Environmental Economics and Policy Studies (2022) 24:307–340
https://doi.org/10.1007/s10018-021-00323-9

RESEARCH ARTICLE

Adoption of environmental standards and a lack of awareness: evidence from the food and beverage industry in Vietnam

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Received: 24 February 2021 / Accepted: 22 August 2021 / Published online: 1 September 2021

Abstract
Voluntary approaches to environmental policy can contribute to stemming environmental degradation in developing countries with weak institutions. We evaluate the role of a lack of awareness of a law in explaining the voluntary adoption of environmental certification by small and medium enterprises (SMEs) in the food and beverage industry in Vietnam. We find that firms, where owners or managers were unaware of the law were 38 percentage points less likely to receive environmental certification. Moreover, this effect is larger for firms that exported, had internet access or paid bribes, and it is weaker for household enterprises. Our results suggest that increasing legal awareness can weaken informational constraints for SMEs, where weak institutions and a lack of information often hamper the uptake of environmental policy initiatives.

Keywords Voluntary environmental standards · Lack of awareness · Small and medium enterprises · Food and beverage industry · Vietnam

JEL Classification D22 · D83 · D91 · O13 · Q56 · Q59

1 Introduction

Environmental degradation and climate change have significant negative consequences, not only on environmental quality and ecosystems, but also on food security, human health as well on livelihoods, both at the global as well as local levels (IPCC 2014). Given the scale of the problem, especially in developing countries that

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are least equipped to deal with its consequences (World Bank 2010), it is imperative to identify possible policy measures that may be relevant in ensuring environmental protection in these contexts, and to understand how to enhance their effectiveness.

Poor environmental quality is considered to be a hallmark of many areas in developing countries, especially as the process of development and urbanization gets underway (Greenstone and Jack 2015). Pollution due to industrial activities, exploitation of natural resources, biodiversity destruction, deforestation, as well as the unsustainable development of agriculture and aquaculture systems are some of the typical problems encountered in these settings, often exacerbated by rapid population growth (Greenstone and Jack 2015). The industrial sector is a significant contributor to environmental degradation in developing countries; for instance, it is one of the leading causes of water, solid waste and air pollution in Vietnam (International Trade Administration 2019). Thus, it is critical to ensure that firms in developing countries find means to reduce their negative environmental impact, and thereby advance the cause of sustainable development.

The set of available policy instruments that may be utilized to mitigate the environmental impact of firms can be categorized as those primarily employed by the state, and others which require initiative to be taken by the firms themselves (Gupta et al. 2007). The state must often intervene in the design and implementation of environmental policy instruments; these can broadly be classified as 'market-based instruments' that encourage changes in behavior through market signals (such as pollution charges, tradable permits, or subsidies) and 'non-market-based instruments' (including command-and-control regulations, such as technology or performance standards, as well as information disclosure programs) (Stavins 2001). Examples of environmental policy initiatives that can be taken by firms include corporate social responsibility (CSR) programs, as well as the adoption of voluntary certification (such as 'ecolabels') and environmental standards.

Voluntary certification and standards have been found to have the potential to achieve environmental targets in developing countries, at least under some conditions (Blackman 2010; Blackman and Guerrero 2012) in contexts, where traditional command-and-control policies have not always been very effective (Eskeland and Jimenez 1992), often because of poor enforcement, lack of funding or trained personnel, lack of political will and a lack of awareness. Weak institutions, and the associated shortcomings in regulatory capacity and implementation, have meant that policy instruments such as voluntary standards and certifications may be an effective means to ensure 'self-regulation' by firms (Khanna and Liao (2014) provide a comprehensive overview of the literature on voluntary standards in developing countries).

The current literature on environmental voluntary standards for firms in developing countries has evaluated the motivation for firms to obtain these certifications, and found that firms often undertake these in response to pressure from regulators, consumers, investors, or environmental interest groups (Khanna and Liao 2014). Examples of some firm-level characteristics that determine voluntary certification have been found to be foreign direct investment, firm size, whether the firm exports, and production of intermediate products (Tambunlertchai et al. 2013). However, some of these studies also find significant heterogeneity in adoption of these

standards, and that not all firms that may benefit from their adoption actually do so (Khanna and Liao 2014).

While this literature has evaluated the socio-economic determinants of voluntary certification, to the best of our knowledge, it has not considered behavioral traits of either owners or managers that may determine voluntary certification outcomes. For instance, a lack of awareness or a lack of interest on the presence or availability of these standards could explain why some firms do not adopt them. The idea of a lack of awareness can be linked to the broader concept of limited attention, which has been extensively studied within the realm of behavioral economics. Some studies have found that limited attention could be an important determinant of firms not undertaking actions that may be in their best interest in developing countries (Beaman et al. 2014). This relatively nascent literature suggests that firm owners may have trouble in attending to all aspects of their business, or have limited capacity to process all available information (Dellavigna 2009; Gabaix and Laibson 2006; Koszegi and Szeidl 2013; Hirshleifer and Teoh 2003). This may explain why in some contexts, firm owners may not adopt these standards, even if it may be beneficial to do so.

In this paper, our objective is to evaluate the role of a lack of awareness in explaining the voluntary adoption of environmental certification by small and medium enterprises (SMEs) in the food and beverage industry in Vietnam. Vietnam has grown rapidly in recent decades, and small and medium enterprises have been the dynamic force behind this growth, comprising almost 98% of all enterprises, and employing more than 60% of the workforce (and contributing to about 45% of the country's GDP) (General Statistics Office 2015). However, this industrialization has resulted in significant environmental deterioration: Vietnam ranks 132 out of 180 countries in the Environmental Protection Index (Wendling et al. 2018), and it ranks among the most affected countries in terms of air pollution (IQAir 2019).

The food industry accounts for about 26% of global greenhouse gas emissions (Poore and Nemecek 2018), with about 18% of these emissions accounted for by the supply chain (including food processing) (Ritchie 2020). While the food and beverage industry is notable for its scale of its environmental impact worldwide, these effects are particularly salient in developing countries. For instance, it contributes about 55% to industrial wastewater pollution in sub-Saharan Africa, and it's ranked second for its impact on air, water and soil pollution (along with rubber, plastics and leather) in South Asia (Stockholm Environmental Institute and University of York 2020).

The food and beverage industry is also one of the most pollution-intensive industries in Vietnam, and it is significant for both its scale of production[1], and its

[1] The food and beverage industry comprised the largest share of all enterprises, with 4480, or 21.9% of 20444 manufacturing firms in the country in 2004 belonging to it (Dore et al. 2008). Not only did this sector represent 40.4% of the total value produced by locally owned state enterprises, it also represented the largest share of all industrial value produced by both the domestic private sector (29.8%), and the foreign-invested sector (18.7%) in Vietnam in 2004 (Dore et al. 2008). Thus, it is an economically significant sector in Vietnam.

pollution load (Dore et al. 2008)[2]. Dore et al. (2008) identify this sector, along with textiles, and chemicals and chemical products, as the biggest contributors to industrial pollution in Vietnam.[3]

At the same time, Vietnam's growing middle class is demanding products certified as being environmentally friendly: according to a recent survey, Vietnamese consumers are among the most socially conscious in Asia-Pacific. Up to 86% of consumers in Vietnam are willing to pay more for products and services from firms that are committed to having a positive social and environmental impact (Nielsen 2015). Thus, in this context, not only can policy instruments such as voluntary environmental certificates contribute towards achieving environmental goals in Vietnam, but they are also likely to bring benefits to firms that obtain them (such as the potential for increased demand for their products, as well the possibility of exporting).

In this study, we analyze the voluntary adoption of an environmental standards certificate (ESC), also known as the 'certification for environmental protection works', using data on a sample of small and medium enterprises (SMEs). Our main explanatory variable captures whether owners or managers of the firm are unaware of (or lack interest in learning about) the Law on Environmental Protection (LEP), which contains detailed and extensive information on how firms can obtain this certification, and is thus an important source of information on how firms can get certified.

The key regulatory instrument at the disposal of policy-makers in Vietnam is the LEP.[4] This law serves as the basis for industrial pollution management policies in Vietnam, as well as for the framing and implementation of environmental standards.

The LEP requires that firms that can produce at a certain minimum scale in specific industries conduct an environmental impact assessment (EIA) before starting operations, with the right to start or continue their business only when their EIA reports have been reviewed, and approved by the State Management Agency for Environmental Protection (The Government of Vietnam 2015; Vietnam Law and Legal Forum 2008).[5] The EIA is expected to provide a detailed description of the project, as well as important information on its environmental impact on the site,

[2] Food processing (particularly seafood processing which includes cold-storage, freezing, drying, and smoking and canning of fish, shrimp, squid, shellfish, algae, and other marine products, as well as the production of fish oil and sauces, seasoning products, and fish meal) has a very high overall environmental impact.

[3] While there is scant information on pollution abatement and control expenditures by firms in Vietnam, the Vietnam General Statistics Office (GSO) conducted a business survey in 2002, where this was asked to firms. While not all firms provided this information, among those that did, the food and beverage industry was the leading industrial sector for pollution abatement and control expenditures (in terms of amount spent) (Dore et al. 2008).

[4] The framing of environmental regulation in Vietnam began with the passing of the LEP in 1993, providing the framework for legal, institutional and administrative instruments for environmental protection in Vietnam. The law was substantially amended in 2005 (as well as in 2015) to increase the stringency of enforcement, as well as to increase the scope of regulation to tackle the environmental challenges in the country.

[5] All other firms that are not required to submit an EIA (i.e., the smaller firms) are expected to submit an environmental protection plan, barring firms belonging to specific sectors or lines of business, such as retail establishments.

and potential risks due to environmental incidents. Moreover, it requires owners to state measures that they plan to take to address any possible environmental concerns, and with these any other environmental commitments as well (Vietnam Law and Legal Forum 2008).

On being granted the approval for the EIA, they then must submit documents to get an inspection done for pollution control. Firms are granted an environmental standards certificate (ESC), or "certificate for completion of environmental protection works" (as it is now called after the amendment of the LEP in 2015) if they comply with the requirements set forth in the EIA, as well as successfully pass the inspection requirements (Vietnam Law and Legal Forum 2008).

Firms that have been granted the ESC receive a signed certificate from the competent authority, normally the same one that conducts the appraisal of the EIA, stating that they have met the requirements for the certification. The criteria for obtaining the ESC are more stringent (especially in terms of treatment as well as monitoring requirements) than those for other forms of environmental certification such as the those for the environmental protection plans. Applications can be rejected if they do not provide sufficient evidence that the firm has taken steps to treat different forms of pollutants, or been monitoring its waste, and firms must continue monitoring environmental performance even after having received certification. Firms found lacking in providing sufficient means of treating environmental factors may receive an extension of the deadline, as well as recommendations from the competent authorities on measures to implement (Vietnam Law and Legal Forum 2008; The Government of Vietnam 2015).

Of course, it is possible for owners or managers of firms to obtain the ESC, irrespective of whether they have knowledge on the LEP. For instance, customers (both other firms as well as individuals) may choose to purchase products only from firms that have been certified, which could incentivize firms to obtain certification. Moreover, firms may learn about certification (and its possible benefits) from other firms. At the same time, being knowledgeable of the LEP and the ESC doesn't imply that owners or managers will obtain certification (it may be too costly, for instance, especially for smaller firms). Thus, while deeper knowledge on the legal framework can be expected to augment the likelihood of voluntary adoption of standards, it is unlikely to result in all firms getting certified. In our paper, we are interested in understanding the contribution (if any) of legal awareness or knowledge in improving voluntary certification outcomes, given that the law is an important source of information on the certificates.

While obtaining this certification is mandatory[6] for large firms belonging to specific sectors in Vietnam, in this paper, we focus on the voluntary adoption of these standards in a sample of small and medium enterprises (SMEs) in the food and beverage industry of Vietnam. We use unbalanced panel data from the UNU–WIDER Vietnam SME firm-level database (United Nations University UNU-WIDER 2011)

[6] Firms that do not conduct an EIA (if they are required to do so), and thus do not obtain the ESC, may face sanctions, varying in severity from monetary penalties, to a complete shutdown.

that collects information on about 2500 firms, mostly SMEs, across industries from 2011 to 2015 biennially.

Our paper presents evidence spanning various estimation methodologies on the effect of a lack of awareness on certification. We employ a probit estimator, a recursive bivariate estimator that is equipped to correct for possible endogeneity, and combine the recursive bivariate methodology with the Mundlak/Chamberlain adjustment (Mundlak 1978; Chamberlain 1982) to address possible unobserved heterogeneity. While the use of the recursive bivariate framework enables identification through assumptions on functional form, we choose to employ an excluded instrument in our first-stage estimation.

We find that firms that lacked awareness of the LEP were 38 percentage points less likely to be certified than firms, where respondents had some knowledge of the law; thus, owners and managers being at least somewhat knowledgeable of the LEP has a noteworthy impact on the likelihood of the firm receiving certification for meeting environmental standards. We control for several other factors that have been found to be important determinants of voluntary certification in the literature.

Moreover, we find heterogeneity in the size of this effect across different dimensions. For example, we find that firms whose owners or managers are college-educated, those that export their goods, or those that have internet access were more likely to have obtained the voluntary certification if they were aware of the LEP. We find the reverse for household enterprises, i.e., they are less likely to be certified, even when they are aware of the LEP.

Our contribution to the literature is that our study provides evidence on the role that psychological or behavioral traits of owners and managers (such as a lack of awareness or interest) can play in hindering the effectiveness of environmental policy instruments (such as the adoption of voluntary environmental certification) for firms in a developing country. We use self-reported information on awareness about the LEP to establish that firms, where owners or managers are more attentive to availability of instruments such as environmental certificates are more likely to make conscious efforts to treat environmental factors (and thus satisfy environmental standards).

Moreover, we also add to the literature on the determinants of a lack of awareness on part of owners and managers, and identify both firm-level and respondent-level factors that may lead to individuals being more aware/knowledgeable of environmental laws. Of course, these factors are likely to be context-specific; however, they still provide interesting insights into how policy-makers can target information and education campaigns.

We believe that it is interesting to find that owners/managers of firms lacking awareness of the law are less likely to adopt environmental standards, given that knowledge of the law increases the probability of learning about the standards themselves, which is likely to augment their adoption on a voluntary basis. The policy implications of this study relate to the importance of informing and educating firm owners and managers about the availability of voluntary environmental instruments, as well as enabling them to understand the legal framework better, given that legal awareness is likely to weaken at least some information constraints for small and medium enterprises. This is of pivotal interest in developing countries, where weak

institutions and a lack of information may hamper the uptake of environmental policy initiatives by firms.

The structure of the paper is as follows: Sect. 2 provides a brief review of the literature, Sect. 3 provides details on the data and methodology used for the analysis, Sect. 4 includes the main results of the paper as well as additional results, while Sect. 5 concludes and includes policy implications.

2 Previous literature

Our paper fits into two strands of the economic literature, one on the determinants of adoption of voluntary environmental standards and certificates by firms, and the other on the role of a lack of awareness or knowledge in determining economic decisions.

Voluntary approaches for environmental protection have been used in several settings as an environmental policy instrument. In general, they have gained traction in industrialized countries, because of the benefits they offer over command-and-control regulation (such as speedier implementation, or reducing the administrative burden on regulatory agencies). Common examples of voluntary approaches adopted include participation in public voluntary programs established by regulatory agencies, negotiated agreements between governments and firms, and initiatives adopted independently by firms, such as certification, eco-labels, and adoption of environmental management systems (such as the ISO-14001) (Khanna and Liao 2014).

The literature on the adoption of voluntary environmental certification and standards in these countries has found that the effectiveness of this policy is, in many cases, mitigated due to "selection-type" problems, namely, that only the cleanest firms and plants obtain these certificates (Vidovic and Khanna 2007). For these firms, the marginal costs of certification are low, and the benefits are often of considerable magnitude.

Firms often adopt these standards under the influence of regulators, consumers, or environmental interest groups. They may do so to minimize current and future costs of compliance with environmental regulations (as Decker (2003) shows, firms obtain permits for new facilities more quickly if they have engaged in voluntary abatement); they may do so to nudge regulators about their compliance (and thus, avoid stricter monitoring), or they may do so to influence the design and prevent the increase in stringency of future regulations (Segerson and Miceli 1998). For instance, Videras and Alberini (2000), Innes and Sam (2008) and Vidovic and Khanna (2007) all find that firms were more likely to join the voluntary 33/50 Program of the United States Environmental Protection Agency (EPA) if they had more polluting sites, and released more toxic chemicals.

Of course, signalling about the environmentally friendly nature of their production to consumers (Arora and Gangopadhyay 1995), or attracting workers (who may be drawn to firms that project themselves to be environmentally conscious) are other important reasons for firms in industrialized countries to get certified on a voluntary basis (Khanna and Liao 2014). Evidence from industrialized countries also suggests that firms with more educated managers or workers, or those, where managers had a

bent towards protecting the environment, were more likely to adopt voluntary certificates (Ervin et al. 2012; Khanna and Speir 2013).

This literature finds a role for mandatory environmental regulation in spurring firms to obtain voluntary certification: Arimura et al. (2008) use data on Japanese firms, and find that plants subject to environmental performance standards and input taxes were more likely to be certified with the ISO 14001, while Potoski and Prakash (2005) find that plants inspected more often were more likely to be certified with it. Other important determinants of certification for firms in industrialized countries include firm size (which is found to be positively associated with adoption) (Arimura et al. 2008; King et al. 2005; Potoski and Prakash 2005) and sales to foreign buyers (King et al. 2005).

Environmental regulation take on a different dimension in developing countries, where weak institutions are a deterrent towards enforcement of regulation. Several papers in development economics have shown that in these settings, policy failures are common, especially when weak incentives and corruption are rampant (Banerjee et al. 2008; Duflo et al. 2012; Banerjee et al. 2013). Eskeland and Jimenez (1992) provide an introduction to the problems of enforcing policy instruments such as fiscal incentives and performance standards in settings with weak institutional characteristics.

The literature on voluntary environmental certification as an environmental policy instrument in developing countries is relatively thin. Given weak institutions, limited capacity to regulate and costly monitoring, the case for voluntary environmental programs such as certification and standards in developing countries is strong. Command-and-control regulation has been known to face institutional and political challenges in low and income country settings (Eskeland and Jimenez 1992). However, Vincent (2010) provides a comprehensive summary of studies that have found that alternate pollution control measures (such as public disclosure and voluntary programs) may have limited success in developing countries in some contexts. In contrast to industrialized countries, voluntary programs in developing countries are generally used to facilitate compliance with mandatory regulation (Blackman and Guerrero 2012).

Blackman et al. (2010) evaluated Mexico's Clean Industry Program, and found that plants that were fined for regulatory violations were more likely to participate in this voluntary program (that awarded firms recognition for submitting to an environmental audit), and that these firms were large and exported to foreign markets (and thus, were more likely to work to satisfy their customer's requirements, rather than only meet domestic regulations). The finding regarding firm size determining participation in voluntary programs is confirmed by Christmann and Taylor (2001) for Chinese firms and Tambunlertchai et al. (2013) for Thai firms, and regarding firms linked to overseas markets being more likely to participate is also confirmed by Montiel and Husted (2009) for Mexican firms, and again by Tambunlertchai et al. (2013).

Blackman et al. (2010) suggests that there are disparities in the adoption of voluntary programs, both within and across developing countries. While several firm-specific characteristics have been used to explain their adoption, the role of owner- or manager-specific behavioral traits, has not been explored in the

literature, to the best of our knowledge. One factor that may explain the under-adoption of such instruments by some firms is a lack of awareness (or interest) in learning about the availability of such instruments by owners of the firms. While not identical, this is somewhat related to the idea of limited attention, a behavioral anomaly that has been found to have an effect on decision-making in various contexts. The vast theoretical literature on limited attention (Dellavigna 2009; Gabaix and Laibson 2006; Koszegi and Szeidl 2013; Bordalo et al. 2013) pinpoints that owners and managers at firms may have limited ability to process all available information, and thus that they may not always take optimal business decisions.

There is an empirical literature from industrialized countries on the role of limited attention (also known as behavioral inattention) in undermining consumer decisions (Chetty et al. 2009; Hossain and Morgan 2006). There is also emerging evidence from developing countries: limited attention has been found to be an important determinant of sub-optimal decisions made by firms, as well as individuals. Beaman et al. (2014), for example, provide evidence from two randomized controlled trials with micro-enterprises in Kenya on the impact of bringing to salience the importance of keeping change, and found that firms were more attentive to keep change to run their businesses in response to being informed about it. Hanna et al. (2014) apply the model of limited attention to explain the decision of seaweed farmers in Indonesia to ignore information on pod size, which is an important input in determining output. Karlan et al. (2016) provide evidence from Bolivia, Peru and the Philippines on the role of reminders in inducing saving behavior among clients of banks.

To our knowledge, our paper is one of the first economic studies to look at the effect of a lack of awareness on the voluntary adoption of environmental certificates by firms in a developing country. We are aware of a couple of other studies that have looked at the role of policy or regulation awareness in environmentally oriented settings: Nkonya et al. (2008) assessed the effect of awareness on compliance with by-laws related to community resource management in Uganda, and Cerruti et al. (2019) evaluated the impact of policy awareness on the decision of households to invest in energy-efficient cars in Switzerland. Both studies have found awareness of regulations/policies to have a significant impact on decisions, as we find in our study as well.

3 Empirical approach and data

3.1 Model specification and empirical approach

To estimate the effect of a lack of awareness on the likelihood of obtaining the certificate for meeting environmental standards on a voluntary basis, we first estimate a simple discrete-choice model. Given the binary nature of our dependent variable, from an econometric point of view, we choose to estimate a univariate probit model. The model specification is as follows:

$$C_{i,t} = \alpha_0 + A_{i,t}\alpha_1 + X_{i,t}\alpha_2 + \eta_j + \gamma_t + \lambda_k + \mu_{i,t} \quad (1)$$

We define the variables used in the model below. $C_{i,t}$, our dependent variable, is a binary variable capturing whether the firm 'i' had an ESC (or a certificate for satisfying environmental standards) in period 't'. The main independent variable $A_{i,t}$ is a binary variable, indicating whether the respondent (either the owner, or the manager of the firm) lacked knowledge or awareness on, or did not have interest in learning about, the Law of Environmental Protection (LEP) (which provides detailed information on how firms can obtain the ESC) in period 't'.[7] The assumption here is that knowledge of the LEP is more likely to stimulate awareness on the presence of the ESCs, as well as on the procedure for obtaining them. $X_{i,t}$ denote the set of controls, η_j denotes a set of province 'j'-specific dummy variables, γ_t denotes year fixed effects, and λ_k denotes sub-sector 'k'-specific dummies. The set of control variables in the estimation $X_{i,t}$ includes various firm-level characteristics (such as whether the firm is a household enterprise, whether the firm has internet access, age of the firm, whether the firm exports, etc.) and respondent-level characteristics (such as gender, age, level of education, etc.).

As mentioned in the Introduction, the adoption of the ESC is mandatory for large firms (based on annual production capacity) within some sub-sectors, and it is voluntary for other firms within the food and beverage industry. In this study, we focus on the voluntary adoption of these standards, by dropping observations for the firms that need to obtain the ESC on a compulsory basis. More details are provided in the Data sub-section.

In our data set, the LEP awareness variable is categorical and with four levels for possible responses: "good", "average", "poor" and "no knowledge or not of my interest". There are two reasons for us to convert this information into a binary variable. First, the category "no knowledge or not of my interest" has the maximum responses, with 63% of respondents belonging to it in our regression sample (the shares are 1%, 11% and 25% for the remaining three categories, respectively). Second, the differences between the categories "good, "average" and "poor" are not necessarily clearly defined, and may introduce an element of subjectivity into our measure, whereas the fourth category is more unambiguous in definition, in our opinion. Thus, we categorize firms as 'lacking awareness' of the LEP if the respondents stated that they had no knowledge of the law, or that it was not of their interest. We acknowledge that a possible limitation of this approach is that we cannot disentangle the effect of no knowledge from that of not having interest in the LEP.

While this estimation is a natural starting point, it is difficult to rule out the concern of endogeneity in the estimation of model 1. It is highly plausible, for example, that firms that have the certificate for meeting environmental standards are more likely to be aware of the LEP, which suggests possible reverse causality in the above

[7] While the 2005 Law on Environmental Protection would have been valid for the first 2 years of our study (2011 and 2013), the 2015 amendment would be relevant for the firms in the final year of our data (2015). However, both versions of the law are very similar in aspects related to obtaining the EIA approval and the ESC, and thus are treated as identical in our analysis.

estimation. Moreover, it is likely that both the likelihood of having received a certificate, as well as a lack of awareness of the LEP, are influenced by factors unobservable to an econometrician such as respondent-level characteristics (for instance, how law-abiding they are), or firm-level traits (such as whether the firm hired the services of a legal consultant), leading to the possibility of correlated unobservables. Finally, measurement error in the variable capturing awareness is also a possible threat to identification, since this information is self-reported.

To address these concerns, we estimate a bivariate probit model, adopting the recursive structure proposed by Maddala (1986). This is our preferred choice of estimation to mitigate endogeneity concerns, given that we use a binary version of the possibly endogenous variable in our model, following Greene (2008, 2018).[8] In this context, we model the decision to get certified as a two-stage decision process. In the first stage we model whether the respondent (owner or manager) lacked awareness of the LEP, and then in the second stage, we model the choice of the firm to get the environmental certification. This two-stage process is modelled as shown below:

$$\begin{aligned} A^*_{i,t} &= \beta_0 + \beta_2 Z_{i,t} + \beta_3 X_{i,t} + \eta_j + \gamma_t + \lambda_k + \epsilon_{i,t}, A_{i,t} = 1 \text{ if } A^*_{i,t} > 0, A_{i,t} = 0 \text{ otherwise,} \\ C^*_{i,t} &= \alpha_0 + \alpha_1 A_{i,t} + \alpha_2 X_{i,t} + \eta_j + \gamma_t + \lambda_k + \mu_{i,t}, C_{i,t} = 1 \text{ if } C^*_{i,t} > 0, C_{i,t} = 0 \text{ otherwise.} \end{aligned} \tag{2}$$

where the assumption is that

$$[\epsilon_{i,t}, \mu_{i,t}] \sim \phi_2[(0,0),(1,1),\rho], \rho \in [-1,1] \tag{3}$$

and where $A^*_{i,t}$ and $C^*_{i,t}$ denote vectors of the latent continuous variables (instead of which the binary variables $A_{i,t}$ and $C_{i,t}$ are observed to the econometrician), $Z_{i,t}$ denotes our instrumental variable, $X_{i,t}$ is the vector of control variables, and $(\epsilon_{i,t},\mu_{i,t})$' is a vector of error terms described by ϕ_2, the bivariate standard normal distribution, with correlation given by ρ. The remaining variables are defined as they were earlier.

Model 2 is generally identified, even if $X_{1i} = X_{2i} = X_i$, i.e., the same set of control variables are used in both stages, granted enough variation is provided by the exogenous covariates in the model. In the narrow case in which $X_{1i} = X_{2i}$ = a set of dummy variables, the absence of an exclusion restriction may result in a failure of identification. A detailed discussion of this case, and on identification in the recursive bivariate model more generally, may be found in Wilde (2000), Mourifié and Méango (2014) and Han and Vytlacil (2017). Further discussion on identification is beyond the scope of this paper.

The main objective of this paper is to understand the determinants of the certification decision of firms, and to estimate the average treatment effect (ATE) of a lack of awareness of the LEP. For this reason, we think that the recursive bivariate model is appropriate when both the outcome variable as well as the endogenous regressor are binary variables, as it circumvents any misspecification error or bias that may

[8] Another approach to address endogeneity could be to estimate a linear probability model, using the two-stage least squares methodology. While this has been found to be appropriate for many contexts (Angrist and Pischke 2010), we choose to estimate the model using the recursive bivariate approach in order to avoid potential issues due to non-linearities.

be engendered in a two-stage least squares (2SLS) estimation (Wooldridge 2010). Moreover, the model is more robust to non-normality than the linear IV-2SLS model (Bhattacharya et al. 2006). The recursive bivariate model allows for arbitrary residual correlation in the awareness and certification equations. It produces efficient estimates of the ATE, while the 2SLS model is better-equipped to obtain robust consistent estimates of the average treatment effect on the treated (ATT) (Nichols 2011). As mentioned above, the model does not require making an exclusion restriction to identify the parameters of the model (Wilde 2000; Greene 2018). Under an assumption of joint normality of error terms, the model can be estimated based on functional form. However, it may be difficult to achieve convergence if an exclusion restriction is not imposed, and exclusion restrictions often improve identification.

We choose to incorporate an excluded instrument in our model ($Z_{i,t}$), which is a constructed measure of the "skill level" of the occupations pursued by the parents of the respondent. It is an index, generated as the sum of the levels of skills of each parent, and measured using a categorical variable. We use this as an instrumental variable under the premise that respondents (owners or managers) who are children of individuals who worked in high-skilled jobs (who are thus also more likely to have a higher level of education) are more likely to be aware of laws in general. Moreover, it is unlikely that the skills of the parents of the respondent will directly influence the certification received by the firm, once we control for respondent-level characteristics, such as age, education, etc.[9]

In the literature, parent's education has been found to be an important determinant of both children's success at school and their educational attainment (Haveman and Wolfe 1995; Alcaraz 2020; Black et al. 2005), as well as their employment outcomes as adults (Dubow et al. 2009). Furthermore, parents' education has been found to influence the rule orientation of children: Fine et al. (2020) find that that children of parents having higher levels of education find it less acceptable to break the law as adolescents and feel more obligated to obey the law (termed "legal socialization"). Moreover, higher levels of parent's education are associated with lower probabilities of committing crime among adolescents (Chalfin and Deza 2019), as well as lower likelihoods of indulging in binge drinking as well as excessive alcohol consumption (Chalfin and Deza 2018). While these studies have focused on the effects of parental education on delinquency and behavior of children as adolescents and young adults, a long-standing sociology and psychology literature has also found that delinquency is a strong predictor for the propensity to commit crimes, break the law and engage in crime as an adult (Simons et al. 2004; Wright and Wright 1994). Thus, it is plausible, we believe, that the level of education of parents will influence legal awareness as well as compliance behavior of respondents in our sample.

[9] In our sample, the average age of the owners/managers of the firms is 48 years. Within the household of the respondents, the share of adults over the age of 60 is only about 9.5%, with 71% of respondents stating that their household had no members over the age of 60. Thus, we are of the opinion that it is unlikely that parents of the respondents will directly influence certification decisions, and that the magnitude of this effect, if it exists, will be negligible.

To control for unobserved heterogeneity across firms in our sample, we could use a fixed effects version of the bivariate probit model. However, as discussed in Greene and Zhang (2019), the use of a fixed effects model within the framework of a nonlinear panel data model gives rise to the 'incidental parameter problem' and thus the estimates would be biased. Therefore, to deal with time-invariant unobserved heterogeneity, we choose to adopt the correlated random effects approach suggested by Mundlak (1978), Chamberlain (1982), and Wooldridge (2005, 2010). This approach is based on including time-averages of all variables having positive within variation in both first and second stages of the model (2) as controls. The model that we estimate is then transformed as follows:

$$\begin{aligned} a^*_{i,t} &= \beta_0 + \beta_2 z_{i,t} + \beta_3 x_{i,t} + u_i + \eta_j + \gamma_t + \lambda_k + \epsilon_{i,t}, a_{i,t} = 1 \text{ if } a^*_{i,t} > 0, a_{i,t} = 0 \text{ otherwise,} \\ c^*_{i,t} &= \alpha_0 + \alpha_1 a_{i,t} + \alpha_2 x_{i,t} + u_i + \eta_j + \gamma_t + \lambda_k + \mu_{i,t}, c_{i,t} = 1 \text{ if } c^*_{i,t} > 0, c_{i,t} = 0 \text{ otherwise.} \end{aligned} \tag{4}$$

where we now assume that u_i can be substituted as

$$u_i = \psi_1 + \bar{x}_i \psi_2 + \delta_i, \delta_i | x_i \sim Normal(0, \sigma^2_{\delta_i}) \tag{5}$$

The Mundlak–Chamberlain adjustment models the firm-level heterogeneity term (u_i) to be a linear function of all exogenous variables x_i, including those that are omitted from model (2) above. In Eq. 5, the term δ_i is assumed to be independent of x_i. By substituting Eq. 5 in Eq. 4, $c_{i,t}$ is allowed to be correlated with unobserved heterogeneity, and the time-varying omitted factor (this approach has been extensively summarized in Greene (2018) and in Wooldridge (2010)).

It is always difficult to demonstrate the validity of the exclusion restriction. It is conceivable that children of parents who used eco-labels themselves may be more likely to adopt the certification, irrespective of their knowledge of the law. To this extent, we may have some unobserved heterogeneity in our estimates. It is also plausible that more highly skilled parents are likely to be adopting the certification themselves, and that may directly influence the adoption of certification by children, or that adoption may be determined by unobserved factors such as general management skills, or joint management of the firm by the household. While we cannot exclude these possibilities with our choice of instrument, we attempt to partially address the time-invariant unobserved heterogeneity using the Mundlak/Chamberlain adjustment, and by controlling for a rich set of observables. Moreover, the model can also be estimated without using an excluded instrument, i.e., by relying on functional form, and we find that the main results are confirmed on doing so.[10]

Summarizing, our approach in this paper is to adopt three methodologies to evaluate the effect of lack of awareness on the likelihood of a firm having received the ESC: the probit model, the recursive bivariate probit model, as well as the recursive bivariate probit model with the Mundlak/Chamberlain adjustment. In the next section, we describe our data, and provide some important summary statistics on our modelling variables.

[10] These results can be provided on request.

3.2 Data

For this study, we use data from the UNU-WIDER Vietnam SME firm-level database (United Nations University UNU-WIDER 2011). The database tracks a sample of 2500 predominantly small and medium-sized firms in nine provinces of Vietnam biennially over the period 2011–2015, creating an unbalanced panel. The data set collects information on the economic accounts, as well as data on various enterprise level, as well as some employee-level characteristics. The enterprises surveyed are distributed over approximately 18 different industries, including the food and beverage. Firms are classified according to the current World Bank definition, with micro-enterprises having up to 10 employees, small-scale enterprises up to 50 employees, medium-sized enterprises up to 300 employees, and large enterprises having more than 300 employees.[11] The database also includes variables related to firm performance, enterprise history, employment, business environment, and owner/manager background characteristics.

The sample for our main results includes firms in the food and beverage industry with manufacturing as the main sector that do not change their industry over the duration of the sample. After accounting for missing values for some variables, this sample comprises 2216 observations. To focus on the voluntary adoption of the ESC in our sample, we first seek to identify those firms that are required to obtain the ESC on a mandatory basis according to the LEP, by generating a dummy variable that takes the value 1 for firms that are required to comply, and then to drop these observations from our sample to obtain our regression sample. The two main determinants for mandatory compliance by firms are the sub-sector that they operate in, and the production capacity of the firm. The appendix to The Government of Vietnam (2015) provides this list of sub-sectors, as well as the production capacity thresholds. Firms that belong to specific sub-sectors, and have a production capacity larger than this predefined threshold, are required to obtain the ESC.

From our data set, we are able to ascertain the sub-sector within which a firm operates (identified by the four-digit Vietnam Standard Industrial Classification (VSIC) code; the exhaustive list of the VSIC codes can be found in Prime Minister's Office (2018)), as well as the quantity produced by a firm in the last year (for its top three products). We use this information on the quantity (of its primary good) produced by the firm in the last year to identify whether a firm meets the threshold for production capacity that is relevant for a firm in that sub-sector to obtain the ESC. If a firm produces more than this threshold in even a single year (out of a maximum of 3 years), we code this dummy variable as taking the value 1 (and these observations are dropped from our regression sample).[12]

[11] The maximum value of the total labour force among the 1837 observations in our main estimation sample is 250.

[12] While we have information on the quantities and units of production for most firms, we were not able to translate the units into English for some of the observations. In other cases, we had to make assumptions to convert the units mentioned in the database to those used to define thresholds in (The Government of Vietnam 2015). For instance, some firms producing beverages in our data set reported production in terms of boxes of product, while the threshold is defined in terms of litres. In such cases, we made suitable assumptions to identify which firms may meet the thresholds.

We are able to approximately match almost all the sub-sectors in our data set with those listed in The Government of Vietnam (2015), except one sub-sector, namely, "manufacturing of other food products: n.e.c", which comprises about 17% of the observations in our sample. We were not able to find a corresponding match for this sub-sector, and thus unable to determine the threshold. To be conservative, we choose to code the dummy for compliance as one for all large firms in this sub-sector, based on the size of their total labour force, i.e., if a firm belonging to this sub-sector employs more than 6 workers (which is the mean number of workers in our data sample over all firms).[13] The dummy variable for mandatory compliance takes the value of '1' for about 17% of the observations in this sample (for 379 out of 2216 observations). These observations are excluded from further analysis, for a total of 1837 observations in our regression sample.

To capture any residual effects on adoption of the ESC due to mandatory compliance by firms, in all our estimations, we include dummy variables for each sub-sector within the food and beverage industry, where firms are required to obtain the ESC. To control for firm size, we include the total labour force of the firm as a control variable in all regressions.

The geographical coverage of our study is nine provinces of Vietnam, from three different regions, the north (Hanoi, Phu Tho, and Hai Phong), south (Ho Chi Minh City, Long An, and Khanh Hoa), and central (Nghe An, Quang Nam, and Lam Dong), including some of the most important manufacturing centers of the country (such as Ha Noi, Hai Phong, Quang Nam, Ho Chi Minh City, and Long An). The survey is representative at the province level (Sharma and Tarp 2018). In this paper, we focus our analyses on the food and beverage industry, which is one of the most important industries in Vietnam, and also the largest in terms of sample size in our data set (it comprises 34% of the total observations).

Panel A of Table 1 provides summary statistics on the main explanatory variables, as well as on the dependent variable, for the regression sample. While about 12% of the firm-year observations have received the certification for meeting environmental standards, about 63.3% of respondents in our data sample said that they were not aware of the LEP, or had no interest in it. About 80% of the respondents were owners (the rest were managers), and 49% of them were male. The average age of the respondent is about 48 years in our sample. However, the share of respondents who were college-educated was fairly low, at about 14%. About 83% of respondents rely on the income or profits from the firm as their main source of household income.

Our data set also contains information on whether the firm was inspected for various reasons (including technical reasons, such as environmental compliance or for fire safety). We control for enforcement, using a lagged indicator of the total number

[13] We also used other values for the size of labour force to determine this cutoff, and were able to confirm the results of all estimations in Table 2. In addition, we attempted dropping this sub-sector from our analysis, and in this case we were able to confirm the probit results of column (1), as well as the recursive bivariate model results of column (2) of Table 2. While we also tried estimating the recursive bivariate model with the Mundlak terms in column (3) of Table 2 by dropping this sub-sector from our data set, we were unable to achieve convergence in this estimation.

Table 1 Summary statistics for the regression sample

Panel A

Variable	Mean	Std. Dev.	Minimum	Maximum
Certification for meeting environmental standards	0.119	0.324	0	1
Lack awareness of the LEP	0.633	0.482	0	1
Whether respondent is owner	0.803	0.398	0	1
Whether respondent is male	0.490	0.500	0	1
Age of the respondent	48.100	10.498	17	89
Whether respondent is college educated	0.139	0.346	0	1
Whether profit/income from firm is the main source of household income	0.829	0.377	0	1
Median number of inspections at the district level	0.118	0.389	0	2
Age of the firm	17.321	10.926	2	76
Whether firm is a household enterprise	0.895	0.307	0	1
Total labor force of the firm	5.740	12.821	1	250
Whether firm has certificate of land use right	0.814	0.389	0	1
Whether firm has multiple owners	0.036	0.188	0	1
Whether firm has internet access	0.131	0.337	0	1
Number of personal computers owned	0.444	2.698	0	98
Current (within district) market share	37.109	42.560	0	100
Whether firm has ever paid a bribe	0.274	0.446	0	1
Whether firm exports	0.014	0.116	0	1
Whether firm produces more than one good	0.068	0.252	0	1
Whether firm faces competition in its field of activity	0.835	0.372	0	1
Whether firm had labor disputes in the last 2 years	0.0005	0.023	0	1

Table 1 (continued)

Panel B

	Obs.	Certified	Unaware of LEP	Total labor force	College-educated	Inspections	Bribed	Exported
Aware of the LEP	675	0.204		9.039	0.246	0.176	0.412	0.027
Lack awareness of the LEP	1162	0.070		3.824	0.077	0.085	0.194	0.006
Firm has received certification	219		0.370	14.137	0.352	0.269	0.461	0.050
Firm has not received certification	1618		0.668	4.604	0.110	0.098	0.248	0.009

Table 2 Main results: coefficients of second-stage and first-stage estimations

Panel A: second-stage results			
Dependent Variable: Whether certified	Probit	Recursive bivariate (RB)	RB with Mundlak adjustment
Column	(1)	(2)	(3)
Lack awareness of the LEP	−0.274***	−1.622***	−1.590***
	(0.094)	(0.372)	(0.428)
Median number of inspections at the district level	−0.157	−0.232**	−0.285**
	(0.123)	(0.111)	(0.140)
Whether respondent is owner	−0.081	−0.045	−0.128
	(0.116)	(0.101)	(0.180)
Whether respondent is male	0.122	0.022	0.021
	(0.093)	(0.086)	(0.173)
Whether firm has certificate of land use right	0.105	0.071	0.153
	(0.117)	(0.105)	(0.218)
Whether respondent is college educated	0.421***	0.143	0.224
	(0.130)	(0.148)	(0.256)
Whether firm has ever paid a bribe	0.076	−0.047	−0.242**
	(0.101)	(0.100)	(0.133)
Whether firm exports	0.181	0.098	0.950
	(0.315)	(0.291)	(0.628)
Whether firm produces more than one good	−0.191	−0.096	−0.314
	(0.196)	(0.158)	(0.277)
Current (within district) market share	0.0005	0.0004	0.001
	(0.001)	(0.001)	(0.002)
Number of personal computers owned	0.049	0.051	0.182***
	(0.046)	(0.038)	(0.071)
Whether firm faces competition in its field of activity	0.311**	0.179	0.042
	(0.160)	(0.144)	(0.186)
Whether firm had labor disputes in the last 2 years		−4.286***	−0.047
		(0.244)	(0.399)
Whether profit/income from firm is the main source of household income	0.222***	0.179	0.101
	(0.146)	(0.126)	(0.181)
Whether firm has multiple owners	0.053	−0.019	−0.351
	(0.229)	(0.206)	(0.393)
Whether firm is a household enterprise	−0.442***	−0.232	−0.369
	(0.169)	(0.168)	(0.425)
Total labor force of the firm	0.001	−0.001	−0.011
	(0.004)	(0.004)	(0.010)
Age of the respondent	−0.0006	−0.002	0.0002
	(0.005)	(0.004)	(0.010)
Age of the firm	0.00003	−0.001	0.009
	(0.004)	(0.004)	(0.017)

Table 2 (continued)

Panel A: second-stage results			
Dependent Variable: Whether certified	Probit	Recursive bivariate (RB)	RB with Mundlak adjustment
Column	(1)	(2)	(3)
Whether firm has internet access	0.254*	0.016	−0.183
	(0.152)	(0.170)	(0.263)
Obs	1819	1837	1837
Wald test-statistic of rho = 0		4.222	3.220
P-value		0.040	0.073
Panel B: first-stage results			
Dependent Variable: Whether lack awareness of the LEP	Probit	RB	RB with Mundlak adjustment
Column	(1)	(2)	(3)
Index of extent of unskilled occupations of parents		0.062**	0.061**
		(0.028)	(0.027)
Median number of inspections at the district level		−0.178*	−0.031
		(0.105)	(0.126)
Whether respondent is owner		0.063	−0.010
		(0.088)	(0.147)
Whether respondent is male		−0.221***	−0.086
		(0.068)	(0.140)
Whether firm has certificate of land use right		−0.055	−0.074
		(0.090)	(0.180)
Whether respondent is college educated		−0.398***	−0.265
		(0.106)	(0.205)
Whether firm has ever paid a bribe		−0.243***	−0.311***
		(0.079)	(0.110)
Whether firm exports		0.294	−0.294
		(0.347)	(0.558)
Whether firm produces more than one good		0.089	0.214
		(0.133)	(0.222)
Current (within district) market share		0.0009	0.0003
		(0.0009)	(0.001)
Number of personal computers owned		0.008	0.007
		(0.009)	(0.013)
Whether firm faces competition in its field of activity		−0.335***	−0.284**
		(0.098)	(0.144)
Whether firm had labor disputes in the last 2 years		5.612***	1.341***
		(0.216)	(0.339)

Table 2 (continued)

Panel B: first-stage results			
Dependent Variable: Whether lack awareness of the LEP	Probit	RB	RB with Mundlak adjustment
Column	(1)	(2)	(3)
Whether profit/income from firm is the main source of household income		−0.064	−0.096
		(0.094)	(0.148)
Whether firm has multiple owners		−0.038	−0.200
		(0.219)	(0.362)
Whether firm is a household enterprise		0.202	0.244
		(0.155)	(0.423)
Total labor force of the firm		−0.019***	−0.010
		(0.006)	(0.011)
Age of the respondent		−0.004	−0.0007
		(0.003)	(0.009)
Age of the firm		−0.003	0.001
		(0.003)	(0.017)
Whether firm has internet access		−0.263**	−0.219*
		(0.124)	(0.240)

Notes: Dependent variable in Panel A is a binary variable denoting whether the firm has been certified for meeting environmental standards. Corresponding first-stage results for the recursive bivariate models in columns (2) and (3) are provided in Panel B. All specifications include province and year fixed effects, as well as dummies for sub-sectors, where certification is mandatory. The specification in column (3) includes time-averages of all exogenous variables having positive within variation. Regression sample comprises food and beverage industry firms with manufacturing as the main production sector that do not change their location or industry of operation over the duration of the sample. The coefficient on the variable "Whether firm had labor disputes in the last two years" could not be estimated in column (1) of panel A, as it perfectly predicted certification. Huber–White standard errors are reported in parentheses. *,** and ***, respectively, denote significance at 10%, 5% and 1% levels. The coefficients of the constant are not reported

of technical inspections. Specifically, our variable captures the median of the lag of number of technical inspections over all firms other than firm 'i' at the district level. Thus, we create a measure of the average number of lagged inspections at the district level for all firms excluding the firm in question, so as to avert endogeneity concerns, and ensure that we control for the monitoring efforts.[14] We find that the mean of this variable is 0.12 for our regression sample.[15]

[14] Firms in our regression sample belong to 65 different districts, with each district having a mean about 28 firms (median of about 24 firms). While we acknowledge that we have a relatively small sample of firms, we feel that these reported sizes are adequate to find the average propensity for regulators to inspect firms at the district-level.

[15] While taking the lag of the number of inspections would have implied a significant loss in observations, given that we would have no values for this variable for 2011, we were able to link our data set to a previous version of this survey which was conducted in 2009, and collected information on inspections.

The average age of the firm in our sample is about 17 years, suggesting that these firms are not very young, on average. About 89.5% of these businesses are run as household firms, with an average total labor force size of about 6 workers per firm. 81% of firms have the certificate for land use right, namely, the right to use the land (since private ownership of land is forbidden in Vietnam). About 3.6% of firms have multiple owners, while about 13% of firms have access to the internet[16], with few firms owning computers (the mean number of computers owned is 0.44). The mean district-level market share of these firms is about 37%.

About 27% of the respondents admitted to having paid bribes for some reason related to the business. Corruption and bribery, especially in the form of "grease money" to fulfil basic tasks and services, is rampant in Vietnam (Bai et al. 2019). While it is unknown whether the firms in our sample paid bribes to get the certification, or to avoid getting it, it is likely to be a determinant of the certification process for firms in Vietnam. Only 1.36% of firm-year observations comprise firms that export, while about 7% comprised firms that had diversified their product base (i.e., produced more than one good). A very large share of firms (about 84%) said that they faced competition in their field of activity. Almost negligible number of respondents stated that there had been a labor dispute within the firm in the past 2 years (0.05%).

Panel B of Table 1 also presents some additional statistics on levels of certification for environmental standards, as well as on the levels of awareness on the LEP for the respondents. The average certification rate was about 7% for firms that were unaware of the environmental law, compared to 20.4% for firms that were aware of it to some extent. On average, the firms that had some awareness were slightly larger (with an average of 9 employees), while unaware firms had about 4 employees. Unaware owners or managers (namely, respondents) were less likely to be college-educated (only about 7.7% of them are college-educated), compared to 24.6% of respondents with some awareness of the LEP who were college-educated. Firms where respondents were aware were also located in districts, where more inspections had taken place (even though the absolute number is rather low), suggesting that inspections may be a means to bring the law and its requirements to the attention

Footnote 15 (continued)
We were able to match most firms in our 2011 sample to the 2009 data set, and thus, we do not end up losing a significant number of observations (out of a total of 748 firms in the food and beverage industry in 2011, we found information on inspections for 610 firms from the 2009 data set).

[16] While internet access is fairly widespread in Vietnam, according to the International Telecommunication Union (ITU), the percentage of population that had access to internet in Vietnam was 35.07%, 38.5% and 45% in 2011, 2013 and 2015, respectively (International Telecommunication Union 2019). In our database, we find that these proportions are 35.11%, 33.2% and 41.3%, respectively (with a slight dip in 2013 because of the unbalanced nature of the panel data set) for firms across all industries. Thus, at an overall level, the average of the internet access variable in our data set is similar to that of national-level statistics. The relatively low levels of internet access in the food and beverage industry in our sample likely reflect the fact that most of the SMEs in this industry are relatively small firms, plausibly located in rural areas of the country (this information was not, however, definitively collected in the data set). As a robustness check, we also estimated the main model (of columns (2) and (3) of Table 2) by dropping this variable, and the main results were confirmed (results can be provided on request).

of respondents. Interestingly, the share of respondents having paid bribes was more than double for firms with some knowledge of the LEP (41.2%), compared to those that were unaware of it (19.36%). Firms where respondents were aware of the LEP were also more likely to export (2.67%, compared to 0.6% for those firms, where respondents were unaware of the LEP). Note that these variable means are all significantly different between respondents who lacked awareness, and those that had some knowledge of the LEP, at the 1% level (using two-sided T tests).

Firms that received the environmental standards certificate were less likely to have owners/managers lacking awareness of the LEP (37%) compared to firms that did not have the certification (66.8%). Likewise, firms that received certification were likely to be larger (an average of 14 employees, compared to 5 employees at firms that have not received certification). Certified firms were also more likely to have college-educated respondents (35% versus 11%), and more likely to have been inspected in the past as well compared to non-certified firms. They were more likely to have paid bribes (about 46% versus 25% of non-certified firms). Finally, 5% of firms that received certification exported, whereas only 0.08% of those without certification end up exporting. Again, the variable means are all significantly different between respondents who worked at firms that had been certified, and those that were not, at the 1% level (using two-sided *T* tests).

In the Appendix, we provide further graphical evidence of the close association between awareness and certification, as well as present summary statistics on our instrumental variable.

4 Results

4.1 Main results

Table 2 presents the main results of this paper. In panel A, we present the second-stage results, whereas the first stage results are presented in panel B. In column (1), we present the results of the estimation using the probit methodology, column (2) includes the results of the recursive bivariate model, whereas column (3) includes the results of the recursive bivariate model using the Mundlak/Chamberlain adjustment to address time-invariant unobserved heterogeneity. Table 2 presents the coefficients of these estimations. All estimations include province and year fixed effects, as well as dummies for sub-industries, where large firms are required to obtain the ESC, and report robust standard errors. Note that the null hypothesis for zero correlation between the error terms in the first and second stages of the estimations in columns (2) and (3) of Table 2 can be rejected at the 5% level, using a Wald test (which provides support in favor of the recursive bivariate methodology).[17]

[17] We also conduct a Wald test based on which we can argue that model (3) in Table 2, i.e., our preferred specification with the Mundlak averages is better than model (2) (the recursive bivariate model without the Mundlak averages). We chose the Wald test, because (a) the likelihood ratio test is not accurate with robust standard errors, and (b) it helps us in determining whether the Mundlak average terms are jointly equal to zero. We found that the chi-squared value generated by the Wald test is equal to 1690.76, with a corresponding p-value of 0. This means that we can reject the null hypothesis that the

The probit results of column (1) reveal that a lack of awareness on the LEP (captured by having no knowledge about it, or no interest in it) is negatively associated with the likelihood of receiving certification for meeting environmental standards. The coefficient is significant at the 1% level. This finding is in line with our intuition. Interestingly, firms who reported facing competition in their field are more likely to receive certification. Internet access is also a positive determinant of the certification likelihood, as are college-educated respondents (either manager or owners).

Finally, firms that are household-run enterprises (as opposed to proprietorships, partnerships, limited liability companies, or joint stock companies without state capital) are less likely to receive certification. Household enterprises may face higher costs of obtaining voluntary certification, given that they are often smaller, and pollution control may be expensive for them even if they were aware of the regulation. Second, household firms are also less likely to be monitored for meeting mandatory requirements, i.e., the enforcement efforts are likely to be weaker for them. This implies they may not have information on the law, compared to other firms that have been monitored, and thus they may be more inclined towards not obtaining environmental certification.

In columns (2) and (3), we present the results of the second-stage models of the recursive bivariate estimations. We find that lacking awareness of the LEP still has a negative effect on the likelihood of receiving certification in the results of column (2) where we attempt to address endogeneity, and that this variable is again significant at the 1% level. We also find that firms that had labor disputes in the last 2 years are less likely to receive certification, as are firms that were located in districts having a high number of technical inspections.

The results of column (3) support our most important finding about the role of being aware of the LEP on the likelihood of receiving certification, with the variable capturing a lack of awareness of owners/managers having a coefficient of slightly smaller magnitude than in column (2), and retaining significance at the 1% level. Thus, we find that the negative effect of a lack of awareness on the certification likelihood is persistent, even when we attempt to address concerns of unobserved heterogeneity. We also find that firms that have paid a bribe in the past for whatever reason are less likely to have been certified. One explanation may be that a bribe in this context can be seen as a means to avoid receiving certification. On the other hand, firms may also be paying bribes to expedite receiving certification, with the implication that this result may represent some firms having paid bribes, but not yet having received certification. It is difficult to pinpoint the exact channel, in the absence of further information on the reason for which the bribe was paid.

Moreover, firms that belong to districts, where more technical inspections have previously taken place are less likely to be certified as well. This suggests that there may be clusters of firms in certain districts that have not been adopting environmental certification, despite some firms having been inspected. On the other hand,

Footnote 17 (continued)
coefficients for the Mundlak averages are all simultaneously equal to zero, implying that including these variables in our final model can significantly improve the fit of the model.

firms having more computers are more likely to receive certification for meeting standards.

In panel B of Table 2, we present the results of the first-stage estimations corresponding to the second-stage results of columns (2) and (3) of panel A of Table 2. In the results of column (2), we find that lower skill levels of the parents' occupations (i.e., higher values of this index) are positively associated with the respondents lacking awareness of the LEP, controlling for respondent-level education. This is in line with our expectation. Moreover, male respondents and college-educated respondents are more likely to be aware of the LEP. We also find that firms that have paid a bribe are more likely to have been aware of the LEP (which, combined with the results of column (3) of panel A, suggests that firms may be paying bribes as grease money to receive certifications quicker), as are those with internet access. We also find that firms facing competition are more likely to be knowledgeable of the LEP, as are firms having a larger workforce.

The results of column (3) partially support the results of column (2), with the difference being that fewer control variables are significant once we include the time averages. For instance, our instrumental variable (skill levels of the parents) still has a significant effect on the likelihood of the respondent being unaware of the LEP, with the expected sign (respondents whose parents worked in lower skill jobs were more likely to lack knowledge). The result on bribery still persists, with firms that bribed being more likely to have been aware. Moreover, firms that had labor disputes in the last 2 years are less likely to be aware of the LEP (which was also confirmed in the results of column (2)).

Table 3 presents the marginal effects for some important explanatory variables drawn from the three estimation results presented in Table 2. Note that the marginal effects for the explanatory variables in columns (2) and (3) represent the direct effect of these variables on the likelihood of being certified. We find that firms, where respondents were unaware of the LEP were 3.5 percentage points less likely to obtain certification for meeting environmental standards, than firms, where respondents had some knowledge or interest in the law, according to the results of the marginal effects for the probit estimation in column (1).

The size of this effect increases once we control for endogeneity in columns (2) and (3), where we find that being unaware of the LEP resulted in firms being 41 percentage points and 38.4 percentage points less likely to obtain certification for meeting environmental standards than firms, where respondents had some knowledge of it, respectively. Thus, we show that controlling for endogeneity may be significant in this context. Moreover, while the use of the recursive bivariate framework can enable us to interpret these effects as causal, given that we were not able to achieve convergence using this methodology in certain estimations involving a specific subsector (refer to Footnote 13), we lean towards being conservative and, therefore, interpret the results as suggestive evidence on the role of a lack of awareness in determining certification.

We also list the marginal effects for some other important controls in Table 3. In column (1), we re-confirm that firms with college-educated respondents (owners or managers) and firms having internet access are 5 percentage points and 3 percentage points more likely, respectively, to be certified for meeting

Table 3 Marginal effects of important explanatory variables

Dependent variable: whether certified	Probit	Recursive bivariate	Recursive bivariate with Mundlak correction
Column	(1)	(2)	(3)
Lack awareness of the LEP	−0.035***	−0.409**	−0.384***
	(0.012)	(0.220)	(0.166)
Whether respondent is college educated	0.053***	0.023	0.033
	(0.017)	(0.022)	(0.035)
Whether firm has ever paid a bribe	0.010	−0.008	−0.036
	(0.013)	(0.017)	(0.024)
Number of personal computers owned	0.006*	0.008*	0.027***
	(0.006)	(0.006)	(0.011)
Whether firm is a household enterprise	−0.056***	−0.038***	−0.054
	(0.022)	(0.025)	(0.061)
Median number of inspections at the district level	−0.020	−0.038**	−0.042**
	(0.015)	(0.020)	(0.021)
Whether firm has internet access	0.032*	0.003	−0.027
	(0.019)	(0.027)	(0.041)
Observations	1819	1837	1837

Notes: Dependent variable is a binary variable denoting whether the firm has been certified for meeting environmental standards. Marginal effects for some important explanatory variables (calculated at the dydx level) are presented, corresponding to the second-stage coefficients of Table 3. Marginal effects are calculated at means of the explanatory variables. Bootstrapping is used to calculate the direct marginal effect for the "Lack awareness of the LEP" variable in columns (2) and (3), run over 1000 iterations. All specifications include province and year fixed effects, as well as dummies for sub-sectors where certification is mandatory. Specification in column (3) includes time-averages of all exogenous variables having positive within variation. Regression sample comprises food and beverage industry firms with manufacturing as the main production sector that do not change their location or industry of operation over the duration of the sample. Huber–White standard errors are reported in parentheses. *,** and ***, respectively, denote significance at 10%, 5% and 1% levels. The coefficients of the constant are not reported

environmental standards, while HH enterprises are 6 percentage points less likely to be certified. The results of column (2) suggest that firms that belong to districts, where more technical inspections took place in previous years are 3.8 percentage points less likely to be certified themselves (this increases to 4.2 percentage points in column (3)). Finally, one additional computer raises the probability of receiving certification by 2.7 percentage points (as shown in column (3)).

These results confirm our hypothesis regarding the importance of awareness of the laws on whether a firm receives voluntary certification for meeting environmental standards. In the next subsection, we derive marginal effects over important subgroups of the data sample, to examine heterogeneity in the magnitude of the main effect.

Table 4 Heterogeneous marginal effects

Binary variables			Province		Year	
Whether firm exports	No	−0.228**	Ha Noi	−0.334**	2011	−0.416***
		(0.116)		(0.152)		(0.155)
	Yes	−0.630***	Phu Tho	−0.029	2013	−0.282**
		(0.172)		(0.023)		(0.127)
Whether respondent is college−educated	No	−0.196**	Ha Tay	−0.166	2015	−0.102
		(0.108)		(0.110)		(0.075)
	Yes	−0.511***	Hai Phong	−0.476***		
		(0.167)		(0.172)		
Whether firm is a household enterprise	No	−0.598***	Nghe An	−0.164		
		(0.170)		(0.108)		
	Yes	−0.195**	Quang Nam	−0.190		
		(0.107)		(0.122)		
Whether firm paid a bribe	No	−0.181*	Khanh Hoa	−0.323**		
		(0.102)		(0.154)		
	Yes	−0.401***	Lam Dong	−0.354***		
		(0.157)		(0.154)		
Whether firm has internet access	No	−0.196**	HCMC	−0.470***		
		(0.109)		(0.170)		
	Yes	−0.528***	Long An	−0.515***		
		(0.161)		(0.172)		

Notes: Dependent variable is a binary variable denoting whether the firm has been certified for meeting environmental standards. Marginal effect of a lack of awareness of the LEP on being certified is calculated over some binary variables, province, and year (at the dydx level), corresponding to the second-stage coefficients of column (3) of Table 2, using 1837 observations. Marginal effects are calculated at means of the explanatory variables. Specification of column (3) of Table 2 includes province and year fixed effects, dummies for sub-sectors, where certification is mandatory, and time-averages of all exogenous variables having positive within variation. Regression sample comprises food and beverage industry firms with manufacturing as the main production sector that do not change their location or industry of operation over the duration of the sample. Huber–White standard errors are reported in parentheses. *,** and ***, respectively, denote significance at 10%, 5% and 1% levels. The coefficients of the constant are not reported

4.2 Extensions

In Table 4, we present some additional results based on our main estimation results of Table 2. We estimate whether the marginal effect of a lack of awareness on certification for meeting environmental standards varies along different dimensions. We use the recursive bivariate probit estimation of column (3) of Table 2 to compute these heterogeneous marginal effects, given that it mitigates the concern of endogeneity, and it also attempts to address the problem of unobserved heterogeneity through the Mundlak/Chamberlain adjustment.

We find that the absolute value of the marginal effect of a lack of awareness on the likelihood of certification is higher for firms with college-educated respondents,

and those that export, i.e., firms that exported, or had college-educated owners or managers, were more likely to have obtained the voluntary certification if they were aware of the LEP, than firms that didn't have college-educated respondents, or didn't export. This confirms findings from previous studies on the role of education and exporting behavior in determining the adoption of voluntary certificates (Ervin et al. 2012; Tambunlertchai et al. 2013). We also find that negative effect of a lack of awareness on certification is weaker for household enterprises, i.e., household enterprises with owners or managers who were aware of the LEP were less likely to obtain certification than non-household enterprises. In line with our previous results, this may be due to household enterprises facing larger costs for adopting voluntary standards, or due to weaker enforcement efforts towards them (that may be a potential source of information for firms on the LEP).

Interestingly, we find that firms that have made informal payments, or bribed, are more likely to obtain certification if they are attentive to the LEP, than firms that have not bribed (based on the absolute values of the marginal effects). This provides further support in favour of our finding that paying bribes may be a means to push authorities to issue certificates for meeting environmental standards (rather than avoid getting the standards) to firms.

Finally, we find that the absolute value of the marginal effect of a lack of awareness on the likelihood of certification is higher for firms that have internet access, i.e., these firms were more likely to obtain certification if they were attentive to the LEP (compared to firms without access to internet). This suggests that better availability of information, as well as perhaps learning from the experiences of other applicants, may be helping firms in receiving certification.

The value of the marginal effect of a lack of awareness on the likelihood of being certified also varies across provinces, with the highest (negative) marginal effects observed in Long An, Hai Phong, and in Ho Chi Minh City (HCMC), which implies that firms in these provinces with owners or managers who were attentive to the LEP were more likely to have obtained environmental certification, than in other provinces. Moreover, we also find that the marginal effect varies over time, with the strongest effect observed in 2011 (firms with owners or managers who were unaware of the LEP were 42 percentage points less likely to obtain environmental certification then), which declined to about 10 percentage points by 2015. As intuition suggests, with time, the effect of knowledge of the LEP on obtaining voluntary certification should weaken, as this finding suggests.

5 Conclusion and policy implications

Our study attempts to shed light on the role of a lack of awareness or knowledge of owners and managers of firms on the Law on Environmental Protection, on their likelihood of voluntarily obtaining certification for meeting environmental standards in the food and beverage industry in Vietnam. We find suggestive evidence that firms, where owners and managers were unaware of the law were 38 percentage points less likely to be certified for meeting environmental standards,

while controlling for measures of enforcement which have traditionally been found to be important in the economic literature.

Moreover, firms where the owners or managers are college-educated, that export goods, and have internet access are more likely to be certified if they are aware of the LEP, suggesting that education, international linkages, and information access may be playing an important role in incentivizing firms to get certified in this context (in line with the previous literature). This effect, however, is weaker for firms that are household enterprises, because the cost of compliance may be higher for them (and levels of enforcement are also likely be lower). Interestingly, we also find that firms that have bribed are more likely to obtain certification if their owners/managers had been aware of the LEP (as opposed to firms that had never bribed). Thus, bribing may be seen as a form of grease money payment in this particular context, in line with other studies (Bai et al. 2019).

The results also highlight which segment of the population is more likely to be have been aware of the regulations. For instance, given that firms with internet access are more likely to have been aware of the LEP, policy-makers may benefit from targeting information and education campaigns to those firms that lack internet access, as well as to owners of businesses who are not very educated, or to smaller firms. Our results also suggest that firms that have paid bribes, or those that faced competition from other firms in their field of activity, were also more likely to be have knowledge of the LEP.

The key takeaway from our study is that increasing legal awareness, and ensuring that firm owners and managers have knowledge of the laws and understand them, may be a critical determinant of firms participation in voluntary programs, especially in contexts, where institutions are weak and factors, such as corruption may incentivize violations on part of firms.

Our results have important policy implications in the context of Vietnam. Given that the food and beverage industry has the highest pollution load in Vietnam (Dore et al. 2008), the findings of this study are very relevant for policy-makers looking for low-cost solutions to ensure greater environmental compliance. While traditional enforcement and implementation tools remain important, enhancing knowledge and awareness on laws and regulations should be a complementary policy measure to ensure that firms have no information constraints to abide with laws, even for inducing the voluntary adoption of policies, such as certificates or environmental standards. Of course, it remains to be seen whether these results are applicable to firms belonging to other industries.

Somanathan (2010) highlights the importance of using information policies along with regulations to improve environmental quality in developing countries. While firms may continue evading adoption of policy instruments if the benefits of doing so exceed the costs, bringing laws and their requirements to salience has the potential, as our study shows, to make it more economically viable for firms to obtain voluntary certificates, by relaxing their information constraints.

Appendix

Graphical evidence of association between certification and awareness

The close association between awareness and certification can also be seen in Fig. 1, which plots the distribution of the levels of awareness of respondents about the LEP in our sample over the two categories of certification status, namely, firms that have not received a certificate, versus those that have. There appears to be a very clear association between a lack of awareness, and not having received certification (the distribution of non-certified firms is heavily concentrated in the category of those firms that "lacked awareness of the LEP"), whereas the difference is more subtle for those firms that have received certification.

In Fig. 2, we plot the proportion of respondents who are unaware of the LEP, as well as the environmental certification rates, across provinces in our sample of firms in the food and beverage industry. We see wide heterogeneity in both levels of awareness and certification levels across provinces. For instance, in Phu Tho, we find that both are rather low (2.5% of the firms have received certification, while 95% were unaware of the LEP). On the other hand, in Ho Chi Minh City, about 42.4% of firms had respondents who lacked awareness, and 24% of firms were certified. In general, it is clear that provinces that have higher levels of attentivity/knowledge of the LEP also have higher levels of certification. While these are just correlations, they still provide descriptive evidence on our main hypothesis.

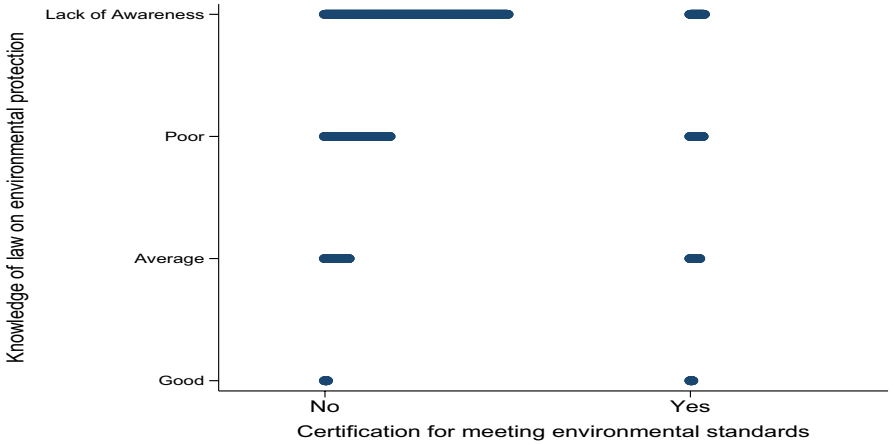

Fig. 1 Association between awareness and certification at the overall level. *Notes*: Source: UNU-WIDER Vietnam Database. The plot uses data of the regression sample of columns (2) and (3) of Table 3, using 1837 observations. The regression sample includes firms in the food and beverage industry that did not change either location or industry of operation over 3 years of the sample (2011, 2013 and 2015) and had manufacturing as the main production sector

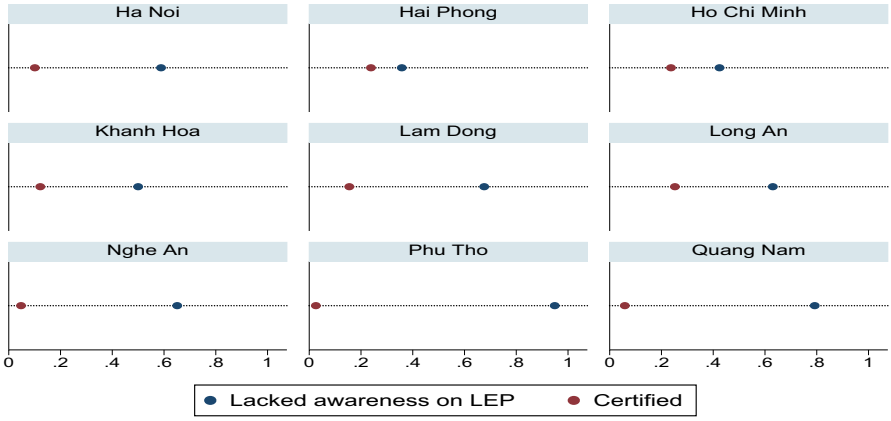

Fig. 2 Association between awareness and certification at the province-level. *Notes*: Source: UNU-WIDER Vietnam Database. The plot uses data of the regression sample of columns (2) and (3) of Table 3, using 1837 observations. The regression sample includes firms in the food and beverage industry that did not change either location or industry of operation over 3 years of the sample (2011, 2013 and 2015) and had manufacturing as the main production sector

Summary statistics on the instrumental variable

Table 5 presents summary statistics on our instrumental variable, namely, the index that we create to denote the skill level of the respondent's parents' occupations. This index is generated as the sum of the skill level of the respondent's mothers' and fathers' occupations. Panel A presents summary statistics on these individual indices for the mothers and fathers, respectively. The left-hand column presents different categories of occupations, along with the value taken by the index for these occupations in brackets. More skilled jobs take lower values (e.g., the respective indices take the value of "1" if the parent works in a management role), whereas lower skilled jobs take higher values (e.g., the respective indices take the value of "5" if the parent works as an unskilled worker).

We find that a larger share of the respondent's mothers are in higher skill occupations than fathers. About 79% of respondent's mothers are unskilled workers, compared to 85% with fathers who are unskilled workers. Panel B presents the distribution of the sum of the two indices denoting mother's and father's occupations (which we call the index of skill of parents' occupations). In case the value for one of the two component indices is missing, the parents' occupational skill index takes the value of the non-missing index. Thus, higher levels of this variable denote lower aggregate skill levels of the parents' occupations.

Table 5 Distribution of the index of skills of parent's occupations

Panel A: index of skills of mother and father's occupations

No of obs. by category	Mother	Father
Management (1)	27	8
Higher educated professional worker (2)	21	10
Medium educated professional worker (3)	29	16
Semi-skilled workers (4)	312	239
Unskilled workers (5)	1,445	1,559
Total observations	1834	1832

Panel B: sum of indices of mother's and father's occupations

Sum of indices	Observations
2	4
3	3
4	7
5	20
6	29
7	17
8	224
9	104
10	1429
Total observations	1837

Notes: Semi-skilled workers include office and customer service workers, sales and security workers, agricultural workers, production workers, operator and installation workers, and members of the army. In case the value for one of the two individual indices in Panel A is missing, the sum of the the indices of parents' occupations takes the value of the non-missing index. Distributions are derived for the regression sample of column (3) of Table 2. This regression sample includes firms in the food and beverage industry that did not change either location or industry of operation over 3 years of the sample (2011, 2013 and 2015) and had manufacturing as the main production sector

Acknowledgements We are grateful to Ho Hoang Anh, Do Huu Luat and the Vietnam Law and Legal Forum for help in understanding environmental law in Vietnam. We are also grateful to Armin Burgmeier and Neda Trifkovic for help with the data. We are responsible for all omissions and errors. We declare that we have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Funding Open Access funding provided by ETH Zurich.

References

Alcaraz M (2020) Beyond Financial Resources: The Role of Parents' Education in Predicting Children's Educational Persistence in Mexico. Int J Educ Dev 75(102188):224–249

Angrist JD, Pischke J-S (2010) The credibility revolution in empirical economics: how better research design is taking the con out of econometrics. J Econ Perspectives 24(2):3–30

Arimura TH, Hibiki A, Katayama H (2008) Is a voluntary approach an effective environmental policy instrument? A case for environmental management systems. J Environ Econ Manag 55(3):281–295

Arora S, Gangopadhyay S (1995) Toward a theoretical model of voluntary overcompliance. J Econ Behav Org 28(3):289–309

Bai J, Jayachandran S, Malesky EJ, Olken BA (2019) Firm growth and corruption: empirical evidence from Vietnam. Econ J 129(618):651–677

Banerjee A, Banerji R, Duflo E, Glennerster R, Khemani S (2008) Pitfalls of participatory programs: evidence from a randomized evaluation in education in India. Am Econ J 2(1):1–30

Banerjee A, Hanna R, Mullainathan S (2013) Corruption. In: Gibbons R, Roberts J (eds) Handbook of Organizational Economics. Princeton University Press, Princeton, pp 1109–47

Beaman L, Magruder J, Robinson J (2014) Minding small change among small firms in Kenya. J Dev Econ 108:69–86

Bhattacharya J, Goldman D, McCaffrey D (2006) Estimating probit models with self-selected treatments. Stat Med 25(3):389–413

Black SE, Devereux PJ, Salvanes KG (2005) Why the Apple Doesn't Fall Far: Understanding Intergenerational Transmission of Human Capital. Am Econ Rev 5(1):437–449

Blackman A (2010) Alternative pollution control policies in developing countries. Rev Environ Econ Policy 4(2):234–253

Blackman A, Guerrero S (2012) What drives voluntary eco-certification in Mexico? J Comparative Econ 40(12):256–268

Blackman A, Lahiri B, Pizer W, Rivera Planter M, Muñoz Piña C (2010) Voluntary Environmental Regulation in Developing Countries: Mexico's Clean Industry Program. J Environ Econ Manag 60(3):182–192

Bordalo P, Gennaioli N, Shleifer A (2013) Salience and consumer choice. J Political Econ 121(5):803–843

Cerruti D, Daminato C, Filippini M (2019) The impact of policy awareness: evidence from vehicle choices response to fiscal incentives. Economics Working Paper Series 19/316

Chalfin A, Deza M (2018) The effect of parental education on children's drug and alcohol use. AEA Papers and Proceedings 108:373–378

Chalfin A, Deza M (2019) The intergenerational effects of education on delinquency. J Econ Behav Org 159:553–571

Chamberlain G (1982) Multivariate regression models for panel data. J Econ 18(1):5–46

Chetty R, Looney A, Kroft K (2009) Salience and taxation: theory and evidence. Am Econ Rev 99(4):1145–1177

Christmann P, Taylor G (2001) Globalization and the environment: determinants of firm self-regulation in China. J Int Business Stud 32(3):439–458

Decker CS (2003) Corporate environmentalism and environmental statutory permitting. J Law Econ 46(1):103–129

Dellavigna S (2009) Psychology and economics: evidence from the field. J Econ Literature 47(2):315–372

Dore G, Brylski P, Nygard J, Thi P, Tran T (2008) Review and analysis of the pollution impacts from the Vietnamese manufacturing sectors. EASRE, The World Bank, Washington

Dubow EF, Boxer P, Huesmann LR (2009) Long-term Effects of Parents' Education on Children's Educational and Occupational Success: Mediation by Family Interactions, Child Aggression, and Teenage Aspirations. Merrill Palmer Quarterly (Wayne State Univ Press) 55(3):224–249

Duflo E, Hanna R, Ryan SP (2012) Incentives work: getting teachers to come to school. Am Econ Rev 102(4):1241–1278

Ervin D, Wu J, Khanna M, Jones C, Wirkkala T (2012) Motivations and barriers to corporate environmental management. Business Strategy Environ 22(6):390–409

Eskeland GS, Jimenez E (1992) Policy instruments for pollution control in developing countries. World Bank Res Observer 7(2):145–169

Fine A, Thomas A, van Rooij B, Cauffman E (2020) Age-Graded Differences and Parental Influences on Adolescents' Obligation to Obey the Law. J Dev Life-Course Criminol 6:25–42

Gabaix X, Laibson D (2006) Shrouded attributes, consumer myopia, and information suppression in competitive markets. Q J Econ 121(2):505–540
General Statistics Office (2015). Statistical Yearbook of Vietnam 2015. http://www.gso.gov.vn/default_en.aspx?tabid=515&idmid=&ItemID=16052
Greene W (2008) Discrete Choice Modeling. In: Mills T, Patterson K (eds) The Handbook of Econometrics, vol 2. Applied Econometrics. Palgrave, London
Greene W (2018) Econometric Analysis. Pearson Education, 8th edn
Greene W, Zhang Q (2019) Nonlinear and Related Panel Data Models. In: Tsionas M (ed) Panel Data Econometrics. Elsevier
Greenstone M, Jack BK (2015) Envirodevonomics: a research agenda for an emerging field. J Econ Literature 53(1):5–42
Gupta S, Tirpak D, Burger N, Gupta J, Höhne N, Boncheva A I, Kanoan G, Kolstad C, Kruger J A, Michaelowa A, Murase S, Pershing J, Saijo T, Sari A (2007) 2007: Policies, Instruments and Cooperative Arrangements. In Metz, B., Davidson, O. R., Bosch, P. R., Dave, R., and Meyer, L., editors, *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, pages 1109–47. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA
Han S, Vytlacil EJJ (2017) Identification in a generalization of bivariate probit models with dummy endogenous regressors. J Econ 199(1):63–73
Hanna R, Mullainathan S, Schwartzstein J (2014) Learning through noticing: theory and evidence from a field experiment. Q J Econ 129(3):1311–1353
Haveman R, Wolfe B (1995) The Determinants of Children's Attainments: A Review of Methods and Findings. Journal of Economic Literature 33(4):1829–1878
Hirshleifer D, Teoh SH (2003) Limited attention, information disclosure, and financial reporting. J Accounting Econ 36(1–3):337–386
Hossain T, Morgan J (2006) Plus shipping and handling: revenue (non) equivalence in field experiments on eBay. Advances. Econ Anal Policy 6(2):63–91
Innes R, Sam AG (2008) Voluntary pollution reductions and the enforcement of environmental law: an empirical study of the 33/50 program. J Law Econ 51(2):271–296
International Telecommunication Union, (2019), World Telecommunication/ICT Indicators Database. , https://data.worldbank.org/indicator/IT.NET.USER.ZS?locations=VN
International Trade Administration (2019), Environmental and Pollution Control Equipment and Services. Vietnam Commercial Guide, (2019)
IPCC (2014). Climate Change 2014: Synthesis Report. *Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*
IQAir (2019). World's Most Polluted Countries in 2019 - PM2.5 Ranking. *https://www.iqair.com/world-most-polluted-countries*
Karlan D, McConnell M, Mullainathan S, Zinman J (2016) Getting to the top of mind: how reminders increase saving. Manag Sci 62(12):3393–3411
Khanna M, Liao Y (2014) Globalization and voluntary environmental management in developing countries. Front Econ China 9(1):138–163
Khanna M, Speir C (2013) Motivations for Proactive Environmental Management. Sustainability (Switzerland) 5(6):2664–2692
King AA, Lenox MJ, Terlaak A (2005) The strategic use of decentralized institutions: exploring certification with the ISO 14001 management standard. Acad Manag J 48(6):1091–1106
Koszegi B, Szeidl A (2013) A model of focusing in economic choice. Q J Econ 128(1):53–104
Maddala GS (1986) Limited-dependent and qualitative variables in econometrics. Cambridge University Press, Cambridge
Montiel I, Husted BW (2009) The adoption of voluntary environmental management programs in Mexico: first movers as institutional entrepreneurs. J Business Ethics 88(SUPPL. 2):349–363
Mourifié I, Méango R (2014) A note on the identification in two equations probit model with dummy endogenous regressor. Econ Lett 125(3):360–363
Mundlak Y (1978) On the pooling of time series and cross section data. Econometrica 46(1):69–85
Nichols A (2011). Causal inference for binary regression with observational data. *CHI11 Stata Conference 6*, Stata Users Group
Nielsen, (2015) Sustainability Influences Purchase Intent of Vietnamese Consumers. Corporate Sustainability. Report

Nkonya E, Pender J, Kato E (2008) Who knows, who cares? The determinants of enactment, awareness, and compliance with community natural resource management regulations in Uganda. Environ Dev Econ 13(1):79–101
Poore J, Nemecek T (2018) Reducing food's environmental impacts through producers and consumers. Science 360(6392):987–992
Potoski M, Prakash A (2005) Green clubs and voluntary governance: ISO 14001 and firms' regulatory compliance. Am J Political Sci 49(2):235–248
Prime Minister's Office (2018). Circular No. 27/2018/QD-TTg: Promulgating Vietnam Standard Industrial Classification
Ritchie H (2020) Environmental impacts of food production. Our World in Data
Segerson K, Miceli TJ (1998) Voluntary environmental agreements: Good or bad news for environmental protection? J Environ Econ Manag 36(2):109–130
Sharma S, Tarp F (2018) Does managerial personality matter? Evidence from firms in Vietnam. J Econ Behav Org 150:432–445
Simons RL, Simons LG, Wallace LE (2004) Families, Delinquency, and Crime: Linking Society's Most Basic Institution to Antisocial Behavior, 1st edn. Oxford University Press
Somanathan E (2010) Effects of information on environmental quality in developing countries. Rev Environ Econ Policy 4(2):275–292
Stavins RN (2001) Experience with Market-Based Environmental Policy Instruments. Resources for the Future Discussion Paper 01–58
Stockholm Environmental Institute and University of York (2020) Manufacturing Pollution in sub-Saharan Africa and South Asia: Implications for the environment, health and future work. Sustainable Manufacturing and Environmental Pollution Programme, UNCTAD
Tambunlertchai K, Kontoleon A, Khanna M (2013) Assessing participation in voluntary environmental programmes in the developing world: the role of FDI and export orientation on ISO14001 adoption in Thailand. Appl Econ 45(15):2039–2048
The Government of Vietnam (2015). Circular No. 18/2015/ND-CP: Prescribing Environmental Protection Master Plan, Strategic Environmental Assessment, Environmental Impact Assessment and Environmental Protection Plan
United Nations University UNU-WIDER (2011) Viet Nam SME database
Videras J, Alberini A (2000) The appeal of voluntary environmental programs: Which firms participate and why? Contemporary Econ Policy 18(4):449–460
Vidovic M, Khanna N (2007) Can Voluntary Pollution Prevention Programs Fulfill Their Promises? Further Evidence from the EPA's 33/50 Program. J Environ Econ Manag 53(2):180–195
Vietnam Law and Legal Forum (2008). Circular No. 05/2008/TT-BTNMT of December 8, 2008, Guiding Strategic Environmental Assessment, Environmental Impact Assessment and Environmental Protection Commitment
Vincent JR (2010) Microeconomic analysis of innovative environmental programs in developing countries. Rev Environ Econ Policy 4(2):221–233
Wendling ZA, Emerson JW, Esty DC, Levy MA, de Sherbinin A et al (2018) 2018 environmental performance index. Yale Center for Environmental Law & Policy, New Haven
Wilde J (2000) Identification of multiple equation probit models with endogenous dummy regressors. Econ Lett 69(3):309–312
Wooldridge JM (2005) Unobserved Heterogeneity and Estimation of Average Partial E. Identification and Inference for Econometric Models: Essays in Honor of Thomas Rothenberg. Cambridge University Press, pp 27–55
Wooldridge JM (2010) Econometric analysis of cross section and panel data. MIT Press, Cambridge
World Bank (2010) World Development Report 2010: Development and Climate Change
Wright K, Wright K (1994) Family Life and Delinquency and Crime: A Policymakers' Guide to the Literature. Office of Juvenile Justice and Delinquency Prevention. p 140517