Non-Compliance with Environmental Product Standards in an International Duopoly

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Abstract

This paper studies the incentives for non-compliant behavior of firms in a two-country duopoly with vertical product differentiation. Both firms have an incentive for non-compliant behavior, while both firms would prefer that the other firm is compliant. The incentive for non-compliance is higher for the high-quality firm than for the low-quality firm. Non-compliant behavior of one firm lowers the incentive for non-compliance by the other firm. A welfare-maximizing government may lack incentives to enforce compliant behavior of the domestic firm.
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Introduction

In the European Union and other OECD countries, firms have to comply with many business process requirements. These include (among others) minimum wages, workers' rights, tax provisions, accounting rules or environmental regulations. Usually, compliance with these requirements results in additional cost. In addition, these rules may have no or only a limited impact on perceived quality from the consumers' perspective. Therefore, they may have an incentive not to comply with all rules perfectly. Cost reduction through non-compliance increases profits and may create a competitive advantage over compliant competitors. As a result, non-compliance may be contagious, with all firms ending up in non-compliant behavior. Non-compliant behavior of firms is not a rare exception in some small markets, but a global phenomenon. It occurs in all economies and is of considerable economic importance, for example in the form of tax-evasion and moonlighting (Medina & Schneider, 2017).

While consumers could be assumed to prefer compliance with the requirements mentioned above over non-compliance, they are often unable to observe compliance. In addition, they are often not affected directly by non-compliance and they do not perceive non-compliance as a reduction in the quality of products. For example, if a firm does not comply perfectly with all local provisions from environmental law this does not necessarily have a negative impact on consumers.

One of the most prominent recent examples of non-compliant behavior is Volkswagen's dieselgate. It turned out recently that the German car manufacturer Volkswagen used a software to create the (wrong) impression that its cars complied with US emission standards for some pollutants. While this caused harm to the environment, the quality of the cars in the eyes of consumers was not lowered by non-compliance.

Interestingly, the US-EPA was the first public authority that detected Volkswagen's deceptive behavior, while the German authorities have remained silent for a long time. This example is instructive because it suggests that governments may have higher incentives to enforce the rules against foreign firms than against domestic ones.

Non-compliance with applicable rules has been investigated in the literature under various aspects and methodologies. The starting point for the economic analysis of rational rule violations is Becker (1968), who examines in particular conditions for optimal detection probabilities and optimal penalties.

The literature on the impact of environmental policy instruments has analyzed in detail the phenomenon of non-compliance with regulations such as environmental standards or emission trading systems and similar instruments (see Heyes, 2000). The focus of the literature is typically on the effect of a specific instrument, taking into account non-compliant behavior. For instance, the effects of non-compliance with environmental standards have been investigated, with different emphasis on the strictness of a standard and measures to enforce it (e. g. Downing & Watson, 1974; Kambhu, 1989; Keeler, 1995; or Arguedas, 2008 and 2013). Emissions trading schemes in the event of imperfect enforcement are analyzed by Malik (1990), Stranlund & Chavez (2000) and Montero (2002). Bachmann et al. (2017) show that the non-compliant behavior of Volkswagen has triggered a negative external effect on other German car manufacturers.

The intensity of competition can have a decisive influence on the decision to non-compliant behavior. Intensive competition can increase the pressure for success on companies and thus the incentives to violate rules (Branco & Villas-Boas, 2015; Baumann & Friehe, 2016). The market form and the intensity of competition are therefore decisive determinants for the occurrence of rule violations and must be taken into account in the conception of a strategy for detecting and preventing rule violations.

Against this background, we investigate incentives for firms in a two-country duopoly with vertical product differentiation to comply with standards on the production process and incentives for governments to enforce compliance. Both firms have an incentive for non-compliant behavior, while both firms would prefer that the other firm is compliant. The incentive for non-compliance is higher for the high-quality firm than for the low-quality firm. Non-compliant behavior of one firm lowers the incentive for non-compliance by the other firm. We show that a welfare-maximizing government may lack incentives to enforce compliant behavior of the domestic firm.

The rest of the paper is organized as follows: In the next section, the model is presented. Section 3 presents results for compliant and non-compliant firm behavior. Section 4 discusses enforcement incentives for governments. Section 5 concludes.

1 The Model

Consider a duopolistic market with vertical product differentiation where products are sold in two countries $j = H, F$. In each of the countries, one firm $i = H, L$ is located, with firm H in country H and firm L in country F. Each firm sells one product in both markets. Products differ in quality i. Assume without loss of generality $s_H > s_L$. This quality ranking applies to both markets. If a firm located in country j exports a product to country $-j$, it incurs trade cost t. Identical cost of quality c_s for both firms is linear in quantity q and convex in quality s: $c_s = \frac{1}{2}s_i^2 q_i$. Constant marginal cost c apply if a firm complies with all legal requirements of production. If firms do not comply, marginal cost decrease to $\gamma < c$.

Governments in j detect non-compliant behavior by firms with the probability ϕ. If a non-compliant firm is detected, it has to pay a per unit fine f plus a lump sum fine F. Compliant firms never have to pay a fine.

Consumers are heterogeneous with respect to quality. Consumers' marginal willingness to pay for quality θ_j is uniformly distributed on the interval $[a, b]$, with $b = a + 1$ in H and $[\alpha, \beta]$, with $\beta = \alpha + 1$ in F. Each consumer buys at most one unit of the most preferred good. The utility of not purchasing a good is zero. A consumer who buys one unit of the good obtains a net utility of $U = \theta_j s_i - p_i$. The marginal consumer in each country, who is indifferent between both products is characterized by $\theta_j^* = \frac{p_H - p_L}{s_H - s_L}$. Therefore demand for products i in both countries j is $q_H = b - \theta_j^*$, $q_L = \theta_j^* - a.U = \theta s_i - p_i$, $i = H, L$.

Consider the following timing after the governments have decided on the detection probability ϕ and the fines f and F: In the first stage, firms decide whether to comply or

not. In the second stage, firms choose quality levels. In the third stage, firms compete in prices. We solve the game by backward induction.

2 Results

2.1 Compliance of both firms

In this section we present the results for market H. As markets only differ in market size, the results are qualitatively similar for market F. Consider that both firms comply with the standard. Profits of both firms are $\pi_H^{C,C} = \left(p_H - c - \frac{1}{2}s_H^2\right) q_H$, and $\pi_L^{C,C} = \left(p_L - c - \frac{1}{2}s_L^2 - t\right) q_L$, respectively. The equilibrium quality levels are

$$s_H^{C,C} = \frac{12b - 8t + 3}{12},\ s_L^{C,C} = \frac{12b - 8t - 15}{12}. \tag{1}$$

Both quality levels increase in the maximum willingness to pay for quality b and decrease in trade cost t.

Equilibrium profits are

$$\pi_H^{C,C} = \frac{(8t + 9)^2}{216},\ \pi_L^{C,C} = \frac{(8t - 9)^2}{216}. \tag{2}$$

Profits of both firms are independent of b and increase in trade cost t. The profit of the high-quality firm H exceeds the profit of the low-quality firm L.

2.2 Non-compliance of the high-quality firm

If firm H does not comply with production requirements, it has lower production cost $\gamma < c$. If firm L complies with the requirements, profits are $\pi_H^{NC,C} = \left(p_H - \gamma - \frac{1}{2}s_H^2 - \phi f\right) q_H - \phi F$ and $\pi_L^{NC,C} = \left(p_L - c - \frac{1}{2}s_L^2\right) q_L$, respectively.

Equilibrium quality levels are

$$s_H^{NC,C} = \frac{3\,(4b + 1) - 8\,(c - \gamma) - 8t + 8f\phi}{12},\ s_L^{NC,C} = \frac{3\,(4b - 5) - 8\,(c - \gamma) - 8t + 8f\phi}{12}. \tag{3}$$

Quality levels of both firms increase in the detection probability ϕ and the per unit fine f.

The quality difference for the high-quality firm compared to compliance of both firms is

$$s_H^{NC,C} - s_H^{C,C} = \frac{2}{3}\,(c - \gamma) - \frac{2}{3}f\phi. \tag{4}$$

The first term reflects the competitive advantage the noncompliant firm has because of its lower cost. The second term reflects the additional cost of non-compliance. If the government calibrated its instruments to $f\phi = (c - \gamma)$, quality levels would be the same under compliance and non-compliance. Results are symmetrical for the compliant firm, as $s_L^{NC,C} - s_H^{C,C} = -\frac{2}{3}(c - \gamma) + \frac{2}{3}f\phi$.

Equilibrium profits are

$$\pi_H^{NC,C} = \frac{(9 + 8(c + t - \gamma) - 8f\phi)^2}{216} - \phi F,\ \pi_L^{NC,C} = \frac{(9 - 8(c + t - \gamma) + 8f\phi)^2}{216} \tag{5}$$

For the non-compliant (compliant) firm, profit increases (decreases) in the cost difference $c - \gamma$; it decreases (increases) in the per unit fine f and the detection probability ϕ.

2.3 Non-compliance of the low-quality firm

If the high-quality firm H is compliant while the low-quality is not, profits are given as $\pi_H^{C,NC} = \left(p_H - c - \frac{1}{2}s_H^2\right) q_H$ and $\pi_L^{C,NC} = \left(p_L - \gamma - \frac{1}{2}s_L^2 - \phi f\right) q_L - \phi F$. Equilibrium quality levels are

$$s_H^{C,NC} = \frac{3(4b + 1) + 8(c - \gamma) - 8t - 8f\phi}{12},\ s_L^{C,NC} = \frac{3(4b - 5) + 8(c - \gamma) - 8t - 8f\phi}{12} \tag{6}$$

Quality levels of both firms decrease in the detection probability ϕ and the per unit fine f. This result shows an asymmetry of the effect of the instruments a government may apply to limit non-compliance: while both quality levels increase in the detection probability ϕ and the per unit fine f when the high-quality firm is non-compliant, they decrease if the low-quality firm is non-compliant. The difference of quality levels is symmetrical to the case discussed in the subsection above.

Equilibrium profits are

$$\pi_H^{C,NC} = \frac{(9 - 8(c - \gamma - t) + 8f\phi)^2}{216}, \pi_L^{C,NC} = \frac{(9 + 8(c - \gamma - t) - 8f\phi)^2}{216} - \phi F \tag{7}$$

For the non-compliant (compliant) firm, profit increases (decreases) in the cost difference $c - \gamma$; it decreases (increases) in the per unit fine f and the detection probability ϕ.

2.4 Non-compliance of both firms

If both firms do not comply with the production requirements, both firms benefit from lower cost, but both firms share the risk of being detected. Profits for both firms are

$\pi_H^{NC,NC} = \left(p_H - \gamma - \frac{1}{2}s_H^2 - \phi f\right) q_H - \phi F$ and $\pi_L^{NC,NC} = \left(p_L - \gamma - \frac{1}{2}s_L^2 - \phi f\right) q_L - \phi F$. Equilibrium quality levels are

$$s_H^{NC,NC} = \frac{12b - 8t + 3}{12},\ s_L^{NC,NC} = \frac{12b - 8t - 15}{12} \tag{8}$$

Quality levels of both firms are independent of the instruments a government may apply to limit non-compliance. They are identical to the case where both firms comply with all production requirements.

Equilibrium profits are

$$\pi_H^{NC,NC} = \frac{(8t+9)^2}{216} - \phi F,\ \pi_L^{NC,NC} = \frac{(8t-9)^2}{216} - \phi F \tag{9}$$

Both firms' profits are identical to the case of compliance by both firms except for the expected lump sump fine. It follows that both firms would prefer the equilibrium, where both firms comply to the symmetric non-compliance equilibrium.

2.5 The incentive for non-compliance

While both firms prefer the symmetric compliance equilibrium to the symmetric non-compliance equilibrium, both firms may have an incentive not to comply if this results in an extra profit. If the other firm is compliant, the extra profit of non-compliance is

$$\begin{aligned} \Delta_H^C &= \frac{2\left(c - \gamma - f\phi\right)\left(9 + 4\left(c - \gamma\right) + 8t - 4f\phi\right)}{27} - \phi F \\ \Delta_L^C &= \frac{2\left(c - \gamma - f\phi\right)\left(9 + 4\left(c - \gamma\right) - 8t - 4f\phi\right)}{27} - \phi F. \end{aligned} \tag{10}$$

The incentive decreases in the instruments a government may apply to limit non-compliance f, F, and ϕ. The incentive is larger for the high-quality firm which sells products in its home market. Trade cost t increase (decrease) the incentive for non-compliance of the high-quality (low-quality) firm. If the government would calibrate ϕF to reduce the incentive of the foreign low-quality firm for non-compliance to zero, the high-quality firm would still have an incentive for non-compliance. But since a compliant firm never has to pay a fine, the government could recalibrate the expected fine to also reduce the incentive of the high-quality firm for non-compliance to zero.

If one firm already shows non-compliant behavior, the incentive of the other firm also

not to comply is

$$\begin{aligned} \Delta_H^{NC} &= \frac{2\left(c-\gamma-f\phi\right)\left(9-4\left(c-\gamma\right)+8t+4f\phi\right)}{27}-\phi F \\ \Delta_L^{NC} &= \frac{2\left(c-\gamma-f\phi\right)\left(9-4\left(c-\gamma\right)-8t+4f\phi\right)}{27}-\phi F. \end{aligned} \tag{11}$$

The incentive for non-compliance is lower for both firms if the other firm already shows non-compliant behavior.

3 Optimal Enforcement

Consider welfare-maximizing governments in both countries. Each government maximizes (local) welfare, given as $W_j = CS_j + \pi_j - c^{\phi}\left(\phi_j\right) + F + f(q_{jH} + q_{jL})$, where CS is consumer surplus, and c^{ϕ} is the cost of enforcement. Governments in j have no interest in decreasing the profit of the firm located in j. Therefore, governments will only enforce production requirements, if the firm not located in j is non-compliant.

If non-compliant behavior of a firm results in harmful effects in j, incentives for enforcing the standard increase. For instance, non-compliance could result in per-unit emissions of a harmful pollutant (which is not considered to be harmful for consumers, so they do not consider this to be a quality decrease). If these emissions result from consumption, the incentive for the government to enforce compliance would increase. If emissions are production-generated, there may result an incentive for the government located in j to enforce non-compliant behavior of the firm located in j.

4 Conclusion

This paper has studied the incentives for non-compliant behavior in a two-country duopoly with vertical product differentiation. Both firms have an incentive for non-compliant behavior, while both firms would prefer that the other firm is compliant. But no firm would like to be compliant if the other firm is not. Therefore non-compliance is contagious. The incentives for non-compliance depend on the product quality. The high-quality firm has a higher incentive for non-compliance than the low-quality firm. This implication could be of some interest for public authorities in calibrating their enforcement policy. So far, we have assumed that enforcement is symmetrically for both firms. For further research, we could consider that public authorities anticipate the asymmetric incentives for firms.

If non-compliance results in cross-border damage, incentives for cooperation of governments could arise. This is also left for future research.

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