Endogenous Assets and Liability: Why Softer Standards are More Efficient*

Juan José Ganuza†and Fernando Gomez‡
Universitat Pompeu Fabra, Barcelona
Ramon Trias Fargas 25-27
08005 Barcelona, Spain

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Abstract

In a recent paper (Ganuza and Gomez, 2008) we have argued that the optimal liability rule when potential injurers have limited assets that may make them unable to pay the full monetary penalty,is a realistic version of the negligence rule that adapts the required standards to the actual levels of assets of the potential injurers. In this paper we extend the analysis to a setting in which the level of assets of the potential injurer is not exogenously given, but can be manipulated by the injurer, though with some constraints based on factors alien to the liability question. We find, counterintuitively, that even when levels of assets are endogenous, adaptive standards outperform the traditional standards based on first best behavior, as well as strict liability. In a explicit dynamic setting we also show, counterintuitively, that when other instruments that restrict firm's size are relaxed, the optimal regulatory response is to relax, and not to tighten, liability standards.Moreover, in a regulatory competition setting we find that a country lowering the regulatory will not attract worse firms in terms of size, but, on the contrary, a full dissasortative matching is the stable equilibrium. Finally, we also show that realistic standards may reduce the incidence of bankruptcy for potential injurers and thus social costs that follow a bankruptcy proceeding.

Keywords: Accidents, Limited Liability and Negligence Rule.

JEL classification numbers: K13, K23, L51, H24.

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†Department of Economics. E-mail: juanjo.ganuza@upf.edu. Juan-José Ganuza gratefully acknowledges the hospitality of FEDEA as well as the Financial support of the Spanish Ministry of Science and Innovation under project SEC2003-08080-C02-01

‡Department of Law. E-mail: fernando.gomez@upf.edu. Fernando Gomez acknowledges the financial support of the Spanish Ministry of Science and Innovation under projects SEC 2005-10041 and SEJ 2005-08663-C02/JURI.

1 Introduction

A substantial fraction of Government action and activities consists of regulating behavior of individuals and firms, most notably when such behavior can produce negative externalities. Regulation can adopt several forms, and many different regulatory instruments are available to Governments when designing their policies. Among those instruments, the use of standards for regulating behavior appears pervasive in fields as diverse as drug safety, water and air pollution, workplace safety and health, and auto safety, as well as in the imposition of legal liability for harm in these and many other areas in which negative externalities arise and a rule of negligence is in place.

Setting standards in order to regulate behavior implies determining goals for the behavior of the regulated agents, along one or more relevant dimensions, and designing or employing behavioral incentives to induce compliance with those goals. Although by no means the only one, probably the most common tool to provide incentives is money, in the form of pecuniary fines or penalties, and/or tort liabilities when the standard of behavior is violated.

The use of monetary sanctions to induce the desired levels of behavior, however, faces an important obstacle: The fact that the potential violators of the standard may be insolvent can prevent the achievement of the desired levels of behavior, even if the content of the standard has been chosen by a policy maker having maximization of social welfare in mind, that is, if the standard coincides with the socially optimal conduct. The Law and Economics literature (Summers, 1983 and Shavell, 1986 are the pioneering contributions) has shown how limited assets on the part of potential injurers make that the first-best in terms of accident prevention is not generally attainable using liability rules, even by those imposing standards using first-best investment in safety as the required level of behavior.

In a recent paper (Ganuza and Gomez, 2008) we have explored a new way to alleviate the so-called judgement proof problem arising from the limited ability of the potential injurer to face liabilities or monetary fines imposed. The idea is to use more realistic standards, adapted to the actual level of wealth of the potential injurer, in order to improve the behavioral incentives given the constraint on available wealth to pay for the consequences of behavior. We propose a new negligence rule[1] which, differently from the ordinary understanding, does not use first-best level of care as the required legal standard of care. The second-best optimal rule we identify in this setting selects as the required level of care the minimum of first-best care and a level of care that takes into account the wealth of the injurer. This realistic rule, although it involves a lower level of legally required effort for the injurer, actually is able to improve –in fact, to maximize- the level of care or effort that the agents are motivated to take by the Law.

In real world legal systems, it is true that the level of due care in negligence is commonly set by Courts for each individual case, but many, if not most, standards are not determined piecemeal for each single injurer, but are determined by legislatures, or regulatory agencies, for an entire population or group of potential injurers. The proposed new way to build standards is applied to the choice of a single standard for an entire population of injurers with different levels of assets, and we show that the optimal choice of the standards should take into account not only the wealth of the population, but also the distribution of wealth inside the population: subject to certain regularity conditions, the standards increase in the level of assets of the population of potential injurers.

[1]The analysis would carry over also to any kind of standard enforced through monetary penalties, resembling the operation of the negligence rule, i. e. compliance with the standard involves no penalty, and the monetary sanction is attached to the violation of the standard.

One of the most natural issues to be raised concerning the use of realistic standards that adapt the legal requirements to the assets of the target population refers to the endogeneity of the levels of those assets. In Ganuza and Gomez (2008), both in the basic model and in the optimal choice of standard for an entire population it was assumed that the level of assets of the agent, and its distribution in the population, was exogenously given. In reality, however, the level of assets may be, to some degree, a choice variable of the potential injurer. For instance, in the case of firms, their level of capitalization is, beyond some minimum threshold that may be legally ordained, a matter of choice for the firm, subject to constraints that may have to do with sufficient financing, minimum efficient size requirements, reputation in the market, and so forth. Thus, a firm can engage in several strategies leading to material undercapitalization that will determine its inability to face the liabilities or monetary penalties resulting from its activities: divest activities in poorly capitalized subsidiaries, or in purely instrumental limited liability entities; externalize risky portions of the activity to small-sized contractors[2]; choose an excessive amount of senior or secured debt that will be preferred to the claims of tort victims for damages, or to the claims of the Government for penalties[3]. There is literature (Beard, 1990, Bebchuk and Fried, 1996) pointing at the fact that liability rules induce firms to outsource the hazardous areas of activity in order to enjoy the advantages of judgement-proofness if an accident materializes, and to shield assets from tort victims and the Government. There is even empirical evidence (Ringleb and Wiggins, 1990) arguing that during the seventies the increased exposure to liability led US firms to segregate risky activities into small and poorly capitalized firms.

Moreover, if there is divergence across National or State borders in terms of the required standards, firms may be able to migrate to jurisdictions with more lenient standards to reduce their liability bill. All of the above introduces an endogeneity dimension in the level of assets of the population of firms faced by the Government determining a given standard.

In this paper we examine whether the realistic standards in negligence and regulation that we advocate when the level of assets are exogenous perform well in a setting in which the assets become an endogenous choice variable for the agents under the standards. At first blush, one could suspect that our modified negligence rule is especially vulnerable and, consequently, will not be desirable when the level of assets can be altered or manipulated by the potential injurer, given that the "softness" and "leniency" of our realistic standards is linked to lower asset levels. In this paper we show that the opposite is really the case: our modified negligence rule based on the use of more realistic standards actually reduces the incentives to undercapitalize, and thus leads the firms subject to the standard and liability to higher levels of assets than they would otherwise choose. In particular, they would opt for higher levels of assets than under standards based on first-best behavior –as is the case under the ordinary negligence rule in the Law and Economics literature- as well as under under strict liability.

For this result, we assume that the legal avenues for undercapitalization and asset shielding are not per se less costly or more easily available under our realistic standards than under more exacting standards, or under strict liability. We think this assumption is highly plausible: The legal possibilities to undercapitalize a firm, outsource activities, create subsidiaries, or take senior debt do not depend on the level of the standard as such, but on other policy choices and other kinds of rules in the legal system, most of them outside the Law of negligence or the relevant regulatory Law, but pertaining to Corporate Law, Bankruptcy Law, or other fields of the Law: mandatory capital requirements, minimum asset obligations for certain activities, debt/equity

[2]See Arlen and MacLeod (2006) for a proposal to extend vicarious liability of the principal in such a setting in order to preserve incentives.

[3]See Che and Spier(2008) for an analysis of this strategy and the alternatives to promote adequate incentives for care and optimal financial structure in the firm.

ratios, priority rules in bankruptcy, the scope of vicarious liability, and so forth. Then, the use of realistic standards, though adapted to the actual level of assets of the injurer, is not more vulnerable to maneuvers for undercapitalization than ordinary standards or strict liability, it is actually less vulnerable: Realistic standards improve the incentives of potential injurers that are tempted to become insolvent to achieve savings in liability and precaution costs.

The intuition behind our result goes along the following lines: Realistic standards induce at least the same level of care than ordinary first-best standards, or strict liability, and for some range of asset levels they induce a higher level of care (Ganuza and Gomez, 2008). Under realistic standards, her costs of care are never greater than her total costs –liability payments plus costs of care- under strict liability, or under ordinary negligence when it is privately optimal for the injurer to disregard the standard and to be negligent and potentially liable. Thus, the incentives to reduce the level of assets and become insolvent –and so to reduce costs of care and, if liability is imposed, to reduce the liability payments or fines- are lower under realistic standards, because there is less to be gained from such a reduction of the level of assets.

In an explict dynamic setting we also characterize the optimal standards in view of other instruments that may affect firm size, such as minimum capital requirements, minimum size rules for given activities, limitations and prohibitions of divestiture and outsourcing. We show that optimal standards should be lower when firms' sizes are easier to manipulate and endogenize. A counterintuitive implication of this result is that liability standards and the policy instruments that impact on firm' size are essentially complements, and not substitutes.

We also explore the implications of our results in a simple regulatory competition setting in which countries set different standards and firms of different fixed asset levels choose where to locate. There is a substantial amount of literature arguing that competition in standards will inefficiently erode their quality : Rauscher, 1995, Hoel, 1997, Van Egteren and Smith, 2002. When potential insolvency of the firms subject to the standards is introduced, the disadvantages of using standards that may be subject to downwards competition are reduced: Van Egteren, Smith, and McAfee, 2004.We cast a more optimistic view on competition in standards. Our basic result is theoretically equivalent to a finding that the firms that will benefit more from regulatory competition in standards are precisely those firms with higher levels of assets. That is, the "better" firms in terms of incentives to take care and to comply with the standards are those who will enjoy relatively more the advantages of a reduction in the regulatory standard, increasing and not decreasing the levels of effort and safety achievable under the lower standard. In the regulatory competition setting, we find that when a country lowers the standard, contrary to popular wisdom, it will not be flooded by extremely undercapitalized firms trying to find a haven, but instead will attract the firms with higher levels of assets, and thus, the safer firms.

Finally, we relate the softer, more realistic standards to the probability of firm bankruptcy -and its associated costs- and also find that they induce lower bankruptcy rates than stricter standards.

Our paper relates to several different strands in the literature. The first is the Law and Economics, and principal-agent literature, dealing with the impact of limited assets on legal liability for accidents, and particularly to those contributions that explore the use of standards set below the first best optimal level for wealth-constrained agents (Ganuza and Gomez, 2008; Stremitzer and Tabbach, 2009). The second is the long literature on the effects of regulatory competition in standards, particularly on environmental quality.

The paper is organized as follows. In section 2 we present the model and the main result on levels of assets and optimal liability standards. In section 3, we characterize the optimal standards in a dynamic setting. In section 4, we analyze the regulatory competition setting. In section 5, we

discuss the effects of realistic standards on bankruptcy costs. Section 6 contains a brief discussion of the implications, and concludes.

2 Model and Main Result

We study a standard accident setting in which the behavior of a potential injurer affects the likelihood of an accident. Let x be the injurer's expenditure on care (or the monetary equivalent of the precautionary effort) and $p(x)$ be the probability of an accident resulting in harm, D, where $p(x)$ is decreasing and convex in x. We denote by x^* the injurer's efficient level of care, which minimizes social cost,

$$x^* \in \arg\min p(x)D + x.$$

The incentives of the injurer are driven by a liability rule (which initially will be assumed to be a negligence rule) and its wealth level l. The negligence rule determines that if an accident materializes the injurer is liable and has to pay accident damages, D, only if her precautionary effort is lower than a pre-specified required level $\overline{x}$.

In this simple setting if the wealth of the injurer l is larger than D, the negligence rule with a standard $\overline{x} = x^*$ (and also strict liability) implements the efficient level of care. However, if the injurer has wealth l lower than D, the problem of insolvency or judgment-proofness becomes an issue. The judgment proof problem arises because the effective monetary penalty the injurer is able to pay for is constrained by his wealth and this reduces the injurer's incentives. The injurer will be liable only for $z = \min\{l, D\}$, implying that first best may be not feasible using a negligence rule [see Shavell (1986)]. Ganuza and Gomez (2008) explores the limits of the negligence rule and characterizes the optimal standard of negligence in case of judgment-proofness. In the present paper, we will take the negligence standard as given, and we focus on the fact that the injurer level of assets is, to some extent at least, endogenous.

Consider that there is a previous stage to the accident stage, in which the injurer may choose its own asset level. We denote as l^* the (privately) optimal asset level, which maximizes the injurer's expected utility,

$$l^* \in \arg\max U(\overline{x}, l) = u_A(\overline{x}, l) + g(l)$$

Where $u_A(\overline{x}, l)$ is the expected utility associated to the accident stage (notice that we can ignore care x in the utility function since, as we mentioned before informally, it will be a function of $\overline{x}$ and l) , and $g(l)$ is a function related to other factors affecting the choice of the asset level, such as market regulation, strategic factors (make or buy optimal decisions, market reputation, etc...) and so on. That is, $g(l)$ captures all other variables, besides liability and precautionary cost, that affect the choice of asset level.

Then, the timing of our model is the following: 1) Choice of size stage: for a given regulatory framework $\overline{x}$, the injurer decides the privately optimal asset level l^*, ii) Accident stage: the injurer chooses a level of care, and the payoffs are realized given nature and the negligence standard $\overline{x}$.

In order to address our question, to characterize the relationship between l^* and the negligence standard $\overline{x}$, we have to solve the model by backwards induction. We start by solving the accident stage, following very closely Ganuza and Gomez (2008), and then we solve the choice of size stage.

2.1 Accident Stage

In this stage, the injurer has already chosen the level of assets l and the effective penalty in case of being liable $z = \min\{l, D\}$. A potentially liable injurer chooses a level of care $x_L(z)$ which

minimizes her expected total cost,

$$x_L(z) \in \arg\min p(x)z + x,$$

where z is the effective penalty (assumed to be monetary) faced by the liable injurer whenever the accident occurs. Let $\gamma(z)$ be the expected private cost of being liable,

$$\gamma(z) = p(x_L(z))z + x_L(z).$$

Intuitively, $x_L(z)$ and $\gamma(z)$ are increasing functions.

Under the negligence rule, the judgment-proof injurer compares its private expected cost of being liable $\gamma(z)$ with the cost of satisfying the negligence standard $\overline{x}$. Then the equilibrium level of care will be

$$x_E(\overline{x}, l) = \begin{cases} \overline{x} & \text{if } \overline{x} < \gamma(z) \\ x_L(z) & \text{otherwise.} \end{cases}$$

2.2 Choice of Size Stage

In the initial stage, the injurer has to choose the level of assets taking into account its specific preferences regarding the liability, $g(l)$, and the expected utility of the accident stage, $u_A(\overline{x}, l)$ that can be easily derived from the previous analysis

$$u(\overline{x}, l) = \begin{cases} -x(\overline{x}, l) & \text{if } \overline{x} < x(\overline{x}, l) \\ -\gamma(l) & \text{otherwise} \end{cases}$$

Then the equilibrium level of assets will be the solution to the following problem:

$$l^* \in \arg\max U(\overline{x}, l) = \begin{cases} -x(\overline{x}, l) + g(l) & \text{if } \overline{x} < x(\overline{x}, l) \\ -\gamma(l) + g(l) & \text{otherwise} \end{cases}$$

We are able to characterize the relationship between the optimal asset level l^* and the standard. Firstly we need to state the following lemma.

LEMMA 1 *$U(\overline{x}, l)$ is a submodular function, i.e, if $\overline{x} > \overline{x}'$ then $U(\overline{x}, l) - U(\overline{x}', l)$ is weakly decreasing in l*

Proof: Consider $\overline{x} > \overline{x}'$,

$$U(\overline{x}, l) - U(\overline{x}', l) = \begin{cases} -\overline{x} + \overline{x}' & \text{if } l : \gamma(l) > \overline{x}. \\ -\gamma(l) + \overline{x}' & \text{if } l : \overline{x} \geq \gamma(l) \geq \overline{x}' \\ 0 & \text{if } l : \gamma(l) < \overline{x}' \end{cases}$$

Notice that as $\gamma(l)$ is increasing on l, then $u(\overline{x}, l) - u(\overline{x}', l)$ is decreasing on l. This implies that the injurer objective function is submodular. ∎

Now, we can establish the basic result of the paper, that the choice of size by firms is inversely related to the level of the standards.

PROPOSITION 1 *The optimal asset level $l(\overline{x})^*$ is weakly decreasing in $\overline{x}$.*

Proof: The result is a direct application of Lemma 1 and the following result of Topkis (1978): if $H(y,\theta)$ is submodular and $y^*(\theta) \in \arg\max H(y,\theta)$, then $y^*$is weakly decreasing on θ.

For completeness we can prove the result: Consider contrary to the Proposition 1 that $\overline{x} > \overline{x}'$ and $l = l(\overline{x})^* > l' = l(\overline{x}')^*$. This implies the following two conditions:

$$\begin{aligned} U(\overline{x}, l) &\geq U(\overline{x}, l') \\ U(\overline{x}', l') &\geq U(\overline{x}', l) \end{aligned}$$

Summing up the two conditions, we obtain:

$$U(\overline{x}, l) - U(\overline{x}', l) \geq U(\overline{x}, l') - U(\overline{x}', l')$$

We have reached a contradiction. This is because the last condition implies that $U(\overline{x}, l) - U(\overline{x}', l)$ is increasing, contradicting Lemma 1. ∎

We can illustrate the result with the following numerical example. Consider that $p(x) = 1 - \sqrt{x}$, $x \in [0,1]$ and $D = 1$.

The injurer chooses a level of care $x_L(z)$ which minimizes her expected total cost given the expected penalty z,

$$x_L^*(z) \in \arg\min(1 - \sqrt{x})z + x. \rightarrow x_L^*(z) = \frac{z^2}{4}$$

Given $x_L(z)$, the expected total cost of being liable is

$$\gamma(z) = p(x_L(z))z + x_L(z) = z - \frac{z^2}{4}.$$

The optimal level of care when the injurer faces a negligence rule with a standard $\overline{x}$ is

$$x_E(\overline{x}, l) = \begin{cases} \overline{x} & \text{if } \overline{x} < l - \frac{l^2}{4} \\ \frac{l^2}{4} & \text{otherwise.} \end{cases}$$

Given $x_E(\overline{x}, l)$, the injurer's expected utility at the accident stage is

$$u_A(\overline{x}, l) = -\min\{\overline{x}, l - \frac{l^2}{4}\}$$

At the choice of size stage, the injurer chooses l in order to maximize the total expected utility

$$l^* \in \arg\max u_A(\overline{x}, l) + g(l)$$

Consider that $g(l) = -(1-l)^2$, then

$$l^* = \begin{cases} 1 & \text{if } \overline{x} < \frac{2}{3} \\ \frac{2}{3} & \text{otherwise} \end{cases}$$

It is easy to derive these results. If the standard is satisfied, the payoff is equal to $-\overline{x} - (1-l)^2$ which is maximized if $l = 1$. This solution generates a total payoff of $-\overline{x}$. If the injurer is going to be liable, his objective function is $-(l - \frac{l^2}{4}) - (1-l)^2 = -1 + l - \frac{3}{4}l^2$ that is maximized if $l = \frac{2}{3}$ yielding to a total payoff of $-\frac{2}{3}$. Then if the standard is lower than $\frac{2}{3}$, the first solution is superior

and the injurer achieves it by choosing $l = 1$. For larger standards, the injurer prefers to be liable, and strategically reduces its level of assets to $l = \frac{2}{3}$.

The implication of Proposition 1 is that lower standards (from first-best levels of care), such as those that may result from realistic standards advocated by Ganuza and Gomez (2008), actually determine a more desirable choice of level of assets by the potential injurers. Given that in this setting strict liability could be characterized as a negligence rule with $\overline{x} = \infty$, it is straightforward that realistic standards also outperform strict liability when the level of assets is endogenous.

3 Optimal Standard with Endogenous Assets Level.

In this section, we extend Ganuza and Gomez (2008) and the above analysis by characterizing the optimal determination standard in an explicit dynamic framework when firms' level of assets are endogenous. We consider the following sequence of actions: 1) In the first stage, the Regulator sets the standard; 2) in the second stage, firms firstly choose the asset level l, and sequentially the level of care. Moreover, we also assume a specific functional form for the portion of the utility function that relates to the other factors affecting the choice of the asset level independent of the exposure to liability, $g(l) = -\beta(l^o - l)^2$. This specification makes explicit the optimal size of the firms regardless of the liability problem, l^o, and a parameter β that captures the cost of departing from this size.

We focus our analysis on β. We want to emphasize that this parameter is besides market, organizational and technological factors, heavily influenced also by different policy measures, such as minimum asset requirements, legal limits on divestiture of activities, and so on.

For extreme values of β, the analysis is straightforward. If $\beta = \infty$, assets are exogenous to the liability problem, $l^* = l^o$, there is no possibility of asset manipulation in view of the imposition of liability, and we are fully in the setting of Ganuza and Gomez (2008). Then, the optimal standard is the minimum of the first best level and the total cost of being liable given the level of assets, $\overline{x}^* = \min\{\gamma(l^o), x^*\}$.[4]

If $\beta = 0$, there are no constraints for firms when choosing size, and given that effective liability increases with size, $l^* = 0$, and liability rules are unable to induce any care. For continutity, $\overline{x}^* = 0$.[5]

From the analysis of the extreme values of β, we can grasp the intuition that the optimal standard for the regulator is increasing in β. The following proposition characterizes the optimal standard and formalizes this intuition.

Proposition 2 *(i) The optimal standard is* $\overline{x}^*(\beta) = \min\{\gamma(\widehat{l}(\beta)), x^*\}$*, where* $\widehat{l}(\beta) \in \arg\max\{-\gamma(l) - \beta(l^o - l)^2\}$*.(ii) The optimal standard is weakly increasing in* β*.*

Proof: We solve the model by backwards induction. The optimal response of the injurer for an arbitrary standard is the solution to the following problem

$$l^{**}(\overline{x}) \in \arg\max\{-\min\{\gamma(l), \overline{x}\} - \beta(l^o - l)^2\}$$

[4]Ganuza and Gomez (2008) shows that the optimal negligence standard $\overline{x}$ must depend on (i.e. increase with) the injurer's level of wealth. When $\overline{x} = \gamma(l)$ injurers, by construction, will find optimal to comply with the required negligence standard, which maximizes the effort exerted by them. The optimal standard results from this, simply with the additional prevention of discouraging any injurer from exerting a level of care larger than x^*.

[5]We apeal to continuity in the following sense: if $l = \epsilon$, then $\overline{x}^* \leq \gamma(\epsilon) \leq \epsilon$ and consequently $\overline{x}^*$ must converge to 0, as ϵ goes to 0.

The best response is a two step function

$$l^{**}(\overline{x}) = \begin{cases} l^o & \text{if } \overline{x} < \gamma(\widehat{l}(\beta)) \\ \widehat{l}(\beta) & \text{otherwise} \end{cases}$$

Where $\widehat{l}(\beta) \in \arg\max\{-\gamma(l) - \beta(l^o - l)^2\}$. Given that $\gamma(l)$ is increasing in l, $\widehat{l}(\beta) < l^o$ and then, $l^{**}(\overline{x})$ is weakly decreasing in $\overline{x}$, as it is stated in Proposition 1. The function $-\gamma(l) - \beta(l^o - l)^2$ is supermodular in (l, β), then by the results of Topkis (1978), $\widehat{l}(\beta)$ is weakly increasing in β. Given $l^{**}(\overline{x})$, the regulator's best response is to maximize the firm's level of assets (and consequently the induced care) by setting a standard $\overline{x}^*(\beta) = \min\{\gamma(\widehat{l}(\beta)), x^*\}$. Finally, notice that given that $\widehat{l}(\beta)$ and $\gamma(\widehat{l}(\beta))$ are two weakly increasing functions, $\overline{x}^*(\beta)$ is also weakly increasing in β. ∎

An immediate corollary is that optimal standards should be lower when firms' sizes are endogenous. A counterintuitive implication of this result is that liability standards and the policy instruments that impact on firm' size are essentially complements, and not substitutes. Think of measures such as minimum capital requirements, minimum size rules for certain activities, or limits on outsourcing. If a given legal system, for whatever reason, relaxes these rules, thus making less costly for firms to effectively reduce their size, one may be tempted to increase the liability standards for firms, in order to counterweigh the expected reduction in incentives for care. That is, to use liability and regulatory standards as a substitute of the rules setting minimum size requirements for firms. We have shown that the opposite is the case. When such rules are relaxed, thus making firm's sizes more "endogenous", more manipulable, if one prefers, the appropriate policy response is actually also to relax the liability standards in order to keep firms' sizes higher, and in the end, inducing higher levels in the underlying firm behavior we are interested in controlling -care, for instance.

We have characterized the optimal standard in a dynamic framework and assuming a specific functional form for the part of the utility function related to other factors affecting the choice of the asset level. However, our main insight, namely that liability standards and the policy instruments that impact on firm' size are essentially complements, and not substitutes, also holds in a framework in which standards and liability are chosen simultaneously, and with a more general specification of the utility function. Figure 1 shows that more stringent constraints over the ability of the firm to reduce its size moves down its best response function (from $BR_{l(\overline{x})}$ to $BR_{l'(\overline{x})}$) and leads to lower equilibrium standard and size levels.

[Figure 1 around here]

4 Regulatory Competition under Realistic Standards

In this section, we explore the implications of our main results in a simple regulatory competition model. Instead of considering endogenous assets levels, we propose an assingment game in which firms of different sizes decide where to operate among two jurisdictions with different standards. Contrary to conventional wisdom, we will show that countries imposing more realistic standards will not find themselves crowded with severely undercapitalized firms. In fact, we show that complete disassortative matching (firms with higher assets levels locate in the country with the lower standard) is the only equilibrium allocation under a natural-although confessedly strong-stability condition. In the following we present the main features of the model.

Consider two countries A and B with different regulatory standards,$\overline{x}_A > \overline{x}_B$. There is a population Λ of N firms of different sizes $\Lambda = (l_1, ..., l_n)$. For convention, if $j > i$ then $l_j \geq l_i$. Firms choose where to locate on the basis of the following utility function.

$$U(\overline{x}, l, I) = \pi_I(n_I) + u(\overline{x}, l)$$

where $\pi_I(n_I)$ is the firm profit from producing in country I. We consider that this profit function is symmetric across firms (it need not be across countries) and it is likely to depends on the n_I number of firms operating in the same country. We are agnostic toward the shape of this function, allowing for clustering as well as congestion effects, but we focus on the interesting case in which in equilibrium we find firms in both countries. As in previous sections $u(\overline{x}, l)$ is the expected utility associated with the probability of accidents and liability[6].

Let H_A (H_B) be the subset of firms located in country A (B), such that $H_A \cup H_B = \Lambda$. We are interested in a full characterization of all the multiple Nash equilibrium allocations (H_A, H_B) but in selecting those satisfying the following stability condition.

A complete allocation (H_A, H_B) is pairwise-stable if we cannot interchange firms $i \in H_A$ and $j \in H_B$ obtaning a net welfare gain.

For a better grasp of the implication of the condition, we want to clarify: 1) regarding welfare we are only considering the utility of firms, who are the only decision makers in this setting. 2) firms not involved in the pairwise exchange will not be affected by it, since we are not altering the number of firms in each country.

PROPOSITION 3 *The only pairwise-stable allocation* (H_A^D, H_B^D) *is the complete disassortative matching.*

Proof: Consider a not fully disassortative matching, $(H'_A, H'_B) \neq (H_A^D, H_B^D)$. Then, there exist two firms $j > i$ where $j \in B$ and $i \in A$. Then we can show that there is a potential welfare gain if we interchange j and i,

$$U(\overline{x}_B\ , l_j, B) + U(\overline{x}_A\ , l_i, A) \leq U(\overline{x}_A\ , l_j, A) + U(\overline{x}_B\ , l_i, B)$$

$$U(\overline{x}_A\ , l_i, A) - U(\overline{x}_B\ , l_i, B) \leq U(\overline{x}_A\ , l_j, A) - U(\overline{x}_B\ , l_j, B)$$

Given that $\pi_I(n_I)$ is symmetric across firms, the differences in utilities only depend on liability functions, $u(\overline{x}, l)$.

$$u(\overline{x}_A\ , l_i) - u(\overline{x}_B\ , l_i) \leq u(\overline{x}_A\ , l_j) - u(\overline{x}_B\ , l_j)$$

From the proof of Lemma 1, we know that if $\overline{x} > \overline{x}'$ then $u(\overline{x}, l) - u(\overline{x}', l)$ is decreasing in l. ∎.

The implication of this result is that larger firms -who also are the "better" firms in terms of incentives for accident prevention- will be exactly the ones more strongly appealed by a country with the lower or more realistic standard. Thus, competition in standards does not lead necessarily to a reduction in the actual levels of care and prevention, given this choice of location decision by the safer firms.

5 The effects on bankruptcy costs

When injurers have limited assets, the occurrence of accidents and the imposition of tort liability or regulatory fines may lead to a formal bankruptcy procedure. It is arguable that bankruptcy procedures as such imply a net destruction of the assets of the individual and firm under bankruptcy, not only for the legal (Court, attorneys, experts) and other costs associated with a formal legal proceeding, but also to the lower likelihood that in bankruptcy the assets will obtain their maximum feasible realization value. Thus, the effects of liability rules on the likelihood of bankruptcy of the potential injurer may also be considered a relevant dimension on which to compare realistic standards with ordinary standards or with strict liability.

[6]Notice that with respect to the utility function of section 2, we skip the cost $g(l)$ of adjusting the level of assets, given that we are considering that firm size is fixed.

For more realism in the analysis, assume that x is monetary, and thus investment in care reduces the assets available to pay damages or monetary fines (this was first considered by Beard (1990)). For simplicity, we will also assume in this section that l is fixed.

Let x_L be the level of care that a liable injurer would take, either under strict liability or under ordinary negligence (if the injurer given l prefers to disregard the standard x^* and be liable). Our realistic standard would be in this case

$$\overline{x}^r = p(x_L)(l - x_L) + x_L \leq x^*$$

If the injurer decides to abide by this realistic standard, there will be no bankruptcy, and no associated bankruptcy costs, given that

$$\overline{x}^r - l = p(x_L)(l - x_L) + x_L - l = -(1 - p(x_L))(l - x_L) < 0$$

That is, the potential injurer that abides by the realistic standard never exhausts all the assets by the choice of care. On the other side, under strict liability or under ordinary negligence, the injurer would choose x_L, and will be bankrupt with likelihood $p(x_L)$.

From the above, we can imply that realistic standards are able to induce less actual bankruptcy by potential injurers and consequently may avoid the costs associated with the ocurrence of bankruptcy.

6 Conclusions

When using standards enforced through monetary sanctions for the violation of the standard, the likelihood that the agent may have limited means to face liabilities and sanctions becomes an important policy matter. To partially overcome the disincentives created by judgement-proofness, it has been shown (Ganuza and Gomez, 2008) that the use of adaptive standards, tailored to the specific level of assets of the potential injurer, actually improves the behavioral incentives of the relevant population.[7]

At first blush, the efficiency argument in favor of realistic standards may seem unconvincing when potential injurers are able to manipulate their level of assets. If assets are not exogeneously given, but can be determined by the potential injurers in contemplation of the liability regime, adaptive standards seem to be doomed to fail, as they would induce a diminution of assets in order to benefit from the reduction in the required standard. In this paper we show that quite the opposite is the case. In fact, realistic and adaptive standards are less vulnerable, and not more, to the strategic use of the endogenous choice of asset levels by potential injurers. The main intuition behind our result is that the incentive to undercapitalize or to reduce assets is even greater under more exacting standards or under strict liability regimes, because what can be gained by reducing assets is always as much -and can be much larger- as what can be gained under realistic standards. Needless to say, this result depends on the cost of reducing assets not being per se lower due to the level of the standard, an assumption that we hold to be highly plausible. The implications of our finding at the policy level are, we believe, substantial, as it can be directly transposed, as a theoretical result, to settings of regulatory competition in standards among different countries.

Moreover, we have found another interesting application of our model. The relationship between liability standards and instruments that directly constrain and affect firms size is not one

[7] In a related paper, Ganuza and Gomez (2009), we extend the previous analysis to a general incentive setting in which agents are heterogenous in terms of their abilities . We show that similarly to the negligence case, optimal standards must be closely related to the agent's particular abilities.

of substitutes, but rather of complements. Thus, when a country reduces minimum firm requirements -following legal harmonization, or due to firm mobility to other jurisdictions, or for other plausible reasons- it should resist the natural temptation to counterweigh this relaxing move with toughening liability standards. Actually, the contrary should be desirable: reduce liability standards so as to make higher firm sizes more attractive for firms.

We have also considered a different advantage of the use of realistic standards, namely the reduction of actual cases of insolvency and bankruptcy by injurers, compared to what one would expect under more rigorous standards and under strict liability for external harm. All in all, it seems that the superiority of realistic standards confronted with other alternatives to regulate behavior in settings of limited assets can be shown to be robust to different extentions and complications of the factual scenarios in which the rules may be actually applied.

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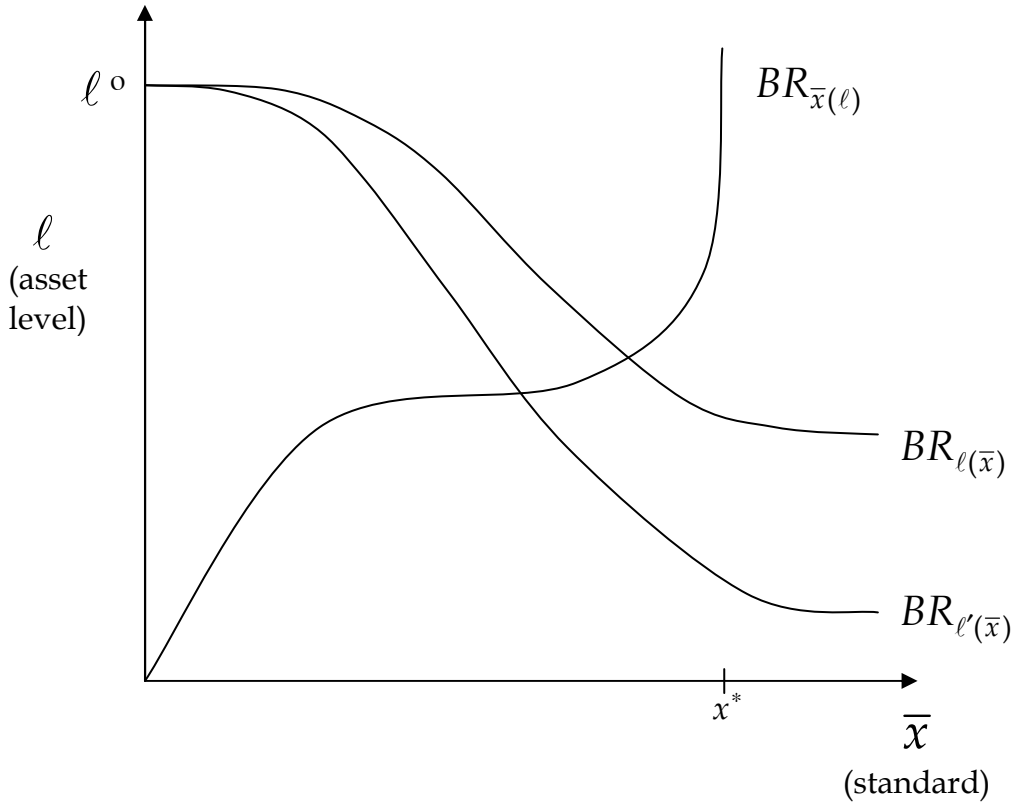
ℓ^o
ℓ
(asset
level)
$BR_{\overline{x}(\ell)}$
$BR_{\ell(\overline{x})}$
$BR_{\ell'(\overline{x})}$
x^*
$\overline{x}$
(standard)

FIGURE 1