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Eco-Management and Audit Scheme Compliance and State Subsidization: Evidences from Italian Firms

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1 Introduction

Eco-Management Systems (EMSs) are sets of processes and practices that enable an organization to reduce its environmental impacts and increase its operating efficiency. In Europe, the two most widely adopted EMSs are the ISO14000 family, developed by the International Organization for Standardization (ISO), and the Eco-Management and Audit System (EMAS), first launched by the European Union in 1993. EMAS is composed of an Eco-Management System and an Audit system, focusing on continuous improvement of KPIs such as energy efficiency water utilization efficiency. While initially only reserved for companies operating in industrial sectors, with the introduction of EMAS II in 2001, eligibility was extended to companies in all sectors, eventually reaching over 4000 companies in compliance in the EU as of 2024.

While existing literature already tackles the impact of EMAS compliance on environmental and economic performance, as well as internal and external factors for adoption, there still is a lack of understanding of the interplay between institutional factors—such as environmental subsidies and tax rebates—and EMAS compliance. Therefore, in this thesis I analyse the impact of subsidization and other monetary incentives on Italian companies' compliance with the EMAS standard.

Section 2 gives a theoretical and empirical background on EMSs and other forms of Voluntary Environmental Protection (VEP), while Section 3 explains environmental subsidization in Italy. Section 4 develops the research hypothesis and describes the research methods. Section 5 presents and discusses the results, followed by suggestions to integrate the findings into policies. Section 6 concludes.

2 Background

Coordinating economic development and environmental protection is a difficult endeavour which many major countries and political actors have undertaken to different degrees. The EU, China, Japan, and the US have all formulated green development strategies in the last decades, through incentives, mandatory disclosures, and subsidies.

This transition in policy from pure economic growth to sustainable development has also been reflected in some of the latest developments in management theory, especially Corporate Social Responsibility (CSR), which is “decisions and actions taken for reasons at least partially beyond the firm's direct economic or technical interest” (Davis, 1960). Beyond mere economic motives, CSR suggests that managers should “perform in a manner consistent with expectations of societal mores and ethical norms” (Carroll, 1991). Blindheim and Langhelle (2010) find that legitimacy, “ the relativistic idea that the social institution of the business should adapt to society’s shifting ideas about the responsible use of power,” to be the strongest external pressure for firms to adopt CSR. Dentchev (2005) finds that as the environmental awareness of the public continues to grow, companies are increasingly adopting CSR as part of their strategy.

CSR also plays the role of complementing financial information available to investors and has been found to decrease the firm’s idiosyncratic risk (He et al., 2023). This effect is strongest for firms that are otherwise informationally opaque. Given the information asymmetries between firms and consumers regarding pollution and resource use, which are inherently hard to measure and lack a standardized unit of account, tools to ensure some degree of standardization and disclosure have been developed by several regulatory agencies.

This has given rise to several EMSs, the most prominent of which are the ISO 14000 family, EMAS and the British BS 8555 standard.

EMAS is generally considered to be more stringent than ISO14000. While both are voluntary, EMAS rests on an EU legal backing, while ISO14000 entails no penalties for incorrect reporting or non-compliance.[1] EMAS also places a strong emphasis on continuous improvements of efficiency measures and other indicators, while ISO14000 has no continuous improvement requirement. Whereas EMAS requires total compliance, ISO14000 only requires a commitment to compliance.

The voluntary nature of EMSs is particularly relevant. Environmental regulations can be divided into three broad categories:

1. Command and Control Instruments (CCIs), entailing the regulatory agencies directly setting standards and regulations.
2. Market-Based Instruments (MBIs), such as cap-and-trade systems for pollution control.
3. Voluntary-Based Instruments (VBIs), which leave freedom to firms regarding course of action, and which comprise EMSs and other tools.

According to Kneller and Maderson (2012), regardless of the type of instrument employed, its stringency is positively correlated with environmental protection. Lade et al. (2018) find MBIs to be the most effective and most widely used throughout the world from 2014 to 2017. Bu, Qiao and Lu (2020) find that voluntary instruments are more effective than CCIs or even MBIs in China, given institutional rigidities and the general policymaking

[1] Unlike EMAS, ISO 14001 does not mandate the disclosure of a public environmental statement.

stance on the matter of environmental protection, though many policies effectively combine two or all three categories.

Khanna and Damon (2002) find voluntary programs to be substantially more effective when there is a strong and credible legal threat backing audit mechanisms, as this legal backing endows the regulator with a higher bargaining power to negotiate higher levels of pollution abatement. Frequent monitoring also increases the strength of the negotiator's position. EMAS' frequent audits and stringent continuous improvement requirements seem to be particularly well-designed from this perspective.[2]

This effectiveness of VBIs can be partly explained by Porter and Van der Linde (1995) through the Porter Hypothesis, which formulated a conceptual reconciliation of the profit motive with environmental protection. This hypothesis states that compliance with well-designed environmental regulation can be profitable for compliant firms because it might trigger an innovation offset, i.e. a reduction in production costs stemming from higher resource utilization efficiency and lower end-of-pipe pollution abatement costs. Such an offset happens when a firm is free to choose its course of action rather than being locked in any particular "best available technology." Such offsets can happen at a national level, providing a competitive advantage to the country where regulation is enforced first. Montobbio and Solito (2017) report evidence of EMAS compliance fostering innovation offsets in Italy and Germany, the two countries with the highest number of compliant firms, when "green patents" are used as a proxy for innovation.

Compliance with stringent and well-designed environmental regulation does not only breed innovation. When shifting our perspective from computing the out-of-pocket costs of

[2] EMAS-compliant companies need to submit to an external audit of their environmental statements at least once every three years.

pollution, such as cleanup and compensation for damages, to computing the opportunity costs of pollution and emissions in terms of resource utilization inefficiency, the benefits of regulation become even clearer. In fact, both energy and material efficiency are part of the six KPIs for EMAS compliance.

At the firm level, motivations behind EMAS compliance are diverse and are motivated and mediated by the industry in which the firm operates. These motives can be categorized into “internal” and “external” factors. Internal factors include corporate culture, commitment to the environment, and ensuring regulatory compliance, while external factors comprise pressure from stakeholders and seeking legitimacy. Henriques and Sadorsky (1996) find pressures to adopt EMSs to be higher in peer and neighbour groups where compliance rates are already high. Khanna et al. (2007) find larger companies and multinational corporations to be more prone to adopting voluntary environmental programs, possibly because of the benefits of large-scale standardization and EMSs representing a reputation advantage in imperfectly competitive markets such as those in which multinationals operate.

There is also a growing number of public organizations joining EMAS, with entire communes, such as the city of Varese Ligure, adopting the certification. In light of the importance of legitimacy, this could give a significant boost to tourism, especially in rural communities which might be underdeveloped in the hospitality sector. Public sector organizations benefit from compliance through better handling of environmental problems, better cooperation between competent authorities, and a heightened awareness and anticipation of possible fines and penalties.

State intervention and coordination can be a significant positive factor on compliance rates within a country if financial support is properly coordinated with strong legal and administrative backing. Financial measures such as tax rebates for firms compliant with

environmental certifications have positive effects both on economic and environmental performance of compliant firms through technological innovation and higher resource utilization efficiency. Zhang and Song (2022) document stronger incentive effect for private firms and firms with higher production capacity. Better environmental performance can lead to increased profitability through a reduction in the tax burden faced by firms, but changing tax enforcement without clear standards may undermine environmental regulations' effectiveness and give way to rent seeking and corruption.

However, European evidence on the effectiveness of tax rebates and exemptions for environmentally intensive sectors, which are often motivated by competitiveness concerns, is lacking. Given the social costs of such policies and the importance of pollution abatement for the European agenda, measures combining rebates with VBIs could be more performant than a pure tax exemption regime. It is of the utmost importance that polluters internalize their clean-up costs by developing either cleaner production processes or appropriate end-of-pipe treatment of pollutants.

Biffi et al. (2021) show a significant amount of inefficiency in the spatial allocation of subsidies, especially in the agricultural sector, affecting both Europe and the US. In the context of the European Union, this might be the result of poor national and regional coordination, but also of political choices, such as targeting female or young farmers and targeting impoverished or underdeveloped regions.

Amenta and Stangnaro (2022) demonstrate that in the energy sector, subsidies are more expensive for the taxpayers than the European market-based cap-and-trade system (Emission Trading System) by one or even two orders of magnitude per ton of CO_2 abated, depending on the Member State we are considering. Subsidies are also found to be inefficient as an

industrial policy, as the European shares of the global markets for renewable energy and for renewable energy infrastructure are steadily dwindling.

In the last decades, governments throughout the world have gradually shifted from a Command-and-Control paradigm for environmental protection to reliance on voluntary mechanisms such as EMAS, which can provide the benefits of reduced transaction and enforcement costs by avoiding the need for designing and implementing regulations at national or industry level. Moreover, behavioral policy interventions to promote sustainable behaviour through mandatory regulation can prove to be ineffective or even backfire, and, in the contemporaneous presence of voluntary environmental programs, small increases in intensity of mandatory regulations have been associated with decreases in voluntary contributions of the same magnitude.

Considering this "crowding out" effect and the Porter Hypothesis, EMAS adoption could be considered an effective policy tool for European governments, both to ensure proper pollution abatement and to foster an innovation offset which might lead to a persistent competitive advantage. Subsidization could provide a financial cushion for firms to absorb their compliance costs in the first years of adoption, which are the most capital-intensive because of the need for redesigning production and management processes.

Yücel, Emir and Göksel (2023) argue that subsidization is most effective when used as a complement to Environmental Related Taxation (ERT) if we measure success as firms' R&D spending on environmental innovation. It is thus important to consider subsidies within a broader context of environmental policies employing CCIs, MBIs and VBIs in unison, both to amplify desired effects and to dampen any drawback, e.g. distortionary effects on prices.

The government can play the role of coordinating these policy efforts to encourage private initiatives and leave the innovation process to the firms themselves to figure out. The

State, as opposed to corporations' managers, does not have to maximize shareholders' value, and can deviate from the profit logic to devise nation-wide medium- and long-term plans, providing financial coverage and administrative guidance. This double role of designing both the VBI and the incentive scheme accompanying it can be exploited in full to align the private sector's objectives with those of civil society, i.e. environmental protection and sustainable growth.

With the intent of understanding the interplay between public incentives and private appetite for environmental protection, I test the impact of subsidization on Voluntary Environmental Protection (VEP), by examining whether industrial sectors with higher subsidization exhibit higher EMAS compliance rates:

H1: Higher availability of subsidies for environmental protection is correlated with higher EMAS compliance rates.

3 Environmental public subsidies in Italy

3.1 Harmful subsidies and direct tax rebates

In Italy, there is no quantitative information available for about 2/3 of all tax expenditure, i.e. the national tax income lost through exemptions and special provisions, leading to the establishment of the Catalogue on Environmentally Harmful and Environmentally Friendly Subsidies (CES) in 2014, which constitutes the main source of information regarding public environmental spending for this paper.

According to the Catalogue on Environmentally Harmful and Environmentally Friendly Subsidies, there is still a significant amount of tax expenditure on environmentally damaging products and activities, mainly through the subsidization of fossil fuels. Italy has committed to supporting oil transportation and refining until 2024, gas extraction until 2026 and oil distribution until 2028, in a move breaking away with all other COP26 countries.

According to PriceofOil, in the period 2016–2021, Italy has spent 13.7€ billion on subsidizing fossil fuels through SACE, an insurance company directly controlled by the Italian ministry of the Economy and Public Finances, the highest amount for fossil fuel subsidization in all of Europe. This has political motivations, mainly stemming from the difficult economic recovery from the COVID-19 pandemic and the oil price surge after Russia's invasion of Ukraine, which outweigh the social costs of pollution and are therefore damaging not only to the environment, but to economic growth and development as a whole, also functioning to preserve the technological status quo.

Fossil fuel subsidization put in place at the end of the pandemic to stimulate economic recovery accounts for a good portion of these damaging subsidies. This is in stark contrast to

the European Commission's 2011 commitment to phasing out environmentally damaging subsidies within 2020. This commitment was then renewed with the 2021 Glasgow statement, which set a new deadline for 2022. All member states have failed phasing out damaging subsidies, raising questions about the political feasibility of this goal. These subsidies often target social groups that are perceived as impoverished and more fragile, so the political cost of such a transition is high.

The CES also accounts for exemptions on the main value-added tax (IVA). Sun, Zhan and Du (2020) argue that VAT exemptions have little effect on and may even be harmful to firm performance. At the industry level, such exemptions may be distortionary on prices and create overcapacity, further reducing the information customers and regulators can deduct from pricing. There is also a high degree of uncertainty and temporal lag associated with VAT rebates and exemptions for environmental protection purposes, which can be further exacerbated by the volatile nature of the prices of assets such as energy and clean water, which account for a significant portion of all subsidized goods and services.

3.2 Environmentally friendly subsidies

According to the Italian Ministry of Environment, Land and Sea Protection, the environmentally friendly public subsidies for all aspects of environmental protection in the period 2016–2021 averaged at €17.559 billion per year, encompassing subsidies for the use of renewable energy, agricultural and fishing subsidies, subsidies for sustainable transportation and other miscellaneous ones. Table 1 provides the yearly budgetary costs of each subsidy category for the period 2016–2021.

Since 1999, 524 regional or nation-wide decrees containing incentives for EMAS-compliant companies have been issued in Italy. These range from outright financial support,

to reduced tariffs for the use of public water and soil, to preferential treatment in public procurements. Of these decrees, 81 were at the national level and the remaining 443 were issued at a regional level. Table 2 reports the geographical distribution of such decrees.

After restricting to the period for which yearly budgetary costs data is available (2016–2021), 217 decrees containing facilitations for EMAS compliance were issued at all levels. Of these, only 38 were issued at a national level. This low amount of national legislation compared to local-level legislation reflects the Legislative Decree 152/2006.

While no data is available to assess the monetary amount of subsidies received by individual firms, I use the subsidies' categorization to match peer groups, as determined by the firms' ATECO code, to the total amount of subsidies available to them, which I call "subsidies pool."

There is a lack of understanding in the literature on the relationship between environmental subsidization and EMAS compliance in firms. A positive correlation would integrate previous research on adoption factors and strengthen the argument for Voluntary-Based Instruments as the primary policy tool for environmental protection at a firm level.

4 Data sources and research design

4.1 Data sources

Data regarding Italian companies currently compliant with EMAS was retrieved from the EU's EMAS registry. The data was then matched with financial information at firm-level from the AIDA database. Total assets and liabilities, Profit, EBITDA, and the number of employees were chosen as complementary information, along with identifiers such as NACE and ATECO codes. Based on the total assets reported in the most recent fiscal year, I selected the 100 largest companies and assigned to each firm of this subset the eligibility to various subsidy categories. Doing this, a "subsidy pool" is defined for each firm-year. This was computed starting from the categorization of the data on subsidies (agricultural and fishing, energy, transportation, and other subsidies), and then by establishing a relationship between the subsidies and the ATECO codes of the firms. Table 3 reports the distribution of the companies both in the initial AIDA search and in the 91 compliant firms that matched with the AIDA set among ATECO sectors.

After this first round of matching, a further refining was performed to account for heterogeneity across these sectors. For example, "manufacturing" encompasses firms operating in the food and beverage industry, which had available to them the subsidies for agriculture and fishing, but also clothing firms which did not have them available. Appendix A lists the companies in the restricted subset and their assigned eligibility.

Out of these 100 largest companies, 9 are EMAS compliant, generating 54 compliant firm-years. Data regarding the budgetary costs of subsidies and the decrees containing incentives for EMAS-compliant firms were retrieved from the ISPRA, The Superior Institute

for Environmental Protection and Research, which relays the Environmental Protection Ministry's (MASE) data and other regional-level legislation.

Table 4 reports the descriptive statistics for the subset of companies used as a sample to test the models and for the dollar amount of subsidies, along with the correlation table. Companies in the subset posted on average sales for €3,397,200, while the median is €1,583,750. This high degree of difference between mean and median shows also in the number of workers hired by the firms, 5,053 and 1,608 respectively. The 99th percentile for this variable is 48,465, while the maximum value is 136,928, indicating the presence of few big outliers, a trend consistent for all variables.

On average, firms in a given year *t* had available to them €9,612,970 in environmental subsidies, with the lowest value in the period being €1,448,000.

4.2 Research design

For this study, we developed this benchmark model to explore whether subsidies availability was positively correlated with EMAS compliance:

$$\text{compliance}_{it} = \beta_0 + \beta_1 \log(\text{incentives}_{it}) + \epsilon_{it}.$$

We also test a multivariate model, to which we add control variables we will discuss below.

$$\text{compliance}_{it} = \beta_0 + \beta_1 \log(\text{incentives}_{it}) + \beta_2 \log(\text{assets}_{it}) + \beta_3 \log(\text{sales}_{it})$$

$$+\beta_4 \log(\text{employees}_{it}) + \epsilon_{it}.$$

For both models, *i* and *t* represent firm and year respectively. The variables are defined as below. Given the binary nature of the dependent variable, we have chosen to perform a

Probit regression to test our research hypothesis, which will yield the probability effects of the explanatory variables on compliance. Probit will provide consistent estimates and robust standard errors even if the error terms are not normally distributed.

EMAS compliance ($compliance_{it}$) is the dependent variable in this regression. For each firm year, the dummy variable is 1 for compliant companies and 0 otherwise.

The main explanatory variable of this regression is the logarithm of the "subsidy pool" available to a firm at a given year ($\log(\text{incentives}_{\text{it}})$). This "subsidy pool" serves as a proxy of the degree of institutional effort for environmental protection through incentivization rather than regulatory or normative means. The value for each firm year was computed according to the method discussed in the previous sub-section.

I use three control variables. Log(assets) is a proxy for firm size. On the one hand, companies with more assets might possess a base of resources to devolve to the process of adoption, functioning either as collateral or as the base of redesigned production processes. On the other hand, it might also be possible that, having already tied in considerable resources in the existing production process, firms might find it difficult and expensive to redesign their operations and management. Log(sales) is the natural logarithm of total sales for the firm year, which is used to account for the fact that many large firms which are in contact with the end-consumers are already engaged in CSR and might value legitimacy more than companies further back in the production chain. Log(employees) is the natural logarithm of the number of employees working for the firm. This variable is included because a higher number of employees might entail a higher degree of flexibility for firms to allocate resources and time to redesigning production and management processes in compliance with EMAS.

5 Results

Table 5 reports the regression results. In addition to coefficients and *t*-statistics, I also report the average partial effect (APE), which is computed from the coefficients of the Probit regression, showing us the average change in probability of the binary outcome of EMAS compliance for a one-unit change in the predictor variables.

The natural logarithm of the subsidy pool available to the firm at *t* has a coefficient of 0.45 in the univariate model, or 0.52, after adding control variables. Its APE is 0.206, meaning that a 1% increase in the subsidies available to firm *i* at year *t* increases the probability of firm *i* being in EMAS compliance by 20.6%. This coefficient is statistically significant at 0.1%, for both the univariate and multivariate models. The result is consistent with previous findings in the literature, which suggests a positive relationship between state incentivization and EMAS compliance.

The regression reports a negative and statistically significant coefficient of –0.39 for the natural logarithm of the total assets of the firm in firm-year *t*. The associated *p*-value is significant at 0.1%. The negative relationship might stem from multiple factors. Firstly, having a significant amount of money tied down on assets could make it difficult to make provisions for the costs of compliance. Secondly, redesigning production and management processes increases in complexity and costs with the sheer amount of machines, factories, and equipment to renew. More research should be done on this topic to further investigate the relationship between asset count and EMSs, especially by using more granular data reporting PPE separately from other assets.

The natural logarithm of firm sales at year *t* has a positive coefficient of 0.036, with a *p*-value at 0.46, thus being insignificant at all common confidence levels. We can thus infer

that sales do not play a role in the compliance decision, and we suspect that analysis on the effect of EMAS compliance on sales would be a more appropriate topic of research.

The regression reports a coefficient of 0.198 on the natural logarithm of employees, with an APE of 0.0784. This positive relationship might be due to greater capacity for diverting effort to set up redesigned processes for compliance, as well as greater attention and pressure from stakeholders. It might also be capturing the fact that some state-participated firms, which tend to employ more people compared to private companies of similar size, were included in the sample. This finding is consistent with those in similar studies done in other regions.

6 Discussion

As we expected, the availability of environmental incentives is strongly and positively correlated with EMAS compliance at firm level. This is consistent with the traditional view of environmental policy, i.e. that compliance costs are a great burden to organizations, and as such the compliance decision rests upon an out-of-pocket costs consideration. This finding may also support existing evidence on the fact that high compliance rates in a firm's peer group, which by our definition have very homogeneous incentive pools available to them, constitute a pressure on firms to adopt EMSs.

In this light, state subsidization serves to lower the barriers to entry by allowing compliant firms to recover part of their expenses, effectively externalizing the cost of compliance to the taxpayers. Such policies are necessary as long as environmental protection efforts still exhibit a high degree of temporal lag and uncertainty in their offsetting effects on resource efficiency and clean-up costs reduction.

This subsidization works in complement with other legal facilitations for compliant firms, such as lower resource costs for the use of public water and soil, higher priority in public procurements and reduced inspections. Firms that comply with EMAS thus accumulate a significant competitive advantage, stemming both from this preferential treatment and the innovation offsets suggested by Porter (1995).

The high degree of environmental subsidization in Italy can thus partly explain why Italy's EMAS compliance is so high, boasting the second highest number of compliant companies in the EU, only trailing the more populous and industrially developed Germany. Subsidization thus becomes a way to ensure the competitive advantages are shared at a national level, by integrating compliance vertically in value chains. This is consistent with

findings from other geographical areas such as China, which found a positive correlation between government incentivization of VBIs and firms' environmental efforts.

The coefficients of the control variables also tell us that compliance is easier for firms with low asset counts and many employees, suggesting that compliance requires a pool of resources to be readily deployable on the challenges arising from implementing new processes and internal regulation. We suspect that we can think of assets as resources that are already tied down and suffer from a degree of inertia in their allocation, while employees are more mobile inputs which can be readily allocated on the steps to compliance. This can provide a key insight into how firms should approach starting any environmental programs, highlighting the importance of training and human resources development. The positive correlation between state incentivization through subsidies and EMAS compliance suggests that States have a double role to play in the EMAS adoption process.

First, States that are EU members design EMAS itself and provide guidance and assistance on its implementation, thus being able to update the EMS to be up to par with technological breakthroughs and more stringent commitments to environmental protection at a political level. While EMAS is already well-designed from an incentive perspective, especially because of its commitment to continuous improvement, States could increase external pressures on firms by promoting public awareness of the EMAS label, a key component of the legitimization firms are seeking through environmental efforts.

While facilitations for SMEs already exist in the form of the European Commission's "EMAS Easy" program, more can be done to integrate the certification at all levels of the private and public sectors. Given that traditionally, we think of profit as the ultimate measure of economic viability, publicizing the savings in terms of improved resource utilization

efficiency and lower clean-up costs will endow firms' decision makers with better knowledge of the benefits of compliance with EMAS.

A better understanding of the costs of pollution, along with a serious legislative effort to avoid their externalization to society through increased accountability of polluters, will be crucial to increase the number of companies in compliance. Currently, there is little publicly available information to assess how much individual Italian firms pollute. Reducing this information asymmetry between polluters and consumers could further increase external pressure on firms to adopt EMAS.

Second, States can design and implement policies to aid and facilitate firms that are either already compliant with EMAS or in the process of compliance, through a plethora of instruments, ranging from subsidization to prioritization in public procurement.

This will be key in the transition from the externalization of the costs of pollution to society to policies based on the polluter pays principle, which should be the ultimate goal of the regulator. Subsidization can thus be considered as a temporary device to build up a base of environmentally friendly firms, which will then give a competitive advantage at regional or national level and exert pressure on peers to fall in line towards compliance and better environmental performance.

The regulator should implement other policies and instruments to correct eventual distortionary effects on pricing, which may give erroneous signals to the general public on the actual costs of subsidized goods. This will be particularly important in the energy and water sectors. This will further reduce the high degree of information asymmetry on pollution and pollution abatement.

Considering the evidence of spatial misallocation of subsidies in Europe, careful consideration must be given to spill-over effects of monetary benefits, both positive, such as the formation of entirely compliant industrial clusters, and negative, such as demographic distortions.

Given the positive relationship between the number of employees of a firm and EMAS compliance, we suspect that subsidizing training on environmental protection and new technologies could also provide considerable benefits to the creation of a more ecologically aware private sector and industrial base. Given the need for better information to be available to firms' decision-makers, proper management training on the opportunity cost of pollution should also be incentivized.

7 Conclusion

The Eco-Management and Audit Scheme is the most widely spread EMS in Europe, with over 4000 firms currently in compliance. While Italy has a comparatively high compliance rate, only a small fraction of its firms possesses the certification, indicating a European Union-wide deficiency in encouraging firms to engage with the EMS.

EMAS is a VBI which is particularly well-suited to generate nation-wide competitive advantage because of its fostering of "innovation offsets", along with a more sustainable environment for workers and citizens.

EMAS has been linked to improvements in both environmental and economic performance, though the traditional view of environmental regulation compliance, which sees regulation as burdening companies with often unsustainable costs, seems to prevail among managers and other decision-makers. Often, a deadlock emerges between the initial costs of compliance and the prospected benefits in terms of resource savings and lower clean-up costs.

For this reason, governmental action plays an essential role in EMAS dissemination, as we have found that environmental subsidies availability is strongly and positively correlated with compliance at firm-level. This has several policy implications for the national and regional regulators, highlighting the need for government support in spreading voluntary-based policy instruments and a better understanding of the costs of pollution against those of pollution abatement.

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Table 1: Environmentally-friendly subsidies, 2016–2021

This table provides the budgetary costs of environmentally-friendly subsidies available to Italian firms in the period 2016–2021, in thousands of Euros. “Other subsidies” is an aggregation of miscellaneous measures lacking categorization from the data source (Italian Ministry of Environmental Protection, MISE). These subsidies are available nation-wide and there is no indication regarding the geographical distribution of the subsidies allotted to firms.

Sector	2016	2017	2018	2019	2020	2021
Agriculture & Fishing	2,521.88	2,760.96	3,347.65	3,269.13	3,289.59	3,283.82
Energy	12,133.04	12,110.84	11,657.89	11,766.07	12,074.38	11,913.02
Transportation	74.60	69.60	38.60	205.30	1,158.31	966.80
Other subsidies	1,448.02	1,728.91	2,014.32	2,331.54	2,379.56	2,397.00
TOTAL	16,458.43	16,955.72	17,375.68	17,620.06	18,919.28	16,163.64

Table 2: Geographical distribution of EMAS-related legislative decrees

This table contains the geographical distribution of all legislative decrees, both at a regional and national level, which directly mention EMAS and offer benefits of various nature to compliant firms. These benefits include direct subsidies, reduced tariffs for the use of public water and soil, preferential treatment in public procurement, reduced inspections and bureaucratic simplifications.

Jurisdiction	Number of decrees
Abruzzo	9
Basilicata	3
Calabria	11
Campania	13
Emilia-Romagna	28
Friuli Venezia Giulia	20
Lazio	9
Liguria	13
Lombardia	58
Marche	10
Molise	7
Piemonte	28
Puglia	9
Sardegna	22
Sicilia	8
Toscana	42
Trentino Alto Adige (Bolzano)	15
Trentino Alto Adige (Trento)	19
Umbria	22
Veneto	19
Regional level	365
National	81
Total	446

Table 3: Distribution of companies among ATECO sectors

This table tabulates the number of companies both in the population, i.e. all firms contained in the original AIDA search batch, and the sample, i.e. EMAS compliant companies in that batch, for each ATECO sector represented. The ATECO sectors are represented by the first two digits of each firm's ATECO 2007 code. The percentage columns show the number as a percentage of both the population and the sample.

Sector	Firms	Firms %	EMAS-compliant firms	EMAS-compliant %
Construction	405	13.45%	2	2.20%
Information and communication	192	6.38%	5	5.49%
Manufacturing	1705	56.63%	38	41.76%
Transportation and storage	308	10.23%	10	10.99%
Water supply; sewerage, waste management and remediation activities	141	4.68%	24	26.37%
Wholesale and retail trade; repair of motor vehicles and motorcycles	260	8.64%	12	13.19%
Total	3011		91	

Table 4: Descriptive statistics and correlation table

This table contains two panels. Panel (A) provides the descriptive statistics for the financials and employee count of the firms in the sample used in the regressions, and the subsidy pool associated to each firm-year. These statistics are computed on firm-year (2013–2022) averages for each firm. Each variable, with the exception of the number of employees, is displayed in Euros. Panel (B) is the correlation table between variables, for both the Pearson and the Spearman methods. Spearman numbers are on the lower left triangle, whereas Pearson numbers are on the upper right

(A) Descriptive statistics

Variable	Mean	Median	SD	Min	Max	1st pctl	99th pctl
Incentives	9612.97	13672.20	5670.12	1448.00	15612.30	1448.00	15612.30
log(incentives)	8.86	9.52	0.90	7.73	9.66	7.73	9.66
Compliance	0.92						
Sales	3,397,200.25	1,583,750	5,284,929.59	0	42,027,731	0	27,842,107.08
log(Sales)	13.71	14.27	3.74	0	17.55	0	17.14
EBITDA	325,391.64	178,257	636,512.10	−1,616,494	6,979,877	−538,225.16	3,473,108.28
Profit	151,921.76	80,476	559,887.83	−2,440,222	7,674,595	−1,135,545	2,007,012.04
Employees	5,052.87	1,608	13,492.48	0	136,928	0	48,464.64
log(Employees)	7.15	7.38	2.45	0	11.83	0	10.69
Assets	7,055,194.55	3,155,442	14,016,792.60	10,280.406	121,072,511	432,732.18	83,305,928.36
log(Assets)	15.11	14.96	1.01	9.23	18.61	12.98	18.23

(B) Correlation table

Variable	log(incentives)	log(assets)	log(employees)	log(sales)
log(incentives)		0.098	0.048	0.195
log(assets)	0.147		0.445	0.256
log(employees)	0.019	0.422		0.439
log(sales)	0.219	0.416	0.377	

Table 5: Regression output

This table contains the results of the Probit regressions on both the univariate and the multivariate models discussed in Section 4. Coefficients and Average Partial Effects are reported for both the univariate and multivariate models, along with t-statistics. Levels of significance of 10%, 5% and 1% are reported as *, **, or ***, respectively.

	Univariate			Multivariate		
	Coefficient		APE	Coefficient		APE
Intercept	–5.40 (–5.37)	***		-2.25 (-1.45)		
log(incentives)	0.44 (4.12)	***	0.178	0.52 (4.44)	***	0.206
log(assets)				-0.3 (-3.50)	***	-0.153
log(employees)				0.20 (2.97)	***	
log(sales)				0.036 (0.73)		0.014
AIC	342.68			331.7		
N	584			584		
DFs	583			580		

Appendix A: Subsidy pool allocation per firm

This table exhibits how each firm in the sample used for the models was matched to the various subsidies categories in Table A. Given the difficulty in discerning the nature of the "Other" category, we consider it to be available to all firms. For each firm, a 1 under a subsidy category means that that particular subsidy pool is available to the firm for the whole period we are considering, i.e. 2016–2021, a 0 indicates otherwise. Further information would be needed to take into account firms which changed the nature of their operations during the period, thus changing the total amount of incentives it had available.

C indicates compliance to EMAS, A&F Agricultural and Fishing, E indicates energy and T transport.

Company	C	A&F	E	T
2IRETEGASSPA	0	0	1	0
A2ASPA	1	0	1	0
ABBSPA	0	0	0	0
ACCIAIERIA ARVEDI SPA	1	0	1	0
ACEAATO2	0	0	0	0
ACEA SPA	0	0	1	0
AU SPA	0	0	1	0
ADRSPA	0	0	1	1
ALSTOM FERROVIARIA SPA	0	0	1	1
ANAS SPA	0	0	1	1
ANGELINI PHARMA SPA	0	0	0	0
ANSALDO ENERGIA SPA	0	0	1	0

Company	C	A&F	E	T
ARETI SPA	0	0	1	1
AUTOMOBI LILAMBORGHINI SPA	0	0	1	1
AUTOSTRADE PER L'ITALIA SPA	0	0	0	1
AXPO ITALIA SPA	0	0	1	0
AZULE ENERGY ANGOLA SPA	0	0	1	0
BARILLA GER FRATELLI SPA	0	0	1	0
BTICINO SPA	0	0	1	0
BUZZI SPA	0	0	0	1
CALZEDONIA SPA	0	0	0	0
CHIES IFARMACEUTICI SPA	0	0	0	0
CONSORZIO COCIV	1	0	0	1
CONSORZIO SATURNO	0	0	0	1
CONSORZIO VENEZIA NUOVA	0	0	0	0
COSTA CROCIERE SPA	0	0	0	1
DANIELI&C SPA	0	0	0	0
DAVIDECAMPARI-MILANONV	0	0	0	0
E-DISTRIBUZIONE SPA	0	0	1	0
ENAV SPA	0	0	0	1
ENEL ENERGIA SPA	0	0	1	1
ENEL GLOBAL TRADING SPA	0	0	0	1
ENEL GREENPOWER SPA	0	0	1	1
ENEL PRODUZIONE SPA	1	0	1	1
ENI PLENITUDE SPA	0	0	1	0

Company	C	A&F	E	T
ENI REWIND SPA	0	0	0	0
ENI SPA	0	0	1	0
EON PRODUZIONE SPA	0	0	1	0
ERG POWER GENERATION SPA	0	0	1	0
ESSELUNGA SPA	0	0	0	1
ESSOITALIANA SRL	0	0	0	0
FCA MELFI SRL	0	0	1	1
FERRARI SPA	0	0	1	1
FINCANTIERI SPA	0	0	1	0
GEAVIO SRL	0	0	1	0
GESTORE DEI MERCATI ENERGETICI SPA	0	0	1	0
GSE SPA	0	0	1	0
GRIMALDI EUROMED SPA	0	0	0	1
GUCCIO GUCCI SPA	0	0	0	0
HM ITALIA CEMENTI SPA	0	0	1	0
HERA COMM SPA	0	0	1	0
HERA SPA	1	0	1	0
HERA TRADING SRL	0	0	1	0
HITACHI RAIL STS SPA	1	0	1	1
IMA SPA	0	0	1	0
IREN ENERGIA SPA	1	0	1	0
IREN SPA	0	0	1	0
IRETI SPA	0	0	1	0

Company	C	A&F	E	T
ISAB SRL	0	0	1	0
ITALGASRETI SPA	0	0	1	0
ITALIANAPETROLI SPA	0	0	1	0
ITALO SPA	0	0	0	1
IVECO SPA	0	0	1	1
KUWAIT PETROLEUM ITALIA SPA	0	0	1	0
LEONARDO SPA	0	0	1	1
LIDL ITALIA SRL	0	0	0	1
LOGISTAITALIA SPA	0	0	0	0
LAVAZZA SPA	0	0	0	1
LUXOTTICA GROUP SPA	0	0	0	0
MARELLI EUROPE SPA	0	0	1	0
MM SPA	0	0	0	0
MOZAMBIQUE ROVUMA VENTURE SPA	0	0	1	0
NUOVO PIGNONE INTERNATIONAL SRL	0	0	1	0
NUOVO PIGNONE SRL	0	0	1	0
ORIZZONTE-SISTEMI NAVALI SPA	0	0	1	0
PLT SPA	0	0	0	0
PFIZER ITALIA SRL	0	0	0	0
PIRELLI TYRE SPA	0	0	1	0
POSTEITALIANE SPA	0	0	1	1
PRADA SPA	0	0	0	0

Company	C	A&F	E	T
PRYSMIAN POWERLINK SRL	0	0	1	0
PRYSMIAN SPA	0	0	0	0
RECORDATISPA	0	0	0	0
RFI SPA	0	0	0	0
SAIPEM SPA	0	0	0	0
SARAS SPA	0	0	1	0
SERVIZIO ELETTRICO NAZIONALE SPA	0	0	1	0
SNAM RG SPA	0	0	1	0
SATAP SPA	0	0	0	1
STELLANTIS EUROPE SPA	0	0	1	1
ST MICROELECTRONICS SRL	1	0	1	0
STOGIT SPA	0	0	1	0
SUPERSTRADA PEDEMONTANA VENETA SPA	0	0	0	1
TERNA SPA	0	0	1	0
TRENITALIA SPA		0	0	1
UNARETI SPA	0	0	1	0
VERSALIS SPA	1	0	1	0
WEBUILD SPA	0	0	0	1
WHIRLPOOL EMEA SRL	0	0	1	0
YNAP SPA	0	0	0	1