

Ecological Communication about Ecological Issues: A Field Experiment on Extended Producer Responsibility

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Abstract

Extended Producer Responsibility (EPR) is a public policy that holds producers accountable for the post-consumer stage of their products. In Slovakia, producers are required to register in the national producer registry and pay the corresponding fees. However, a significant number of producers – particularly those dealing with packaging and non-packaging products – fail to comply, effectively becoming free riders. To compare the effectiveness of electronic versus paper-based communication, we sent registration and payment reminders to over 3,000 firms. Among companies established in the previous year, there was no significant difference in registration rates between the two types of communication. However, for longer-established firms, paper-based reminders proved more effective when the message consisted only of a general reminder. This difference disappeared when the reminder included a threat of penalty, suggesting that electronic and paper-based messages were equally effective in that context.

Keywords: *field experiment, randomized controlled trial, communication methods, waste disposal, extended producer responsibility*

JEL Classification: Q52, Q53, Q58, D01, D02, D22, D81, D83, D91, C93

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Introduction

Extended Producer Responsibility (EPR) is a public policy that shifts responsibility for products at the end of their life cycle from consumers to producers. It introduces a financial incentive for producers through variable fees based on the materials used in production, as producers are the ones who determine the technical and material specifications of their products. The goal is to encourage the use of environmentally friendly materials by offering lower fees for such materials compared to their alternatives. At the same time, EPR aims to promote better product design, improve waste management, increase waste separation and material recovery, and enhance transparency within the system (OECD, 2024).

In Slovakia, EPR currently applies to electrical equipment, batteries and accumulators, vehicles, tires, as well as packaging and non-packaging products. This study focuses on improving compliance in the packaging and non-packaging products category, which has been identified as particularly vulnerable due to systemic shortcomings and instability within the framework (Dráb et al., 2020).

The policy for this product group has been in place in its current form in Slovakia since 2016, with minor adjustments made periodically. Producers are legally required to register in the registry of specific products and begin paying the corresponding fees to producer responsibility organizations. They must independently select and contact one of these organizations to sign a contract. However, the Institute for Environmental Policy (IEP) has highlighted several issues related to fee structures – such as inappropriate fee levels for certain materials, the exclusion of littering responsibilities, and insufficient enforcement – that create significant opportunities for free riding. The Slovak Environmental Inspectorate (SIZP), which is responsible for inspecting producers, faces capacity constraints and therefore struggles to enforce the policy effectively. As a result, penalties are rarely applied, and when they are, they tend to be very low (Dráb et al., 2020).

To help reduce the number of free riders in the system, we implemented a soft policy instrument – a simple reminder issued by the Ministry of Environment about the obligation to register. To evaluate its effectiveness, we conducted a field experiment in which more than 3,000 messages were sent to producers, reminding them of their duty to register in the relevant registries and to pay the associated fees for packaging and non-packaging products.

In this paper, we compare the outcomes of two different forms of the reminder, each with two variations in content. Some producers were contacted via a traditional paper-based letter, while others received a more environmentally friendly electronic notification through the Central Government Portal. We then analysed the registration rates in the months following the intervention, comparing them to a control group that received no communication from the Ministry.

We also assess the impact of message content by comparing a simple general reminder with a version that included an explicit threat of penalty. Our main contribution lies in the comparison of different communication channels combined with varying message content in a real-life setting. In addition, evaluating the effectiveness of electronic communication is particularly relevant given the environmental context of the message itself.

The paper is structured as follows. Section 1 presents the motivation for the treatment design and provides background information on Extended Producer Responsibility. Section 2 describes the experimental design, outlines the main hypotheses, and specifies the sample of firms included in the study. Section 3 presents and discusses the results, and the last section concludes.

1. Motivation and Background

Reminders are commonly used as a soft instrument to encourage compliance with legal obligations, and their effectiveness has been studied across various contexts (Bott et al., 2019; Drago et al., 2020; Heynes et al., 2013; Kettle et al., 2016). Public authorities in different countries employ diverse communication methods such as letters, emails, SMS, or website notifications to reach target groups (Hernandez et al., 2017). Such communication not only reminds individuals of their responsibilities – whether they have forgotten or were unaware in the first place – but also serves to signal the importance of the issue to recipients (Ortega and Scartascini, 2020).

Governments may also favour behavioural interventions like reminders because they offer additional advantages, including cost-effectiveness and ease of implementation (Hernandez et al., 2017). Importantly, these interventions do not require precise identification of non-compliers – a task that is often difficult. Instead, they can be applied to a broader sample of potential non-compliers (Drago et al., 2020; Eerola et al., 2019).

This approach is applicable in our case, as it is not always clear which specific firms are failing to comply and which are exempt due to not meeting the legal criteria. Therefore, messages were sent to a wider group of firms identified as the most likely to fall under the rules of Extended Producer Responsibility for packaging and non-packaging products.

1.1. Choice of Treatments

Our main objective is to compare the effectiveness of paper-based communication versus electronic communication by the government in improving compliance with financial obligations related to an environmental policy. Specifically,

we evaluate the impact of using the Central Government Portal as a delivery method, which is more cost-effective since it incurs no message fees, in contrast to traditional postal mail delivery by Slovak Postal Services.

This evaluation is necessary due to the different channels through which communication methods may influence recipients' decisions to register or to declare and pay the required fees and taxes. The chosen communication method can be perceived as a signal of the importance of the issue from the sender. Moreover, methods may differ in terms of reliability, trustworthiness, and effectiveness in reaching the intended recipients (Ortega and Scartascini, 2020). Our research builds on previous studies that have shown positive effects of non-traditional communication methods – such as personal visits, hand-delivered letters, or emails – on tax and fee compliance (Doerrenberg and Schmitz, 2017; Feher and Menashe, 2021; Ortega and Scartascini, 2020).

The content of both the letter and the electronic notification was grounded in basic principles of behavioral economics. Prior research has demonstrated that simple, informative letters can positively influence compliance in the context of various fees and taxes (Chirico et al., 2016; Fellner et al., 2013; Hernandez et al., 2017). Drawing on evidence that simplification improves compliance (De Neve et al., 2021; Dwenger et al., 2016), the message was designed to be concise, straightforward, and easy to understand.

Each message was also personalized by addressing it directly to the firm, as personalization has been shown to enhance compliance (Haynes et al., 2013; Lu et al., 2016). The general reminder was purely informative, without specific references to detection probabilities. However, in line with Eerola et al. (2019), we expect the perceived probability of detection to increase due to the message being signed by an authoritative body and containing clear instructions on how to fulfil the Extended Producer Responsibility obligations.

To enable a broader comparison of communication method effectiveness, we included a second type of message in our experiment. This allowed us to examine the interaction between the form and content of the message. The second message was nearly identical to the first but included an additional sentence emphasizing the maximum possible fine for non-compliance. This deterrence element was chosen based on its demonstrated success in previous experiments involving reminders about financial obligations (Fellner et al., 2013; Lu et al., 2016). Effective deterrence messages typically focus on one or both of the following: the probability of detection and the magnitude of the penalty or other consequences (De Neve et al., 2021; Fellner et al., 2013; Pomeranz, 2015). In our case, the message concentrated solely on the size of the potential penalty, which is substantial under Slovak legislation.

Our experiment also builds on prior behavioural interventions conducted in Slovakia. The design benefits from earlier findings showing that reminder letters increased the reporting of capital gains taxes (Rybošová et al., 2021), that simplifying letters led to higher compliance with TV license fee payments (Priesol et al., 2023), and that incorporating deterrence messages in annual letters from the Social Insurance Agency increased social insurance contributions by raising the perceived probability of detection (Priesol et al., 2024).

1.2. Extended Producer Responsibility Policy

Extended Producer Responsibility (EPR), as the name suggests, extends the responsibility of producers to the final stage of their product's life cycle. This means that producers are held accountable for the treatment of waste generated from their products, which they finance through corresponding fees based on the type and quantity of materials used. The fee structure is intended to incentivize more environmentally responsible decisions by applying differentiated charges depending on a material's recyclability or recoverability (OECD, 2024).

In addition to influencing producers, the system is also designed to encourage consumers to sort their waste. Since producers finance the processing of sorted waste – but not mixed residual waste – consumers are indirectly motivated to separate their waste to reduce overall financial costs. However, according to the Institute for Environmental Policy, this mechanism is not consistently followed in practice (Dráb et al., 2020).

To implement the policy systematically, producers of specified products are legally required to register in relevant registries and subsequently pay for waste treatment, as stipulated by Act No. 79/2015 of the Collection of Laws on Waste. This obligation can be fulfilled either through producer responsibility organizations (PROs) or, in limited cases, individually. The option for individual compliance applies only in specific circumstances – for instance, when a firm produces less than 100 kg of the designated product annually, or can demonstrate that its waste does not enter municipal waste streams (e.g., if the firm handles the waste internally).

In most cases, funds for processing sorted waste are administered through PROs. Producers are expected to select a PRO, sign a contract, and pay the corresponding fees. In exchange, these organizations represent the producers and indirectly ensure the collection and treatment of their waste.

However, it is estimated that between 15% and 30% of producers fail to meet these obligations and may therefore be considered free riders (Supreme Audit Office of the Slovak Republic, 2020).

2. Methodology and Data

We conducted a field experiment to compare two alternative communication methods and two variations in message content used by the Ministry of Environment to engage potential free riders under the Extended Producer Responsibility scheme. The experiment employed a between-subjects design with four treatment groups. Both communication methods – electronic and paper-based – were used to deliver both types of messages: a general reminder and a reminder that included a threat of penalty.

To evaluate the impact of these interventions, we compared the registration rates of contacted firms with those of a control group that received no communication. The outcome of interest was registration in the official registries of producers of packaging and non-packaging products during the six-month period following the intervention.

2.1. Treatment Groups

We employed an orthogonal experimental design that resulted in four treatment groups and one control group, which received no communication. The first dimension of the treatment distinguished between two communication methods: a paper-based letter (T1) and an electronic notification (T2) sent by the Ministry of Environment via the Central Government Portal.

Both formats contained the same content, differing only in how links to the relevant resources were presented. Specifically, the paper-based letter included an explicitly written URL and a printed QR code for convenient access to the registry of producers and the list of producer responsibility organizations. In contrast, the electronic notification contained hyperlinks embedded in the text, indicated by the phrase „this webpage.” Apart from this difference in link formatting, the wording and design of the paper-based and electronic messages were identical.

In addition to testing communication method, we applied an orthogonal variation in the content of the message. The two content types – referred to as the general reminder (TA) and the reminder with a threat of penalty (TB) – differed by a single sentence in the second paragraph. Both versions (English translations are available in the Appendix) were personally addressed to the recipient firm, in line with findings that personalization increases compliance (Haynes et al., 2013). They provided a clear explanation of the policy’s applicability and recommended next steps in a concise and simple format, following the principle of simplification (De Neve et al., 2021).

The general reminder (TA) maintained an informative tone and did not reference any consequences of non-compliance. In contrast, the reminder with a threat of penalty (TB) was identical in structure and tone but included an additional sentence:

„However, remember that if you do not fulfil your legal obligations, you may be fined up to 120,000 euros.” This sentence served as a deterrence element, which has been shown to increase compliance (Fellner et al., 2013). This was the only difference between the two versions, both in the paper-based and electronic formats. By combining the method treatments (T1 and T2) with the content treatments (TA and TB), we established four distinct treatment groups.

2.2. Sample and Procedures

The experiment was conducted in April 2023 on a sample of 4,926 firms. We focused specifically on registration in the registries of producers of packaging and non-packaging products, as these categories are the most susceptible to free riding (Dráb et al., 2020). Because it was not possible to definitively identify which firms were legally required to register, we targeted a broader group – firms operating in sectors where the registration rate in these two registries exceeds 10% (see Table 1).

Table 1

Economic Sectors with the Registration Rate at Least 10%

NACE	Title of subsector	Registration rate (in %)
C.10	Manufacture of food products	20.18
C.11	Manufacture of beverages	16.89
C.13	Manufacture of textiles	10.39
C.15	Manufacture of leather and related products	15.65
C.17	Manufacture of paper and paper products	27.92
C.18	Printing and reproduction of recorded media	15.52
C.20	Manufacture of chemicals and chemical products	27.27
C.22	Manufacture of rubber and plastic products	26.28
C.23	Manufacture of other non-metallic mineral products	10.14
C.24	Manufacture of basic metals	11.51
C.27	Manufacture of electrical equipment	14.75
C.28	Manufacture of machinery and equipment n.e.c.	17.11
C.29	Manufacture of motor vehicles, trailers and semi-trailers	27.88
C.31	Manufacture of furniture	17.92
G.46	Wholesale trade, except of motor vehicles and motorcycles	15.83
G.47	Retail trade, except of motor vehicles and motorcycles	12.20

Note: The registration rate refers to the proportion of firms within a given NACE division that were registered in the registries of producers of packaging and non-packaging products, relative to the total number of firms in that NACE division in Slovakia as of January 2023.

Source: Author's own calculation based on the ISOH database.

Our full sample was composed of two subsamples. The first subsample included firms established in 2021 or earlier (referred to as „older firms“). These firms had been active for more than one year and, as such, had already prepared at least one annual financial statement and filed at least one tax return. Therefore, they could be expected to have sufficient information to estimate their annual production of packaging and non-packaging products and to understand their legal obligations under the EPR system. Based on this, we anticipated a low rate of spontaneous registration within the control group – i.e. without any external prompting.

From a pool of approximately 49,000 unregistered older firms operating in sectors with registration rates above 10%, we excluded those with annual sales below 100,000 EUR based on their most recent tax declarations, as such firms may fall below the threshold of relevance for EPR obligations. We then randomly selected 3,000 firms for inclusion in the experiment. These firms were stratified into treatment and control groups according to several characteristics: business sector, region, municipality size, number of employees, declared sales, and company age.

The second subsample consisted of firms established in 2022 (referred to as „new firms“). At the time of the experiment’s preparation, these firms had not yet reached the deadline for submitting their first tax return. Given their relatively short time in the market, we expected a higher number of new registrations in the control group compared to older firms.

There were 1,926 unregistered firms founded in 2022 operating in sectors where the registration rate in the packaging and non-packaging producer registries exceeded 10%. As no data were available on the number of employees or sales for these firms at the time, we included the entire population in the experiment. This group also covered very new and very small firms that may not have initiated production yet and were therefore unlikely to register during the experimental period. All firms in this subsample were stratified according to business sector, region, and the size of the municipality in which they were based.

Initially, both new and older firms were divided into three equally sized groups. The first group received no communication (T0) and served as the control group. The second group received a paper-based letter (T1); this group was further divided equally, with half receiving a general reminder (T1A) and the other half receiving a reminder containing a threat of penalty (T1B). The third group received an electronic notification (T2) delivered via the Central Government Portal; again, half received the general reminder (T2A) and the other half received the reminder containing a threat of penalty (T2B). The exact number of firms in each treatment group is shown in Table 2.

Table 2

Stratification of Firms into Treatment Cells

	Control group (T0)	General reminder (TA)	Reminder with a threat (TB)	Total number of firms
Control group (T0)	645 / 1001			645 / 1001
Paper-based letter (T1)		320 / 489	321 / 514	641 / 1003
Electronic notification (T2)		318 / 505	322 / 491	640 / 996
Total number of firms	645 / 1001	638 / 994	643 / 1005	1926 / 3000

Note: The first number refers to the number of new firms established in 2022, while the second number refers to the number of older firms established prior to 2022.

Source: Author’s own calculation based on MF SR data.

The messages were sent to firms in April 2023. At no point were the firms or their representatives deceived during the experiment, and the procedures used did not cause any discomfort or harm. No sensitive data were collected from the firms or their representatives in connection with the project. All collected data were stored securely and have been presented only in aggregate form. Access to the data was restricted to employees of authorized government offices responsible for monitoring compliance with Extended Producer Responsibility and for conducting related research.

A total of 96 firms could not be reached due to undelivered messages and were therefore excluded from the analysis. Based on the available data, we identified no signs of selection bias. Specifically, there were no systematic differences in the characteristics of unreachable firms in terms of business sector, region, municipality size, and, for older firms, the number of employees, reported sales, and length of operation. The analysis of registration rates was conducted in October 2023 on the remaining 4,830 firms.

2.3. Outcome and Hypotheses

To evaluate the effectiveness of our interventions, we defined the registration rate in the registries of producers of packaging and non-packaging products – measured six months after the messages were sent – as the primary outcome variable. We then compared registration rates between the treatment and control groups, separately for new and older firms.

In total, we formulated three hypotheses. The first is as follows:

Hypothesis 1: Both new and older firms are more likely to register if they receive any reminder regarding their legal obligation to register.

This hypothesis is based on the assumption that a major reason for non-registration is a lack of awareness among producers about their legal responsibilities. If this is the case, we would expect significantly higher registration rates in the treatment groups compared to the control group. This expectation is supported by findings from previous studies that documented the positive effects of sending reminder letters in similar contexts (Bott et al., 2019; Hallsworth et al., 2017; Rybošová et al., 2021).

Hypothesis 2: Both new and older firms are more likely to register if they receive a paper-based message than if they receive an electronic message with the same content.

The method of message delivery may signal the importance of the issue to the sender and may also be perceived differently in terms of trustworthiness and seriousness (Ortega and Scartascini, 2020). Based on this, we hypothesized that

a paper-based message delivered via traditional mail serves as a stronger signal of importance than an electronic message sent online, primarily because it is more costly to deliver. A higher-cost communication may lead the recipient to believe that the sender places greater importance on the matter, which could in turn increase the perceived likelihood of follow-up actions – such as audits, penalties, or other sanctions – in the event of non-compliance. Accordingly, we expected a significantly higher registration rate in the paper-based treatment group (T1) compared to the electronic message group (T2), supporting the hypothesis.

Hypothesis 3: Both new and older firms are more likely to register if they receive a reminder that includes a threat of penalty, compared to an otherwise identical reminder without such a threat.

Drawing on existing literature, we hypothesized that including specific information about the potential for a relatively high financial penalty would further increase compliance beyond that achieved with a general reminder (De Neve et al., 2021; Fellner et al., 2013). We therefore expected a significantly higher registration rate in the deterrence message group (TB) compared to the general reminder group (TA), providing support for this hypothesis.

3. Results and Discussion

We analysed the registration rate of firms in the registries of producers of packaging and non-packaging products over a six-month period following the intervention –specifically, from April 17th, 2023, to October 17th, 2023. The analysis was conducted separately for the sample of new firms and the sample of older firms. We compared the registration rates across treatment and control groups within each subsample.

This approach allowed us to distinguish between the effects of the messages on firms established in the previous year –who may still be adjusting to their legal obligations – and those established earlier, which are assumed to operate more steadily, based on sales data, and to have greater awareness of their compliance responsibilities stemming from their ongoing production activities. By separately analysing new and older firms, we aim to provide more targeted insights for designing effective communication strategies in future annual outreach campaigns.

As a robustness check, we repeated the analysis on the full sample, which confirmed our main results (see Table A1 in the Appendix). All regression models were estimated using robust standard errors. In addition, we performed an auxiliary analysis of registration rates within the first three months after the intervention (Tables A3 and A4 in the Appendix).

3.1. Results for Older Firms

In the group of older firms, we observed significant differences in registration rates across the various treatment groups, despite the overall number of registrations being relatively low. Only one firm in the control group registered during the six-month observation period. In contrast, among firms that received any form of communication, the registration rate increased by 3.8 percentage points – an effect that is statistically significant (see Table 3).

These findings support our first hypothesis, suggesting that firms contacted with a reminder are more likely to register than those who were not approached. This effect is likely attributable to a lack of information among firms (Bott et al., 2019) or an increase in the perceived probability of detection following contact by an official authority (Eerola et al., 2019).

However, the effectiveness of the intervention varied by communication method. Firms contacted via electronic notification exhibited a 3.0 percentage point increase in registration, whereas those contacted via paper-based letters showed a larger increase of 4.6 percentage points (Table 3). Although the difference between the two communication methods is only weakly significant,¹ it lends some support to our second hypothesis. This result is unlikely to be driven by differences in how effectively the messages reached recipients, as unreachable firms were excluded from the analysis. Instead, the paper-based letter may have served as a stronger signal of importance or as a more trustworthy form of communication (Ortega and Scartascini, 2020).

Moreover, we observed a substantial and statistically significant difference between the effectiveness of the two message types. The general reminder increased the registration rate by 1.8 percentage points, while the message that included a threat of penalty led to a much larger increase of 5.7 percentage points (Table 3). These findings strongly support our third hypothesis and align with existing literature suggesting that messages highlighting potential penalties are more effective in eliciting compliance. Explicit reference to penalties in official correspondence can make the costs of non-compliance more salient, which is particularly effective when the communication also encourages immediate action (De Neve et al., 2021).

Additionally, the inclusion of a deterrence message may provide new information to the recipient. If this increases their perceived subjective probability of detection, it changes the cost-benefit calculation of non-compliance – in this case, avoiding registration (Bott et al., 2019).

¹ We refer to results as weakly significant at the 10% level ($p < 0.10$) and as statistically significant at the 5% level ($p < 0.05$).

Table 3

Results of Regressions of the Treatments on the Registration Rate Six Months after the Messages Were Sent on the Sample of Older Firms Established before 2022

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Any message	0.0379 (0.0045) ***						
Paper-based letter		0.0461 (0.0069) ***			0.0163 (0.0087) *		0.0399 (0.0090) ***
Electronic notification		0.0299 (0.0056) ***					
General message			0.0183 (0.0045) ***				
Message with threat			0.0573 (0.0075) ***			0.0390 (0.0087) ***	0.0626 (0.0110) ***
General letter				0.0388 (0.0091) ***			
Letter with threat				0.0530 (0.0102) ***			
General notification				–0.0011 (0.0012)			
Notification with threat				0.0617 (0.0110) ***			
Interaction of letter and threat							–0.0484 (0.0175) ***
Constant	–0.0205 (0.0186)	–0.0204 (0.0185)	–0.0216 (0.0186)	–0.0205 (0.0185)	–0.0014 (0.0271)	–0.0146 (0.0275)	–0.0323 (0.0271)
Observations	2,974	2,974	2,974	2,974	1,973	1,973	1,973
R-squared	0.016	0.018	0.026	0.031	0.006	0.015	0.020

Note: All regressions include the following control variables: number of employees, sales reported in tax declarations, firm age, business sector, region of operation, and municipality size. Columns 1 to 4 include all observations, while Columns 5 to 7 include only firms that received a message. Robust standard errors are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Source: Author's own calculation based on MF SR data.

By examining the interaction between the form and content of the message (Table 3), alongside registration rates in each treatment group (Table 4), we gain a deeper understanding of firms' behaviour. While both the paper-based letter and the electronic notification significantly increased registration rates overall, the effect of the electronic notification was entirely driven by the version that included a threat of penalty. The general notification had no statistically significant effect on registration. The observed difference in effectiveness between the letter and the notification is thus largely attributable to the ineffectiveness of the general notification – particularly since the notification with a threat of penalty actually led to a higher registration rate than the letter with the same threat.

The null results of the general notification treatment may be due to the communication method signalling low importance, having lower trustworthiness, or being perceived as less effective in reaching recipients (Ortega and Scartascini, 2020). However, since we excluded firms that we were not able to reach from the analysis, we do not attribute the null results to the actual reachability of the method. Furthermore, given that the difference between the effects of the general notification and the notification with a threat is significant – while the delivery method and its perceived trustworthiness are expected to be the same in both cases – we attribute the null effect of the general notification to its insufficient ability to signal the importance of the issue.

Table 4

Registration Rates of Older Firms

	Control group	General letter	Letter with a threat	General notification	Notification with a threat
Number of registered firms	1	19	27	0	31
Percentage of registered firms	0.1%	3.9%	5.3%	0.0%	6.3%

Note: The table shows the number of firms registered in the registries of producers of packaging and non-packaging products six months after the intervention, along with the percentage of registered firms out of the total number of firms in each treatment group.

Source: Author's own calculation based on MF SR data.

3.2. Results for New Firms

The results for the group of new firms – those established in the previous year – were slightly weaker but followed a similar pattern. In the control group, six firms registered during the six-month observation period. As expected, this represents a higher baseline registration rate compared to the group of older firms. Among firms that received any message, the registration rate was 1.0 percentage point higher than in the control group – a difference that is only weakly significant, but still offers tentative support for our first hypothesis. As before, we attribute this effect to increased awareness or a higher perceived probability of detection (Bott et al., 2019; Eerola et al., 2019).

However, the electronic notification did not significantly increase the registration rate, while the paper-based letter led to an increase of 1.3 percentage points (Table 5), a result that is also only weakly significant. The difference in effectiveness between the letter and the notification was not statistically significant, and therefore we do not find sufficient empirical evidence to support our second hypothesis in the case of new firms. This suggests that newly established firms may not perceive a substantial difference in the efficiency, trustworthiness, or importance of the message based on the communication method.

Moreover, the general message did not lead to a significant increase in the registration rate when compared to the control group. In contrast, the message that included a threat of penalty was effective: it not only significantly increased the registration rate relative to the control group, but also outperformed the general message. Specifically, the registration rate among firms receiving the message with a threat of penalty was 1.8 percentage points higher than in the control group and 1.6 percentage points higher than in the group receiving the general message (Table 5). These results are consistent with existing literature and support our third hypothesis. As in the case of older firms, explicitly stating the potential penalty for non-compliance likely increased the salience of the consequences and may have led recipients to update their subjective probability of detection (Bott et al., 2019; De Neve et al., 2021).

Table 5

Results of Regressions of the Treatments on the Registration Rate Six Months after the Messages Were Sent on the Sample of New Firms Established in 2022

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Any message	0.0103 (0.0055) *						
Paper-based letter		0.0130 (0.0073) *			0.0051 (0.0081)		0.0112 (0.0091)
Electronic notification		0.0078 (0.0064)					
General message			0.0022 (0.0058)				
Message with threat			0.0182 (0.0076) **			0.0160 (0.0080) **	0.0218 (0.0103) **
General letter				0.0082 (0.0088)			
Letter with threat				0.0176 (0.0102) *			
General notification				–0.0031 (0.0059)			
Notification with threat				0.0186 (0.0100) *			
Interaction of letter and threat							–0.0124 (0.0162)
Constant	–0.0056 (0.0141)	–0.0055 (0.0141)	–0.0057 (0.0141)	–0.0057 (0.0141)	0.0029 (0.0188)	–0.0032 (0.0189)	–0.0084 (0.0172)
Observations	1,856	1,856	1,856	1,856	1,211	1,211	1,211
R-squared	0.004	0.004	0.006	0.007	0.004	0.007	0.008

Note: All regressions include the following control variables: business sector, region of operation, and municipality size. Columns 1 to 4 include all observations, while Columns 5 to 7 include only firms that received a message. Robust standard errors are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Source: Author's own calculation based on MF SR data.

By examining the interaction between the form and content of the message (Table 5), along with registration rates in each treatment group (Table 6), we observe that the general message delivered via electronic notification had no significant effect – consistent with the results observed among older firms. However, unlike in the older firm group, the general message in the form of a paper-based letter also failed to produce a significant effect in the case of new firms. This suggests that the new firms contacted during the experiment may have refrained from registering for reasons other than a lack of information about the Extended Producer Responsibility system (Bott et al., 2019).

In contrast, messages that included a threat of penalty significantly increased registration rates – both when delivered as a paper-based letter and as an electronic notification. Furthermore, there was no significant difference between the effectiveness of the notification with a threat and the letter with a threat, again mirroring the pattern observed among older firms.

Table 6

Registration Rates of New Firms

	Control group	General letter	Letter with a threat	General notification	Notification with a threat
Number of registered firms	6	5	8	2	9
Percentage of registered firms	0.9%	1.6%	2.5%	0.6%	2.8%

Note: The table presents the number of firms registered in the registries of producers of packaging and non-packaging products six months after the intervention, along with the percentage of registered firms relative to the total number of firms in each treatment group.

Source: Author's own calculation based on MF SR data.

Concluding Remarks

We conducted a field experiment to evaluate the effectiveness of different communication strategies aimed at reducing the number of free riders in Slovakia's Extended Producer Responsibility (EPR) system. By sending simple reminders to potential non-compliant firms, we informed them about their obligation to register in the registries of producers of packaging and non-packaging products and to sign a contract with a producer responsibility organization (PRO) in order to pay the applicable product fees.

The experiment tested two different delivery formats: a traditional paper-based letter and an electronic notification sent via the Central Government Portal. We also tested two slightly different message contents. The first was a general reminder outlining the obligation, including who it applies to and what steps should be taken. The second was identical but included an additional sentence highlighting the potential penalty for non-compliance.

To assess the impact of the treatments, we measured the registration rate within six months of the messages being sent. Overall, reminders significantly increased the registration rate among contacted firms. Paper-based letters were more effective than electronic notifications among firms that had been established for at least one year – but only when the message did not mention a penalty. When the threat of a penalty was included, the effectiveness of the electronic notification rose to the same level as the paper-based letter, effectively eliminating the difference between communication formats.

Among newly established firms (those founded in the previous year), no significant difference was found between the communication formats. However, across both new and older firms, messages that included a threat of penalty consistently led to higher registration rates than general reminders. This highlights the importance of message content in improving compliance with EPR obligations.

There are some differences in outcomes between older and new firms, which may be attributed to varying perceptions of the communication methods. These differences could arise from differing signals of importance associated with the delivery format, varying levels of trust in the communication channels, or differences in the effectiveness of message delivery (Ortega and Scartascini, 2020). However, these discrepancies might also be influenced by the smaller sample size of new firms compared to older firms, or by differences in sample composition. Specifically, the new firm sample included all firms regardless of size, while the older firm sample included only those with annual sales exceeding 100,000 EUR – where the likelihood of relevant production activities (and thus the obligation to register) is higher. Regardless of the cause, we conclude that while the form of the message may act as a signal of the issue's importance for some firms, this signal becomes redundant when the content of the message sufficiently emphasizes the importance – such as through the inclusion of a penalty.

Our findings are relevant beyond Slovakia and may inform policy efforts in other countries as well. Extended Producer Responsibility is governed by several European Union directives, notably the Packaging and Packaging Waste Directive (PPWD), which mandates compliance across all member states (Mallick et al., 2024). Free riding poses a threat to the efficiency of EPR systems more broadly (Corsini and Frey, 2023), and our results contribute to the understanding of how soft enforcement tools can be used to address it.

We believe our findings are internationally applicable, especially since the use of penalties to increase compliance has been well documented across countries and policy domains (De Neve et al., 2021; Fellner et al., 2013). Moreover, sanctions for non-compliance within EPR systems are not unique to Slovakia; they have been successfully applied in other countries, such as Italy (Winternitz et al., 2019).

It is important to note that our experiment was limited to sectors with a registration rate above 10%. As such, the results should not be generalized to all firms across the economy. Unless there are significant underrepresented sectors with a large number of free riders, we would expect overall registration rates to be lower if the experiment were applied to the full population of firms. Additionally, messages related to Extended Producer Responsibility (EPR) may be perceived as irrelevant by firms in certain sectors, which could negatively affect the salience and addressability of the message. Therefore, in practical implementation, we recommend targeting only the most relevant sectors – particularly when exact identification of free riders is not feasible. However, the method for selecting those sectors may vary depending on the context.

It is also worth emphasizing that, even within the pre-selected sectors, the total number of registered firms remained relatively low. Several factors may contribute to this outcome. While we excluded firms for which message delivery failed, we had no way of confirming whether recipients actually read the message. Furthermore, the message may not have been considered trustworthy, may have failed to act as a sufficiently strong signal of importance, or may not have been simple and intuitive enough to be easily understood (De Neve et al., 2021; Ortega and Scartascini, 2020).

Given that the messages were sent officially by the Ministry of the Environment – either via postal service or through the Central Government Portal – it is reasonable to assume they were generally opened and perceived as legitimate. However, the content itself may not have been fully understood due to the use of some technical terms or legal concepts that are not intuitive to the general public² but couldn't be avoided. The messages may also have lacked perceived urgency or relevance, especially in light of weak law enforcement in this area (Dráb et al., 2020).

Based on these observations, we recommend that future research focus on two potential barriers to successful compliance: misunderstanding of the legal requirements and low perceived enforcement. Addressing these issues could improve both the effectiveness of communication strategies and overall compliance with EPR obligations.

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² This assumption is based on the practical experience of administrative staff at the Ministry of Environment of the Slovak Republic in handling public inquiries.

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Appendix

General reminder (TA)

Subject: Registration in the register of producers of packaging and non-packaging products

Dear XXX team,

Based on Extended Producer Responsibility (EPR), you may have a legal obligation to register in the register of producers of a specific product. This obligation arises under Act No. 79/2015 Coll. on waste for all producers of packaging or non-packaging products after they are placed on the Slovak market. If you do not fall into any of these categories, please consider this message as informative only.

What should you do now?



*You must enter a contractual relationship with your chosen **Producer Responsibility Organization (PRO)**, which will then register you in the relevant register and take over responsibility for the treatment of waste from your products. Please do so as soon as possible. The list of PROs can be found on the website <https://www.isoh.gov.sk/uvod/registre> (or scan the QR code on the left).*

*If you place less than 100 kg of packaging or non-packaging products on the market annually or can prove that the waste from your product is not part of municipal waste, the obligation to conclude a contract with the PRO does not apply to you. In this case, **you log in to the relevant register** on the website https://www.isoh.gov.sk/uvod/formulare/ziadost/registracia/registracia_vyrobcu (or scan the QR code on the right) and **fulfill your obligations individually**.³ When registering, you will need the following information:*

Identification data of the legal entity

- Contact details of the statutory body and contact person
- In the case of a foreign manufacturer, also details of the authorized representative



Regards,

Ministry of the Environment

³ If you produce both packaging and non-packaging products, you must register separately in the packaging register and separately in the non-packaging products register.

Reminder with a threat of penalty (TB)

Subject: Registration in the register of producers of packaging and non-packaging products

Dear XXX team,

Based on Extended Producer Responsibility (EPR), you may have a legal obligation to register in the register of producers of a specific product. This obligation arises under Act No. 79/2015 Coll. on waste for all producers of packaging or non-packaging products after they are placed on the Slovak market. If you do not fall into any of these categories, please consider this message as informative only. However, remember that if you do not fulfil your legal obligations, you may be fined up to 120,000 euros.

What should you do now?



You must enter a contractual relationship with your chosen Producer Responsibility Organization (PRO), which will then register you in the relevant register and take over responsibility for the treatment of waste from your products. Please do so as soon as possible. The list of PROs can be found on the website <https://www.isoh.gov.sk/uvod/registre> (or scan the QR code on the left).

If you place less than 100 kg of packaging or non-packaging products on the market annually or can prove that the waste from your product is not part of municipal waste, the obligation to conclude a contract with the PRO does not apply to you. In this case, you log in to the relevant register on the website https://www.isoh.gov.sk/uvod/formulare/ziadost/registracia/registracia_vyrobcu (or scan the QR code on the right) and fulfill your obligations individually.⁴ When registering, you will need the following information:

Identification data of the legal entity

- Contact details of the statutory body and contact person***
- In the case of a foreign manufacturer, also details of the authorized representative***



Regards,

Ministry of the Environment

⁴ If you produce both packaging and non-packaging products, you must register separately in the packaging register and separately in the non-packaging products register.

Table A1

Results of Regressions of the Treatments on the Registration Rate Six Months after the Messages Were Sent on the Full Sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Any message	0.0274 (0.0035) ***						
Paper-based letter		0.0337 (0.0051) ***			0.0120 (0.0062) *		0.0291 (0.0066) ***
Electronic notification		0.0215 (0.0042) ***					
General message			0.0122 (0.0036) ***				
Message with threat			0.0424 (0.0055) ***			0.0303 (0.0062) ***	0.0470 (0.0078) ***
General letter				0.0275 (0.0066) ***			
Letter with threat				0.0397 (0.0074) ***			
General notification				-0.0018 (0.0024)			
Notification with threat				0.0451 (0.0078) ***			
Interaction of letter and threat							-0.0348 (0.0125) ***
Constant	-0.0064 (0.0100)	-0.0064 (0.0100)	-0.0068 (0.0100)	-0.0065 (0.0100)	0.0143 (0.0149)	0.0042 (0.0151)	-0.0094 (0.0149)
Observations	4,830	4,830	4,830	4,830	3,184	3,184	3,184
R-squared	0.009	0.011	0.016	0.020	0.005	0.011	0.015

Note: All regressions include the following control variables: firm age (binary – whether the firm is new or older), business sector, region of operation, and municipality size. Columns 1 to 4 include all observations, while Columns 5 to 7 include only firms that received a message. Robust standard errors are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Source: Author's own calculation based on MF SR data.

Table A2

Results of Regressions of the Treatments on the Registration Rate Three Months after the Messages Were Sent on the Sample of Older Firms Established before 2022

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Any message	0.0274 (0.0037) ***						
Paper-based letter		0.0340 (0.0058) ***			0.0131 (0.0074) *		0.0276 (0.0075) ***
Electronic notification		0.0210 (0.0046) ***					
General message			0.0133 (0.0036) ***				
Message with threat			0.0413 (0.0063) ***			0.0281 (0.0073) ***	0.0426 (0.0091) ***
General letter				0.0275 (0.0075) ***			
Letter with threat				0.0401 (0.0088) ***			
General notification				0.0000 (0.0004)			
Notification with threat				0.0426 (0.0091) ***			
							-0.0299 (0.0147) **
Constant	-0.0033 (0.0157)	-0.0033 (0.0157)	-0.0041 (0.0157)	-0.0034 (0.0157)	0.0160 (0.0231)	0.0071 (0.0238)	-0.0052 (0.0231)
Observations	2,974	2,974	2,974	2,974	1,973	1,973	1,973
R-squared	0.012	0.014	0.019	0.023	0.006	0.012	0.015

Note: All regressions include the following control variables: number of employees, sales reported in tax declarations, firm age (duration of existence), business sector, region of operation, and municipality size. Columns 1 to 4 include all observations, while Columns 5 to 7 include only firms that received a message. Robust standard errors are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Source: Author's own calculation based on MF SR data.

Table A3

Results of Regressions of the Treatments on the Registration Rate Three Months after the Messages Were Sent on the Sample of New Firms Established in 2022

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Any message	0.0092 (0.0047) **						
Paper-based letter		0.0108 (0.0063) *			0.0028 (0.0072)		0.0038 (0.0077)
Electronic notification		0.0078 (0.0056)					
General message			0.0018 (0.0048)				
Message with threat			0.0164 (0.0067) **			0.0146 (0.0071) **	0.0156 (0.0093) *
General letter				0.0040 (0.0069)			
Letter with threat				0.0173 (0.0094) *			
General notification				0.0000 (0.0054)			
Notification with threat				0.0156 (0.0087) *			
Constant	−0.0040 (0.0108)	−0.0040 (0.0108)	−0.0041 (0.0108)	−0.0041 (0.0108)	0.0037 (0.0158)	−0.0026 (0.0163)	−0.0043 (0.0168)
Observations	1,856	1,856	1,856	1,856	1,211	1,211	1,211
R-squared	0.006	0.006	0.009	0.009	0.006	0.009	0.009

Note: All regressions include the following control variables: business sector, region of operation, and municipality size. Columns 1 to 4 include all observations, while Columns 5 to 7 include only firms that received a message. Robust standard errors are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Source: Author's own calculation based on MF SR data.