Assume that a product "ban" results in a situation equivalent to that where unconstrained consumers expect some low quality level, without any further enforcement costs or losses. Finally, assume that the amount of the product purchased under a ban is somewhere between the amount which would be purchased if consumers were certain that the product was of the worst possible quality, and the amount which would be purchased if the not-entirely trusted regulator, with no authority to ban, simply declared the product to be in the worst possible quality category.

Given these assumptions, neither the regulator, nor an agent who most preferred the quantity that unconstrained quality-informed consumers would choose, nor an agent who cared only about social welfare, would ex-ante prefer that the regulator have the authority to ban the product. With bans possible, however, the regulator will sometimes choose bans in equilibrium.

How well can we use this cheap talk model of product bans to understand real-world product bans? Do any categories of real bans fit the above description of bans which should be attributed to commitment failures?

The United States has largely committed to not banning print media. Such a commitment would make sense in terms of our model if the writers of the U.S. Constitution expected to largely agree with later regulators, who they expected would typically estimate that people tend to under-consume print media, given media of a known quality.

We can also make sense of the failure of the U.S. political process to extend this ban to electronic media such as radio and television (de Sola Pool, 1983), if we assume that more recent regulators did not expect people to under-consume electronic media of known quality. That is, whereas political elites once believed that the public should be encouraged to read more, political elites today aren't so sure the public should be encouraged to watch more television.

What about health, finance, and law, three large areas where consumers choices are now limited?

Regarding health and safety, health elites and regulators seem to prefer citizens to be healthier than they choose themselves to be, even when citizens are equally informed about how to become healthy. Citizens are subject to a blizzard of health advice explaining how to become healthier, most of which seems to imply that this would be a wise choice. For example, health elites actively discourage smoking, even though smokers seem to overestimate the risks of smoking (Viscusi, 1992b). Similarly, even though most everyone must know by now that exercise is healthy, public health messages encouraging more exercise seem to outnumber messages encouraging less exercise by a large factor.

If most consumers perceive that health and safety policy and advice is strongly influenced by "goody two shoes" public health-niks who are overly concerned about health relative to other things, then consumers will naturally discount official health and safety advice. Health policy elites would then note that consumers are not very responsive to health advice, and perhaps attribute this to irrationality or other cognitive barriers to appreciating the advice. And so such elites would likely favor bans on products they expect to be especially harmful to health, and favor requirements for products they expect to be especially helpful for health.

Thus if health regulators prefer people to be healthier, we can make sense of required health purchases such as Medicare and required health plan features. We can also make sense of bans on "recreational" drugs, which feel good but may harm health, and on muscle-building or weight-loss drugs where improved appearance may come at the expense of reduced health. Bans on specific food, drugs and medical devices which claim to mainly improve health, and bans on unlicensed health professionals, however, would seem to be examples of political commitment failure.

In finance, one often hears laments that citizens save too little, and very rarely hears complaints that they save too much. We can thus make sense of required savings plans, such as Social Security is claimed to be, in terms of finance regulators who think people save too little, even when uncertainty about investment quality is not an issue. Bans on specific investments of uncertain quality, however, such as unapproved stocks and commodity futures, might be attributed to a political commitment failure.

In law, regarding professional licensing we should ask whether regulators think that, setting aside issues of the quality of any one lawyer, people are too likely or too unlikely to hire a lawyer. Regarding freedom of contract, we should ask whether judges think that people make too many or too few formal contracts with one another. We can make sense of professional licensing and limits to freedom of contract if regulators think people are too quick to sue one other and to resort to formal contracts. On the other hand, if regulators think people don't sue each other often enough, or make too few formal contracts, then these legal limits may be commitment failures.

Our general results can also be translated to the domain of a parent concerned about a child's activity level, for an activity of uncertain value. Assume that the child would want to do more of the activity if it had higher value. Assume that for any given value level known to both parent and child, the parent would prefer a higher activity level than the child would choose, and that an ideal external observer would prefer some activity level between these. Assume the parent knows more about value than the child. Finally, assume that if the parent were to "ban" this activity, the resulting activity level would be somewhere between what the child would choose if certain that the value were the worst possible, and the level the child would choose if the not entirely-trusted parent, with no ability to ban, were to just tell the child that this activity is the worst.

Given these assumptions, neither the child, the parent, nor the external observer would ex-ante prefer that the parent be able to ban the activity. Given the power to ban, however, a parent will choose to ban activities she estimates to be of low value.

Can this model explain paternalistic behavior by parents, and can we identify potential commitment failures in this context?

The basic elements of this model seem to be present. Parents quite often have better information than their children. And while the interests of parents and children are closely aligned, they are hardly identical (Barkow, Cosmides, & Tooby, 1992; Harris, 1998). One might question the assumption that children are rational agents, but many studies do suggest that the rationality of nine and fourteen year old children in making such decisions is comparable to that of adults (Melton et al., 1983).

For example, all else equal parents prefer their children to become allies in parental social networks, i.e., to mate with the children of other allies, to work in the family business, to live nearby, and to adopt customs accepted in parental social networks. This can make children skeptical about parental advice regarding fashions, lines of work, and potential mates. And this skepticism can lead parents to ban disapproved friends, dates, or clothing.

Also, children care more than their parents about "fun," i.e., building relations with peers and learning child-chosen skills, than "work," i.e., learning parent-chosen skills and contributing to household production. This can make children skeptical about parental advice regarding the harms from various kinds of fun, leading parents to ban sometimes fun activities, like drinking or driving.

Activities that parents ban seem to agree with the sign, if not the magnitude, of identified parental biases. Thus we have not identified any potential parental commitment failures.

5 Conclusion

This paper presents a game-theoretic model of product bans. This model combines the regulator information explanation of product bans with at least a small amount of one of the other reasons for banning products.

The basic intuition is that when a "nanny" keeps dangerous things out of a "child's" reach, that child becomes more complacent about possible harms. This in turn encourages "paternalism" in the nanny, who is unwilling to live with the consequences when complacence encounters real danger. When this child knows that the nanny must treat them as an "adult," however, and can only warn them about dangers, they become more cautious. And if, given equal information, the nanny is less concerned about possible harms than the child, they are both better off if the child is treated as an adult. This intuition applies to the relationship between parents and children, and to the relation between a "nanny state" regulator and its citizens.

This intuition is formalized in a simple model of a one-dimensional choice set and a single extreme action which can be forced. Focusing on the product ban application, we imagine that regulators have quality information not otherwise available to fully rational consumers, and that they care only about the market outcomes which result from their signals, and not about the signals themselves. We assume at least some small degree of either regulator capture or market failure, such as a signaling, non-competitive market, or externality problem. Finally, and probably most limiting, we assume that product labeling or banning are the only policy options available to the regulator.

Given these assumptions, regulator labeling is a cheap talk signaling game, and so there are cases where the regulator would rather ban a product than live with the consequences of consumers who don't believe their labeling advice, but who may nonetheless hold the regulator accountable for the consequences of consumer choices.

Giving the regulator the ability to ban products changes the equilibria, and we have identified a general class of situations in which the ability to ban reduces social welfare. These are situations where the regulator would never ban the product if consumers knew what she knew, since she would then prefer even more consumption than consumers would choose. If regulators would not ban the product for informed consumers, they should not be allowed to ban the product for uninformed consumers.

When bans are ex-ante worse, product bans can be viewed as commitment failures. Without a commitment not to ban, regulators will want to ban sometimes, and consumers will base their inferences on this possibility. With a commitment not to ban, consumers make different inferences, to their ex-ante benefit. A commitment not to ban can also align the ex-ante preferences of all groups toward minimizing the magnitude of regulator bias.

Using this cheap talk model of product bans, we can understand the constitutional protection of print but not electronic media in terms of regulatory elites wanting to promote reading but not television. We can also understand required purchases of health care and savings in terms of regulatory elites prefering people to be healthier and to save more than they do. These assumptions, however, suggest that licensing of health professionals bans on health-promoting drugs and medical devices, and bans on various investments, may be political commitment failures.

There are many directions for future work. It would be nice to better characterize when bans are ex-ante better in the case of negative regulator bias, to consider bias functions which can be zero at points, and to consider the case where a regulator can choose to either ban or require a product. It is also important to examine the degree to which the cheap talk aspect of regulator advice is broken by repeated play with some later information revelation to consumers about true product quality.

Beyond this, we might consider imperfect enforcement, imperfect commitments to not ban, and regulator powers to place taxes or subsidies on products. We might allow consumers to be uncertain about regulator bias. And we might let regulators signal via "burned money," such as purposely expensive advertising (Austen-Smith & Banks, 2000), or some other means. We might also model the case where one or more private information sources can also certify the product, and we might explicitly model exogenous label-reading costs and ban enforcement costs. Finally, we might consider a model with endogenous quality, where producers decide what products to develop and market.

Empirical work to illuminate the range of application of this model is also appropriate. Lab experiments could verify that people really do play according to one of the analyzed equilibria of such games, and data on the rates and correlates of activity bans which parents impose on their nearly-mature children could be informative.

Finally, the correlates of regulator product bans may help us to confirm or reject this cheap talk model of such bans. This model predicts political debates focused on quality levels, predicts that bans will focus on new unfamiliar harms about products where better regulator information is plausible, predicts bans by regulators biased in favor of a product, and predicts large rates of bans from small levels of bias.

The model also suggests larger rates of product bans from regulators whose advice consumers treat more skeptically. Finally, the model suggests that voters and candidates will be unreceptive to proposals for ban-exceptions using special stores and tests, and suggests that consumer disregard for product labels is due more to skepticism than to cognitive processing limits. One or more of these predictions may be testable empirically.

6 Appendix

6.1 Quadratic Preferences from Linear Supply & Demand

Let us first consider product bans in a case of not fully competitive markets with linear supply and demand. Specifically, let us consider two products, 1 and 2, with linear supply, i.e., industry marginal cost, given by

$$MC_1 = a_1 + b_1 Q_1$$

$$MC_2 = a_2 + b_2 Q_2$$

and linear demand, i.e., consumer marginal value, given by

$$MV_1 = c_1 - d_1 Q_1 - e_1 Q_2$$

$$MV_2 = c_2 - d_2 Q_2 - e_2 Q_1.$$

We assume non-negative slope coefficients $b_1, b_2, d_1, d_2, e_1, e_2$, and assume $d_1 d_2 > e_1 e_2$ to ensure the familiar sign of slopes in expressions like $Q_1 = A_1 - \alpha_1 MV_1 + \beta_1 MV_2$.

We also assume Cournot competition. Each of n_1 identical producers of product 1, facing an individual marginal cost of $MC_i = a_1 + n_1 b_1 Q_{1i}$, simultaneously chooses its quantity Q_{1i}. At the same time, n_2 identical producers of product 2 similarly choose Q_{2i}. Then consumers drive prices to their marginal value at the quantities produced, as in $P_1 = MV_1(Q_1, Q_2)$ with $Q_1 = \sum_{i=1}^{n_1} Q_{1i}$, and similarly for P_2 and Q_2.

Defining marginal welfare loss to be $L_1 = MV_1 - MC_1$, the Cournot equilibrium satisfies $L_1 = (d_1/n_1)Q_1$. Thus welfare loss is positive, but decreases as more firms compete (n_1 larger), as demand becomes more inelastic (d_1 smaller), and as total demand decreases (Q_1 smaller). (This last dependence on quantity may be an artifact of holding the number of firms fixed as quantity decreases, rather than modeling the entry and exist of firms from each industry.)

Defining

$$f_1 = \frac{1}{e_1}(d_1 \frac{n_1 + 1}{n_1} + b_1), \qquad g_1 = \frac{c_1 - a_1}{e_1}$$

(and L_2, f_2, and g_2 similarly, with the labels 1 and 2 switched), we can write the equilibrium quantities as

$$Q_1 = \frac{f_1 g_1 - g_2}{f_1 f_2 - 1}, \qquad Q_2 = \frac{f_2 g_2 - g_1}{f_1 f_2 - 1}.$$

Consider now the consequences of varying the quality q of product 1, which varies the parameter $c_1 = q + \tilde{c}_1$ while holding constant n_1, n_2 and all the other supply and demand parameters. The quantities $Q_1(q), Q_2(q)$ then vary linearly with g_1, and hence linearly with q, and they vary in opposite directions. At $Q_1 = 0$, $Q_2 = \bar{Q}_2 = g_2/f_1$ and at $Q_2 = 0$, $Q_1 = \bar{Q}_1 = g_2$.

For example, in the symmetric case where $a_1 = a_2 = 0$, $b_1 = b_2 = 0.5$, $c_2 = 1$, $d_1 = d_2 = 1.2$, $e_1 = e_2 = 1$, and $n_1 = n_2 = 100$, as Q_1 varies over $[0, 1]$, c_1 varies over $[0.584, 1.712]$, Q_2 ranges over $[0.584, 0]$, P_1 ranges over $[0, 0.512]$, and P_2 ranges over $[0.299, 0]$. All these variables are linear in c_1, and hence are linear in each other.

Risk-neutral consumers who are symmetrically uncertain about quality q will act according to their common expectation of quality $\hat{q} = \mathrm{E}[q]$, inducing a market quantity $\hat{Q} = Q_1(\hat{q})$, instead of the quantity $Q = Q_1(q)$ which would be induced by perfect information. Incentives for any agent to deceive consumers about product quality can then be described by the way in which that agent's payoff changes with consumer expectation $\hat{q}$, given a fixed true quality q.

Let π_1, π_2 be the producer profits for the two industries, let π_C be consumer surplus, let $W_0 = \pi_C + \pi_1 + \pi_2$ be total welfare given equal welfare weights, and for any X let $X' = dX/d\hat{q}$ evaluated at $\hat{q}$. Then we can write the change in welfare W_0 with perceived quality $\hat{q}$ as

$$W_0' = (q - \hat{q} + L_1)Q_1' + L_2 Q_2',$$

which combines the consequences of quality misperceptions with the welfare losses of non-competitive markets.

In the competitive limit ($n_1, n_2 \to \infty$), W_0 is maximized at $q = \hat{q}$, so someone seeking to maximize total welfare would have no incentive to deceive consumers about quality. For a finite number of firms, however, this expression W_0' can be non-zero even when $q = \hat{q}$. This is because quantity increases due to misperceptions of product quality can be used to compensate for quantity reductions due to non-competitive markets.

Further incentives to deceive consumers about quality can arise from use externalities, or from not giving equal welfare weights to the three groups, consumers and two producer industries, as in $W_\gamma = W_0 + \gamma_1 \pi_1 + \gamma_2 \pi_2$, with γ_1, γ_2 being the weight *deviations* of the two producer industries.

Before describing these more general incentives in detail, let us note that since W_0' and all π_j' are linear in both q and $\hat{q}$ (e.g., $\pi_1' = L_1 Q_1' + \hat{Q}_1 MV_1'$), all preferences are quadratic in $\hat{q}$, with a convexity W_γ'' independent of q. For agents with such quadratic preferences, we need only consider their ideal points. For such quadratic agents, we can also generalize our information structure; q and Q can now refer to the expected value of quality and quantity using the regulator's superior but not necessarily full information.

Thus we need only consider such an agent's *bias*, defined as the difference $\beta(Q) = \hat{Q}^* - Q$, where ideal point $\hat{Q}^*$ solves $W_\gamma' = 0$ for a given Q. Bias is the difference between the true quantity $Q = Q_1(q)$ and the ideal quantity $\hat{Q} = Q_1(\hat{q})$ one would like consumers to believe. A bit of algebra then reveals that

$$\beta(Q) = \frac{(H_1 + H_2)Q - H_2 \bar{Q}_1}{H_0 + H_1 + H_2}$$

where $H_0 = e_1 f_1 (f_1 f_2 - 1)$ and

$$H_1 = \gamma_1 H_0 + \gamma_1 f_1 (e_2 - d_1 f_1) + (1 + \gamma_1) f_1^2 \frac{d_1}{n_1}$$

$$H_2 = \gamma_2 f_1(e_2 f_1 - d_2) + (1+\gamma_2)\frac{d_2}{n_2}.$$

To ensure the concavity of W_γ, we assume $H_0 > H_1 + H_2$. (Note that when we assume constant bias, we are essentially focusing on a particular one-dimensional subspace of the two-dimensional space of linear bias functions possible in this linear model.)

Bias vanishes, i.e., $\beta(Q^0) = 0$, at $Q^0 = \bar{Q}_1 H_2/(H_1 + H_2)$. The sign of the bias changes at this boundary, and for $Q > Q^0$, $\text{sign}(\beta) = \text{sign}(H_1 + H_2)$. Thus when Q^0 lies in $[0, \bar{Q}_1]$, $H_1 + H_2 > 0$ gives an *outward* bias, toward the extremes, while $H_1 + H_2 < 0$ gives an *inward* bias, toward the boundary Q^0. When $H_1 + H_2 = 0$, the bias is *constant*.

In the special case of zero weight deviations, $\gamma_1 = \gamma_2 = 0$, the bias is outward with $Q^0 = n_1 d_2 \bar{Q}_1/(n_1 d_2 + n_2 d_1 f_1^2)$. For example, as quality q rises so that Q_2 goes to zero, the welfare loss from a not fully competitive market in product 2 also falls to zero, while the welfare loss from a not fully competitive market in product 1 gets larger. In this case, one might prefer that consumers overestimate the quality of product 1 to compensate for the producer's strategic reductions in the quantity of that product.

In the special case of fully competitive markets ($n_1, n_2 \to \infty$), we can write $H_1 = \gamma_1 \tilde{H}_1$ and $H_2 = \gamma_2 \tilde{H}_2$, with $\tilde{H}_1, \tilde{H}_2$ independent of γ_1, γ_2. Thus for $\gamma_2 = 0$ and $\gamma_1 > 0$, $Q^0 = 0$ and for positive Q, bias β is positive for $\tilde{H}_1$ positive. That is, someone who gives extra weight only to producers of product 1 prefers consumers to overestimate the quality of that product. Similarly, for H_2 positive someone who gives extra weight only to producers of product 2 prefers consumers to underestimate the quality of product 1.

For example, in the specific symmetric example described earlier, with $n_1 = n_2 = 100$, zero weight deviations $(\gamma_1, \gamma_2) = (0, 0)$ imply an outward bias that ranges over $[-0.00368, 0.01079]$ as Q ranges over $[0, 1]$, with a zero bias at $Q^0 = 0.254$. That is, with one hundred competing firms for each of two symmetric products, bias is a bit less that one part in a hundred, and toward overestimating quality over most of the quality range. Exactly zero bias can come from symmetric negative deviations for both producers, specifically $(\gamma_1, \gamma_2) = (-0.0229, -0.0229)$. A constant negative bias of -0.01 comes from deviations $(\gamma_1, \gamma_2) = (-0.0444, 0.0402)$, while a constant positive bias of 0.01 comes from deviations $(\gamma_1, \gamma_2) = (-0.00138, -0.0860)$.

Let us assume that regulators just care about the consequences of their actions for consumer and producer welfare, and not more directly about the act itself. Thus in the above example we assume our regulator seeks to maximize W_γ for some values of γ_1, γ_2. Having a regulator maximize a linear

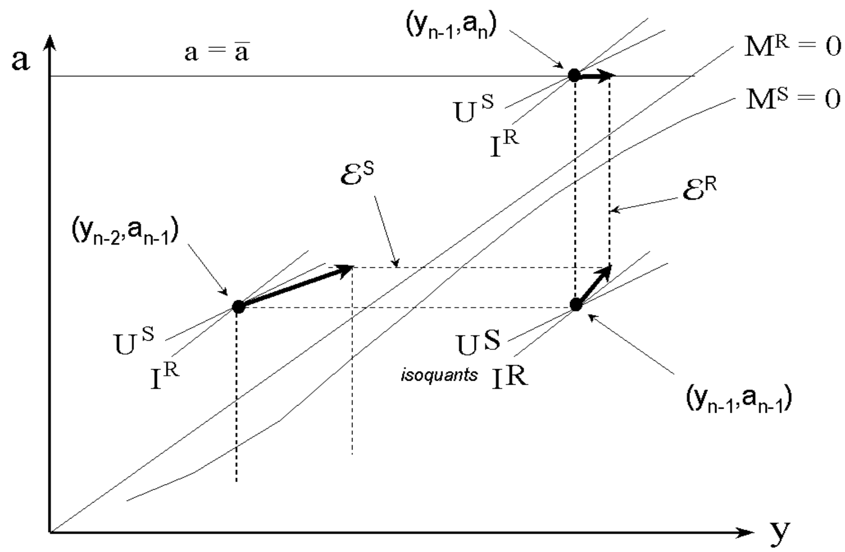

Figure 2: Aid To Monotonicity Proof

welfare function such as this is a standard assumption in the economics of regulation literature (Laffont & Tirole, 1993).

Note that this assumption ignores the internal structure of the regulatory process, such as that examined by Hopenhayn and Lohmann (1996). We are implicitly assuming something like retrospective voting; come election day voters don't remember much about the specific actions taken by regulators, but they can estimate how happy they are with recent consequences in some regulatory area.

What are the ex-ante preferences of the various groups regarding product bans and regulator bias? If bans are not allowed, *all* groups ex-ante prefer that regulator bias be made as small as possible. The different groups have different ex-ante preferences, however, over bans and regulator bias given bans.

Specifically, producers of competing products ex-ante prefer that bans be allowed on this product, and given bans competing producers ex-ante prefer regulators to be biased as far as possible in their favor. Regulators also prefer bans be allowed when they are biased in favor of these competing producers. In contrast, potential consumers and producers of this product always ex-ante prefer no bans and a small bias, as do regulators biased in favor of these producers.

6.2 Proof of Lemma 2

PROOF: (See Figure 2.) An equilibrium can be thought of as a path through the (y, a) plane.

The forced act point (x, a_{i+1}) for $i = \hat{\imath}$ is connected by a horizontal line representing equation $\mathcal{E}_{i+1}^S$ to a point (y_{i+1}, a_{i+1}). A vertical line representing equation $\mathcal{E}_{i+1}^R$ then connects this to a point (y_{i+1}, a_{i+2}). This zig-zag pattern continues until a vertical line reaches the last point $(y_{n-1}, \bar{a})$. If x is interior, then going in the other direction from point (x, a_{i+1}), the zig-zag pattern ends at a vertical line reaching $(y_0, \underline{a})$.

As x varies, each point (y, a) will vary with some vector $(dy/dx, da/dx)$, and the equations corresponding to each line connect the vectors on the two ends of the lines. The $\mathcal{E}_i^S$ equations say that if the vector on one side of a horizontal line cuts the U^S isoquants so as to move toward lower U^S, the other side must cut in the opposite direction, so as to also move toward lower U^S. Since points connected by lines are on opposite sides of the maximal Q^S (i.e., $M^S = 0$) curve, opposite movement means they both move “inside” (toward $M^S = 0$), or both move “outside” (away from $M^S = 0$). Similarly, the $\mathcal{E}_i^R$ equations say that the vector must cut the I^R isoquants in opposite directions from the $y = x$ (i.e., $M^R = 0$) line at the two ends of a vertical line.

The end point $(y_{n-1}, \bar{a})$ must vary along the line $a = \bar{a}$, which as y_{n-1} increases must cut inside the isoquants of I^R. Thus at (y_{n-1}, a_{n-1}) the vector must also be inside I^R, and is hence positive, and the assumption of a steeper I^R vector implies inside U^S as well. Continuing, at (y_{n-2}, a_{n-1}) the vector must cut inside U^S and be positive, which is now also inside I^R, since we are on the other side of $M^S = 0$.

Since all the constructions leave the vector in the $(+, +)$ direction, the vector at (x, a_{i+1}) is also in this direction, and so all da/dx and dy/dx are positive for $i > \hat{\imath}$. The same argument applies when starting from end point (y_0, r) which varies along the line $a = \underline{a}$, implying that all dy/dx and dy/dx are positive for $i < \hat{\imath}$. QED.

6.3 Proof of Lemma 3

In general ex-ante expected utility for any agent is

$$E[U] = \sum_{i=0}^{n-1} \int_{a_i}^{a_{i+1}} U(y_i, a) dF(a).$$

To compare utility between equilibria, we will continuously vary one equilibrium into another, and in a way such that the local derivative of $E[U]$ along the way maintains the same sign. (This proof closely follows C&S's proof of their theorem three.)

Let us define y_{-1} to be the solution to $\mathcal{E}_0^S(y_{-1}, \underline{a}, z)$. For $x < y_{-1}$, S never chooses x, so the extended and basic equilibria are identical.

For $x \geq y_{-1}$, as we vary $x = y_0$ in the extended game from y_{-1} to x to z, we move from an equilibria with the same y_i as an $n+1$ step solution of the basic game over $[y_{-1}, \bar{a}]$, to an n step solution of the extended game on $[\underline{a}, \bar{a}]$, to an n step solution of the basic game on $[\underline{a}, \bar{a}]$. (All the while we hold $[\underline{a}, \bar{a}]$ fixed.) Along this path, the local derivative of $E[U]$ with respect to x is

$$\frac{dE[U]}{dx} = \sum_{i=0}^{n-1} \left(\frac{dy_i}{dx} \int_{a_i}^{a_{i+1}} M(y_i, a) dF(a) - \frac{da_i}{dx} \int_{y_{i-1}}^{y_i} M(y, a_i) dy \right).$$

Given monotonicity all the da_i/dx and dy_i/dx are positive.

For S, the second integral is exactly zero for all i, and so given $M^S \geq M^T$, for T this integral term contributes non-negatively. For R the first integral is exactly zero for all $i \neq 0$, and for $i = 0$ is positive for any $x \in [y_{-1}, z)$, since x is less than R's ideal $\bar{y}(r, a_1)$ where this integral is zero. (x is clearly less at $x = \underline{a}$, and by continuity stays less across this range; otherwise it would be equal somewhere between, identifying another n step solution of the basic game, which contradicts monotonicity.) Thus for T the first integral contributes positively.

Thus the sum is positive, and so T strictly prefers a distinct n step equilibrium of the basic game to an extended n step equilibrium for $x \geq r$. QED.

6.4 Proof of Lemma 4

PROOF: We need to show that for $\underline{a} \leq x = y_0$ and $M^S > M^R$, introducing the forced act x does not increase the number of equilibrium steps possible, i.e., that $N \geq \hat{N}(x)$.

Let us focus first on $x = \underline{a}$ in the extended game. And let us consider allowing the range $[\underline{a}, \bar{a}]$ to vary within a larger range $[\underline{r}, \bar{r}]$. A varying $F_{\underline{a},\bar{a}}$ will be obtained by conditioning on a differentiable c.d.f $G(a)$ with support $[\underline{r}, \bar{r}]$, as in

$$F_{\underline{a},\bar{a}}(a) = \frac{G(a) - G(r)}{G(r') - G(r)}.$$

Observe that since the equations $\mathcal{E}_i^S, \mathcal{E}_i^R$ are in terms of continuous functions of the a_i, y_i, their solutions vary continuously as we vary $\underline{a}$, in both the case where $\underline{a} = x$ and where there is no forced act. The only thing preventing one from taking a solution with n steps over range $[\underline{a}, \bar{a}]$ and collapsing it all the way to $[\bar{a}, \bar{a}]$ is that at some point the solutions found this way will begin to violate one of the constraints $a_i \leq a_{i+1}$ or $y_{i-1} \leq y_i$.

If there were a sequence of solutions to $\mathcal{E}_i^S$ approaching $y_{i-1} = y_i$, then we would have $M^S(y_{i-1}, a_i) = 0 \geq M^R(y_{i-1}, a_i)$. $M_2 > 0$ and $\mathcal{E}_{i-1}^R$ imply that if this $M^R(y_{i-1}, a_i)$ is zero, then $a_i = a_{i-1}$, and otherwise $\mathcal{E}_{i-1}^R$ has no solution. Thus as r increases, $N_{rr'}$ and $\hat{N}_{rr'}$ can decrease only immediately after the r points which have *boundary solutions* where $a_i = a_{i+1}$ for some i.

$\mathcal{E}_i^R$, $M_2^R > 0$, and $M^R(y, y) = 0$ imply that if any two of a_i, y_i, a_{i+1} become equal, all three must be equal. Similarly, $M^S \geq M^R$, $M^R(y, y) = 0$, and $M_1 < 0$ imply that $\mathcal{E}_i^S$ has no solution for $y_{i-1} < a_i = y_i$. Taken together these imply that boundary solutions must satisfy $\underline{a} = a_0 = a_1$, in both the basic and extended game, with $a_i < a_{i+1}$ for all $i > 0$. In the basic game $\mathcal{E}_0^R$ implies $y_0 = a_0$, while in the extended game $x = \underline{a}$ implies the same thing. Thus both games will have a boundary solution for a given $\underline{a}$ if either does. Since for $\underline{a} = \bar{a}$ we have $N = \hat{N} = 1$, and since $N, \hat{N}$ change by one unit at a time, we must have $N_{\underline{a}\bar{a}} = \hat{N}_{\underline{a}\bar{a}}$ for all $\underline{a}, \bar{a}$ for $x = \underline{a}$.

Now consider forced acts $y_0 = x \geq \underline{a}$. For any equilibrium of the extended game with $x = y_0$, a_0 only appears in the constraint $\underline{a} = a_0 \leq a_1$. Thus given such an equilibrium, we can construct other equilibria on other ranges by simply varying $\underline{a} = a_0$ within $[\underline{r}, a_1]$. This implies that for $y_0 = x \geq \underline{a}$, $N_{\underline{a}\bar{a}} \geq \hat{N}_{\underline{a}\bar{a}}(x)$.

Thus for any equilibria of the extended game meeting the conditions, there is an equilibria of the basic game with at least as many steps. QED.

6.5 Proof of Theorem 2

The only change that $\underline{y} > \underline{a}$ induces in the basic game that in some equilibria the equation $\mathcal{E}_0^R$, which is $\bar{y}(\underline{a}, a_1) = \underline{y}$, is replaced by $y_0 = \underline{y}$ when $\bar{y}(\underline{a}, a_1) < \underline{y}$. Since $\hat{z}_\infty = \max(\underline{y}, \underline{a})$ and $\hat{z}_n = \max(\underline{y}, z_n)$, then $x \in [\hat{z}_\infty, \hat{z}_n]$ is the same as $x = \underline{y}$ or $x \in [\underline{a}, z_n]$. For $x = \underline{y}$ then, if there is an n step equilibrium of the extended game, then the only way there can fail to be an identical n step equilibrium of the basic game is if $\bar{y}(\underline{a}, a_1) > \underline{y}$ for the a_1 of this extended equilibrium. But by monotonicity $\underline{y} < z_n$, and so in this case $x \in [\underline{a}, z_n]$. For this condition, the n step basic game equilibria exists without modification from the $\underline{y} \leq \underline{a}$ case. Here the result of theorem 1 applies directly. QED.

References

Aghion, P., & Hermalin, B. (1990). Legal Restrictions on Private Contracts Can Enhance Efficiency. *Journal of Law, Economics, and Organization*, *6*(2), 381–409.

Akerlof, G., & Dickens, W. (1982). The Economic Consequences of Cognitive Dissonance. *American Economic Review*, *72*, 307–319.

Andersson, F. (1996). Income taxation and job-market signaling. *Journal of Public Economics*, *59*, 277–298.

Austen-Smith, D. (1990). Information Transmission in Debate. *American Journal of Political Science*, *34*(1), 124–152.

Austen-Smith, D., & Banks, J. S. (2000). Cheap Talk and Burned Money. *Journal of Economic Theory*, *91*(1), 1–16.

Banks, J. S., & Sundaram, R. K. (1993). Adverse selection and moral hazard in a repeated elections model. In Barnett, Hinich, & Schofield (Eds.), *Institutions, Competition and Representation*. Cambridge University Press.

Barker, J. M. (1905). *The Saloon Problem and Social Reform*. The Everett Press, Boston.

Barkow, J. H., Cosmides, L., & Tooby, J. (1992). *The Adapted Mind: Evolutionary Psychology and the Generation of Culture*. Oxford University Press, New York.

Bester, H. (1998). Quality Uncertainty Mitigates Product Differentiation. *Rand Journal of Economics*, *29*(4).

Blume, A. (1996). Information Transmission and Preference Similarity. Tech. rep..

Boom, A. (1995). Asymmetric international minimum quality standards and vertical differentiation. *Journal of Industrial Economics*, *43*, 101–119.

Browne, M. J., & Doerpinghaus, H. I. (1993). Information Asymmetries and Adverse Selection in the Market for Individual Medical Expense Insurance. *Journal of Risk and Insurance*, *60*(2), 300–312.

Burkholz, H. (1994). *The FDA Follies*. Basic Books, New York.

Burrows, P. (1993). Patronizing Paternalism. *Oxford Economic Papers*, *45*, 542–572.

Cawley, J., & Philipson, T. (1999). An Empirical Examination of Information Barriers to Trade in Insurance. *American Economic Review*, *89*(4).

Coate, S., & Morris, S. (1995). On the Form of Transfers to Special Interests. *Journal of Political Economy*, *103*(6), 1210–1235.

Constantatos, C., & Perrakis, S. (1998). Minimum quality standards, entry, and the timing of the quality decision. *Journal of Regulatory Economics*, *13*(1), 47–58.

Crawford, V. P., & Sobel, J. (1982). Strategic Information Transmission. *Econometrica*, *50*(6), 1431–51.

de Sola Pool, I. (1983). *Technologies of freedom*. Belknap Press, Cambridge, Mass.

Diamond, P. (1992). Organizing the Health Insurance Market. *Econometrica*, *60*(6), 1233–1254.

Eisenberg, M. A. (1995). The Limits of Cognition and the Limits of Contract. *Stanford Law Review*, *27*, 211–259.

Farrell, J., & Gibbons, R. (1989). Cheap Talk with Two Audiences. *American Economic Review*, *79*(5), 1214–1223.

Feinstein, R. J. (1985). The Ethics of Professional Regulation. *The New England Journal of Medicine*, *312*(12), 801–804.

for Health, A. S. (1987). Review of the research literature on the effects of health warning labels: a report to the United States Congress. Tech. rep., Department of Health and Human Services, Washington, D.C.

Frank, R. H. (1985). *Choosing the Right Pond, Human Behavior and the Quest for Status*. Oxford University Press, New York.

Gale, D. (1997). Spoiled for Choice: Variety and Efficiency in Markets with Incomplete Information. *Research in Economics*, *51*(1), 41–67.

Gehrig, T., & Jost, P.-J. (1995). Quacks, Lemons, and Self Regulation: A Welfare Analysis. *Journal of Regulatory Economics*, *8*(3), 309–325.

Gieringer, D. H. (1985). The Safety and Efficacy of New Drug Approval. *Cato Journal*, *5*(1).

Gigler, F. (1994). Self-Enforcing Voluntary Disclosures. *Journal of Accounting Research*, *32*(2), 224–240.

Harris, J. R. (1998). *The Nurture Assumption, Why Children Turn Out The Way They Do*. The Free Press, New York.

Hemenway, D. (1992). Propitious Selection in Insurance. *Journal of Risk and Uncertainty*, *5*, 247–251.

Higgs, R. (1995). *Hazardous to Our Health? FDA Regulation of Health Care Products*. The Independent Institute, Oakland, California.

Hopenhayn, H., & Lohmann, S. (1996). Fire-Alarm Signals and the Political Oversight of Regulatory Agencies. *Journal of Law, Economics, and Organization*, *12*(1), 196–213.

Ireland, N. (1994). On limiting the market for status signals. *Journal of Public Economics*, *53*, 91–110.

Isaac, P. E. (1965). *Prohibition and Politics, Turbulent Decades in Tennessee, 1885-1920*. University of Tennessee Press, Knoxville.

Jensen, G. (1992). Regulating the Content of Health Plans. In Holmes, R. (Ed.), *American Health Policy: Critical Issues for Reform*, pp. 167–193. AEI Press, Washington, D.C.

Johnson, B., Goldstein, P., Preble, E., Schmeidler, J., Lipton, D., & Spunt, B. (1985). *Taking Care of Busines, The Economics of Crime by Heroin Abusers*. Lexington Books, Toronto.

Kaplow, L., & Shavell, S. (1998). On the Superiority of Corrective Taxes to Quality Regulation..

Kelman, S. (1981). Regulation and Paternalism. *Public Policy*, *29*(2).

Kennedy, D. (1982). Distributive and Paternalistic Motives in Contract and Tort Law, With Special Reference to Compulsory Terms and Unequal Bargaining Power. *Maryland Law Review*, *41*(4), 563–658.

Laffont, J.-J., & Tirole, J. (1993). *A Theory of Incentives in Procurement and Regulation*. MIT Press, Cambridge, Massachusetts.

Lambert, D. A., & McGuire, G. (1990). Political and Economic Determinants of Insurance Regulation in Mental Health. *Journal of Health, Policy, and Law*, *15*(1).

Landers, R. M., Rebitzer, J. B., & Taylor, L. J. (1996). Rat Race Redux: Adverse Selection in the Determination of Work Hours in Law Firms. *American Economic Review*, *86*(3), 329–348.

Leffler, K. B. (1978). Physician Licensure: Competition and Monopoly in American Medicine. *Journal of Law and Economics*, *21*(1), 165–186.

Leland, H. E. (1979). Quacks, Lemons and Licensing: A Theory of Minimum Quality Standards. *Journal of Political Economy*, *87*(6), 1328–46.

Levy, B., & Spiller, P. T. (1994). The Institutional Foundations of Regulatory Commitment: a Comparative Analysis of Telecommunications Regulation. *Journal of Law, Economics and Organization*, *10*(2), 201–46.

Lipset, S. M., & Schneider, W. (1979). The Public View of Regulation. *Public Opinion*, 6–13.

Lueck, D., Olsen, R., & Ransom, M. (1995). Market and Regulatory Forces in the Pricing of Legal Services. *Journal of Regulatory Economics*, *7*, 63–83.

Lupia, A., & McCubbins, M. D. (1996). *The Triumph of Reason: Knowledge and the Foundation of Democracy*.

Lutz, S. (2000). Trade Effects of Minimum Quality Standards With and Without Deterred Entry. *Journal of Economic Integration*, *15*(2), 314–44.

Magat, W. A., & Viscusi, W. K. (1992). *Informational approaches to regulation*. MIT Press, Cambridge, Mass.

Maurizi, A. (1974). Occupational Licensing and the Public Interest. *Journal of Political Economy*, *82*, 399–413.

Maxwell, J. W. (1998). Minimum quality standards as a barrier to innovation. *Economics Letters*, *58*, 355–360.

Mayer, R. N., Smith, K. R., & Scammon, D. L. (1991). Read Any Good Labels Lately? Evaluating the Impact of Alcohol Warning Labels. In Mayer, R. N. (Ed.), *Enhancing Consumer Choice, Proceedings of the Second International Conference on Research in the Consumer Interest* Columbia, Missouri. American Council on Consumer Interests.

Melton, G. B., Koocher, G. P., & Saks, M. J. (1983). *Children's Competence to Consent.* Plenum Press, New York.

Miller, R. L. (1991). *The Case For Legalizing Drugs.* Praeger, New York.

Mussa, M., & Rosen, S. (1978). Monpoly and Product Quality. *Journal of Economic Theory*, *18*, 301–317.

New, B. (1999). Paternalism and Public Policy. *Economics and Philosophy*, *15*(1), 63–83.

Novak, W. J. (1996). *The People's Welfare: Law and Regulation in Nineteenth-Century America.* University of North Carolina Press, Chapel Hill.

O'Donoghue, T., & Rabin, M. (1999). Doing It Now or Later. *American Economic Review*, *89*(1), 103–24.

Ordover, J. A. (1979). Products Liability in Markets with Heterogeneous Customers. *Journal of Legal Studies*, *8*, 505–25.

Park, J. (1988). *A General Strategic Information Transmission.* Ph.D. thesis, University of California at San Diego.

Pearson, D., & Shaw, S. (1982). *Life Extension: A Practical Scientific Approach.* Warner Books, New York.

Posner, E. A. (1995). Contract Law in the Welfare State: A Defense of the Unconscionability Doctrine, Usury Laws, and Related Limitations on the Freedom to Contract. *Journal of Legal Studies*, *24*.

Rabin, M., & O Donoghue, T. (1997). Addiction and Self Control..

Radin, M. J. (1996). *Contested Commodities.* Harvard University Press, Cambridge, Massachusetts.

Ronnen, U. (1991). Minimum quality standards, fixed costs, and competition. *RAND Journal of Economics*, *22*(4), 490–504.

Rothschild, M., & Stiglitz, J. (1976). Equilibrium in Competitive insurance markets; An essay on the economics of imperfect information. *Quarterly Journal of Economics*, *90*, 629–649.

Scarpa, C. (1998). Miniumum quality standards with more than two firms. *International Journal of Industrial Organization*, *16*, 665–676.

Schlee, E. E. (1996). The value of information about product quality. *Rand Journal of Economics*, *27*(4), 803–815.

Shaked, A., & Sutton, J. (1981). The Self-Regulating Profession. *Review of Economic Studies*, *48*, 217–234.

Shapiro, C. (1986). Investment, Moral Hazard, and Occupational Licensing. *Review of Economic Studies*, *53*, 843–862.

Shavell, S. (1987). *Economic Analysis of Accident Law*. Harvard University Press, Cambridge, Massachusetts.

Sobel, J. (1985). A Theory of Credibility. *Review of Economic Studies*, *52*, 557–573.

Spense, M. (1977). Consumer Misperceptions, Product Failure, and Product Liability. *Review of Economic Studies*, *77*, 561–572.

Stein, J. C. (1989). Cheap Talk and the Fed: A Theory of Imprecise Policy Annoucements. *American Economic Review*, *79*(1), 32–42.

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

Trebilcock, M. J. (1993). *The Limits of Freedom of Contract*. Harvard University Press, Cambridge.

Viscusi, W. K. (1992a). *Fatal tradeoffs: public and private responsibilities for risk*. Oxford University Press, New York.

Viscusi, W. K. (1992b). *Smoking: making the risky decision*. Oxford University Press, New York.

Viscusi, W. K., Vernon, J. M., & Harrington, J. E. (1995). *The Economics of Regulation and Antitrust* (Second edition). The MIT Press, Cambridge, Mass.

Weiner, M. (1980). Should the Public Have the Legal Right to Use Unproven Remedies? Yes. In Lasagna, L. (Ed.), *Controversies in Therapeutics*. W.B. Saunders, Philadelphia.

Wilson, R. (1985). Reputations in games and markets. In Roth, A. E. (Ed.), *Game-theoretic models of bargaining*. Cambridge University Press, Cambridge.