The Impact of Green Policies on Local Economic Performance: Evidence from the EU ETS

Ireri Hernandez Carballo[1,2], Gian Maria Mallarino[1], and Marco Percoco[1]

[1]Department of Social and Political Sciences, Bocconi University

[2]RFF-CMCC European Institute on Economics and the Environment (EIEE)

Abstract

Environmental policies such as the European Union Emissions Trading System (EU ETS) raise concerns about their impact on employment and competitiveness. Yet, existing EU ETS studies focus on firm-level outcomes and the initial phases of the program. We construct a panel dataset of about 900 European NUTS 3 level provinces between 2000 and 2019 to assess the impact of the EU ETS, and in particular on its Phase III, on the local economic performance, namely gross value added (GVA), employment, and productivity per employee (PPE) of European provinces. We employ data on emissions covered by the EU ETS to construct a continuous measure of local level exposure. Using a continuous difference-in-differences fixed effects framework, we find that that being more exposed to the EU ETS is associated with negative and significant results on employment and significant increases in productivity, starting from Phase II. These results are confirmed both at the sector and general NUTS 3 level, suggesting that local economies have generally been able to increase their productivity as an answer to the constraints posed by the EU ETS system.

Keywords: EU ETS, Carbon policies, CO2 Emissions, Regional Economics, Economic Geography

1. Introduction

Inaugurated in 2005, the EU Emission Trading System (EU ETS) represents the main pillar of the European Union's strategy in decarbonizing its economy. With currently 31 countries participating,[1] the EU ETS covers 45% of the EU's greenhouse gases (GHG) emissions. Designed to reduce emissions while stimulating heavy emitting companies to innovate their production systems, the EU ETS has raised concerns about its impact on employment, firm competitiveness and subsequent carbon leakage (see, for example, Commins, 2011; Costantini & Mazzanti, 2012; Reinaud, 2008; Yu, 2011; and Dechezleprêtre, 2023). Given the recent undergoing reforms to expand the EU ETS and concerns about local economic impacts, it is important to more thoroughly understand its effects, particularly in the most recent phases.

While the impacts for the first two phases have been studied by several scholars, there is a need to study the impacts on the later phases, which have been marked by significantly higher permit prices. A recently published literature review, Verde (2020) grouped and analyzed the entire econometric literature concerned with the effects of the EU ETS on firm productivity and carbon leakage, concluding that "to date, there is no evidence of the EU ETS having had widespread negative effects on the competitiveness of regulated firms nor is there evidence of significant carbon leakage". However, they point that a major limitation is that most of the evidence is on the first two phases.

Furthermore, alongside the possible impacts of the EU ETS at the firm and sector levels, growing interest has been channeled through the effects of this policy in the local economies. Following the same logic for which companies, especially the least innovative ones, might face severe pressure to downsize or to relocate, another aspect worth considering is the impact that those decisions might have on the overall performance of the local economies where these companies operate. Existing literature on the topic is still limited, and the existing published articles point at the possible heterogeneous effects deriving from the high concentration of regulated emissions in a limited number of regions (Roseta-Palma et al., 2011; Robaina et al., 2019)

This paper contributes to this stream of literature by analyzing the impact of the EU ETS on the local European provinces (NUTS3), and in particular its impact on three indicators: gross value added (GVA), employment levels, and productivity per employee (PPE). We use data from the Eurostat "Regions and Cities" Database and from the paper published by Mura et al. (2021) to construct a measure of local exposure to the EU ETS. In this regard, we employ a continuous difference-in-differences framework to estimate the effects of the

[1] Croatia is the latest add and the United Kingdom being the first country to resign from it

policy on the aforementioned independent variables. Initial results support the hypothesis that European provinces that were most exposed to the policy have experienced an increase in productivity per employee. Additionally, data show that this increase could be attributed mainly to the decrease in employment levels, for which we find negative and significant results both at the industry and the NUTS3 levels. The evidence provided therefore suggests that sectors, when collectively called to comply with new regulation, have been able to restructure their production processes, managing to decrease their emissions and at the same time increase their productivity, in line with the intended goals of the European Union for the EU ETS policy. The findings raise important questions, both from an academic and a policy perspective, on the geographically heterogeneous effects of the so called "green policies". The rest of the paper is organized as follows: section 2 provides some background on the literature on the EU Emission Trading System; section 3 outlines the research design and the data sources used for the analysis; section 4 presents and discuss the results and section 5 summarizes and concludes the study.

2. Background: EU Emission Trading System

An emissions trading system (ETS) is a system that sets a limit on emissions while allowing emitters to trade emission units to meet their targets. To comply with their emission targets at least cost, regulated entities can either implement internal abatement measures or acquire emission units in the carbon market, depending on the relative costs of these options. By creating supply and demand for emissions units, an ETS establishes a market price for GHG emissions (Valaguzza and Huges 2021). The EU ETS system is one of the so-called "cap-and-trade" systems, where a cap or absolute limit on the emissions in set within the ETS and emissions allowances (called EUA - emission unit allowance) are distributed, usually for free or through auctions, for the amount of emissions equivalent to the cap. It has been divided in four periods and the goal of this system is to reduce the GHG emission by 43% relative to 2005, the year in which the policy has been inaugurated (European Parliament and Council, 2018). The EU ETS has recently entered its Phase IV (2021-2030) and, since its inauguration in 2005 it has witnessed profound changes.

The first phase of this policy (2005-2007) has been thoroughly analyzed by Ellerman et al. (2010), who defined it "a major innovation in the field of climate policies". During this pilot phase, the EU countries were responsible for deciding the amount and the recipients of free allowances, based on ex-ante evaluation of the possible needs and prices of EUA allocations. However, ex-post evaluation of effective emission levels demonstrated that verified emissions for the year 2005 were lower than initially expected. As an answer, the price of EUA progressively dropped to zero in 2007 as it became clear that the quantity of allowances was sufficient to cover verified emissions over the period, and since banking between Phase I and Phase II was forbidden (De Perthuis et al., 2014).

In practice this system, as conceived in Phase I and II, can be best understood as a system for linking 25 individual systems that set their own caps and determined their own allocations subject to some mutually agreed review by the European Commission (Ellerman et al., 2014). This mechanisms lasted until 2012, the end of phase II, and proved to be inefficient at the point that already in 2008 member states agreed unanimously to abandon this process, delegating the European Commission to decide how the cap should be shared and regulated (Mirzaee et al., 2021).

During phase II, the EU ETS system faced another set of challenges, this time deriving from the unexpected global economic recession. The unforeseen financial crisis and the degraded growth outlooks had a negative impact on the price for EUA allowances, which dropped below 10€/tCO2 in 2012, as shown by Perhuis et al. (2014) in Figure 1.

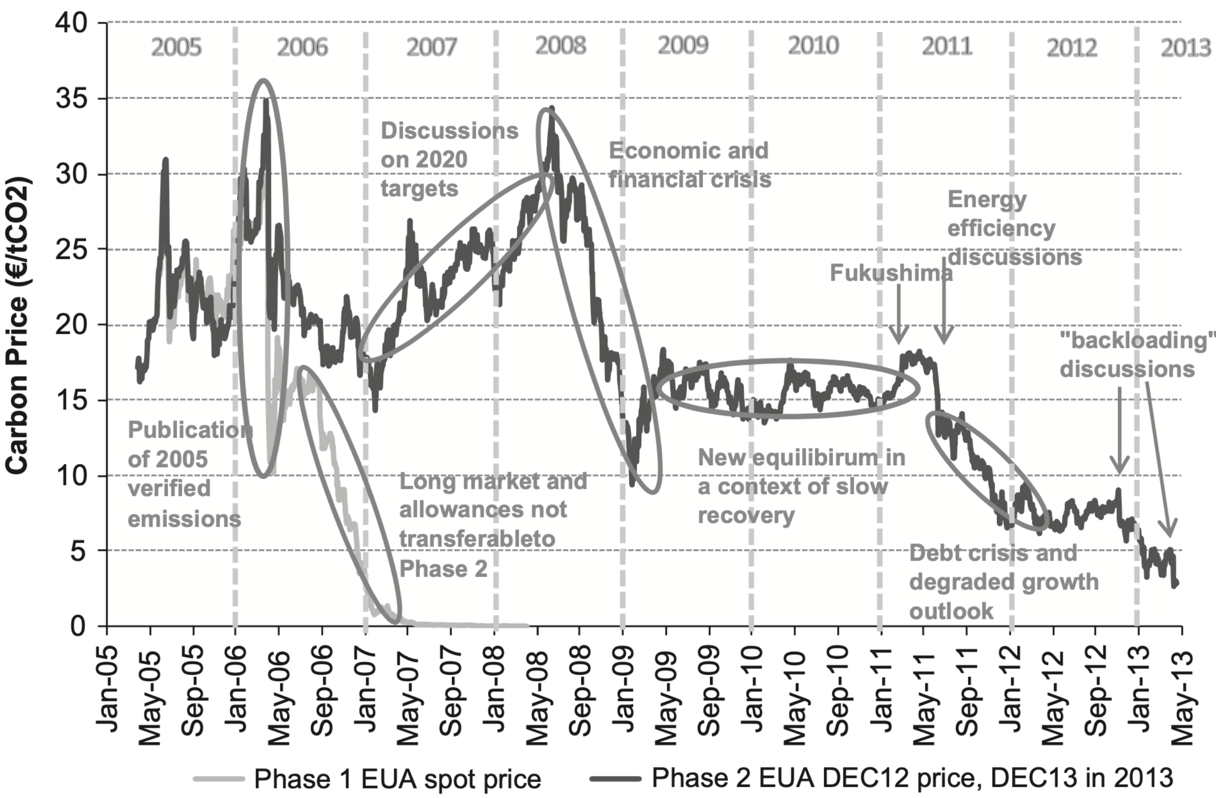

Fig. 1. Observed EUA price in the period 2005-2012. Source: Perhuis et al. 2014

All these reasons led to profound changes to the EU ETS system starting from phase III, in 2013. The series of reforms implemented by the European Commission touched several aspects of the EU ETS. First, the reform introduced a European-wide cap subject to a linear reduction factor of 1.74% until 2020. Second, free allocations were no longer determined at the state level but at the EU level and distributed using benchmarks calculated based on the installation's input/output. In addition, the regulation introduced a progressive phase out of the free allocation system, to be replaced with auctioning as the primary method of allowance allocation (Mirazee et al.,2021). Third, in order to prevent oversupply, EU regulators applied two main policy measures (De Clara, 2018): back-loading and the Market Stability Reserve (MSR) mechanism. The first tool has been implemented as a short-term tool to set the supply side of the market to avert price collapse while the MSR, to be intended as a long-term instrument, aimed at tackling the glut of EUAs and enhance the scheme's resiliency to disturbances by fine-tuning the number of allowances to be auctioned (European Commission,). It appears evident that, before 2013, several internal and external factors might have undermined the efficacy of this policy. In light of this evidence and the profound structural policy differences between each phase, this paper investigates the potential phase-specific externalities on the EU's local economies.

3. Data

We use data on local economic performance and emissions collected from two main sources: the Eurostat Regions Database (2021), and the recent emissions dataset published by Mura et al. (2021).

3.1. Data on local economic performance

The Eurostat Regions and Cities Database provide a detailed picture of the diverse EU territories and is used to monitor EU regional policy targets (2021). Data retrieved from this database include different social and economic aspects of European regions such as demography, economy, employment, and education. Thanks to the granularity of the dataset, data have been extracted at the four different NUTS (Nomenclature of Territorial Units for Statistics) levels, the reference point for coding geographical space through data (Herz and Varela-Irima, 2020). The initial dataset presents over 37,000 entries, containing data on 34 countries located in the European continent over the period 2000-2020. In particular, the dataset includes variables on (at NUTS0, NUTS1, NUTS2 and NUTS3 levels):

- Geography: geographical nomenclature according to NUTS categorization, country and region of reference, area.

- Economic performance: data on GDP, GVA by sector (according to ISIC Rev. 4 categorization) and total GVA.
- Employment: employment by sector (according to ISIC Rev. 4 categorization), total employment, active population, inactive population and unemployed population
- Demography: population
- Education: share of population per education level. Three different levels according to ISCED 11 categorization: less than primary education (levels 0-2); upper secondary and post-secondary non-tertiary education (levels 3 and 4); and tertiary education (levels 5-8).

3.2. Data on CO2 emissions

In order to compute a measure of exposure of a local economy to the ETS, data on emissions have been used from the datasets published by Mura et al. (2021). This dataset on CO2 emissions, collected at plant level from the EU Emission Trading System (EU-ETS) register, is aggregated at different geographical scales, based on the National Units of Territorial Statistics (NUTS) established by Eurostat. Data on emissions are recorded from 2005, year of the start of the EU ETS, until 2017.

3.3. Descriptive statistics

In this part, some descriptive characteristics of the two datasets are presented.

Table 1 presents descriptive statistics for the main variables analyzed. The first column shows the mean and standard errors (below in parentheses) for the pre-ETS period (2000-2004), while the second column shows the outcomes for the ETS period (2005-2009).

3.3.1. Descriptive statistics on Emissions Indicators

Figure 2 shows the regional heterogeneity in 2005 Emissions at the NUTS3 level, indicated by emission quintiles.

Table 1: Descriptive Statistics

	Pre-ETS: 2000-2004	ETS: 2005-2019
log total gross value added (million euros)	8.39	8.67
	(1.005)	(1.014)
log gross value added industry B-E (million euros)	6.87	7.09
	(1.102)	(1.081)
log employment total	11.61	11.65
	(0.883)	(0.894)
log employment industry B-E	9.91	9.83
	(0.993)	(0.968)
log PPE total	3.69	3.92
	(0.415)	(0.335)
log PPE industry B-E	3.86	4.16
	(0.503)	(0.435)
log emissions 2005	–	11.89
	(3.868)	(3.867)
population (thsds)	378.86	393.63
	(459.828)	(499.530)
education level 0-2: up to lower secondary	31.50	24.05
	(18.707)	(15.079)
education level 3-4: up to upper secondary	48.64	50.33
	(16.008)	(13.807)
education level 5-8: tertiary and above	19.86	25.61
	(6.773)	(7.632)
Observations	4390	13170

Table shows mean log values and standard errors in parentheses below.

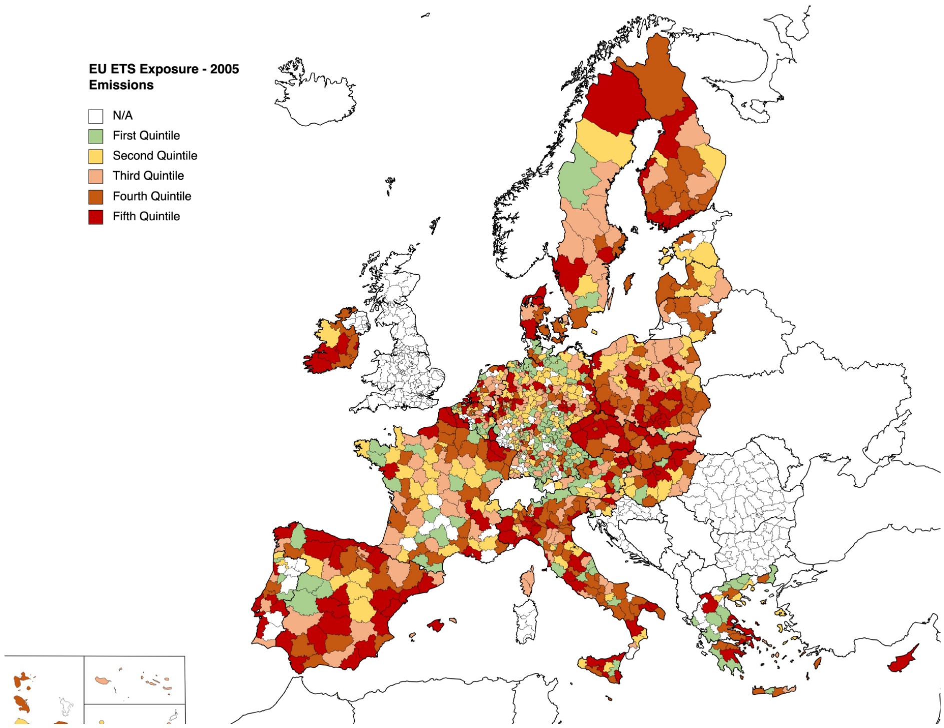

Fig. 2. EU ETS 2005 CO2 Emissions at NUTS 3 level by Quintile

4. Empirical Strategy

We use a continuous difference-in-differences two-way fixed effects framework to estimate the impact of the EU ETS on employment, GVA, and productivity per employee at the NUTS3 level. We exploit NUTS3 variation in regulation intensity under of the EU ETS based on the level of emissions in 2005 the first year the ETS[2]. Given the pricing of emissions under EU ETS, NUTS3 regions with higher initial emissions are expected to be impacted relatively more than regions with lower initial emissions. We use 2000-2004 as our pre-treatment period and 2005 onwards as our post-treatment period, differentiating by EU ETS phases. Given the varying stringency and regulatory changes across phases, we estimate heterogeneous impacts for each phase, relative to the pre-treatment period, using phase-specific indicators (relative to the base period 2000-2004) interacted with the continuous treatment indicator as in equation 1 below:

$$logY_{it} = \alpha + \beta_{it} ETSD_i * Phase_t + \gamma_t + \lambda_i + \boldsymbol{\sigma} X_{it} + \epsilon_{it} \qquad (1)$$

Where i indexes the area, i.e., the provinces at NUTS3 level, and t the years. Log(Y_{it}) is the dependent variable: i.e., the logarithm of GVA or employment at the overall NUTS3 level

[2] We use 2005 since this is the first year EU ETS emissions are reported. We expect pre-2005 emissions to be highly correlated with 2005 emissions

or the NUTS3 industry sector level (sectors B to E according to NACE Rev.2 [3]). $ETSD_i$ is the exposure calculated as the logarithm of the amount of emissions covered by the ETS in each province in 2005 ("ETS dose"), while $Phase_t$ is an indicator variable for each of the 3 phases. Our coefficients of interest are the β_{it} which indicate the average treatment effect of the ETS for an increasing level of initial emissions in the NUTS3 region, for each phase relative to the pre-treatment period. γ_t is a set of year fixed effects and λ_i are NUTS3 fixed effects. The time fixed effects eliminate omitted variable bias that comes from common unobservables that change over time across NUTS3 regions, while unit fixed effects control for factors that differ across entities but are constant over time. Of concern then are time-varying factors that vary within NUTS3 regions across time. We therefore include, X_{it}, a vector of controls that vary over NUTS3 and time, including population and education levels. Finally, ϵ_{it} is the error term.

5. Results

We first report in Table 2 the results for the beta coefficients on the impact of the EU ETS on the sample all sectors, using the specification in equation 1 which includes a full set of year and NUTS3 fixed effects and controls for population and education. We find that there was a positive and significant impact of the ETS on total NUTS3 log gross value added, with the estimated coefficient ranging from 0.0029 (phases 1 and 3) to 0.0039 (phase 2). As shown in column 1 of Table 2 10% increase in initial emissions leads to about at 0.03% increase in total NUTS3-level GVA in phases 1 and 3, and a 0.04% increase in phase 2.

For total employment (column 2 of Table 2), we find negative and significant coefficients on phases 2 (marginally significant) and 3 (significant at the 0.01% level). A 10% increase in initial NUTS3 emissions leads to a -0.026% decrease in total NUTS3 level employment.

For productivity per employee (PPE), we find positive and significant coefficients across all phases. This implies that while employment decreased, output per worker increased, increasing labor productivity. This impact is smaller for phase 1, while it doubles for phase 2 and remains the same for phase 3. The results imply that a 10% increase in initial NUTS3 emissions resulted in a 0.055% increase in total output per employee in phases 2 and 3.

Table 5 shows the results of the beta coefficients of regression specification 1, focusing on NACE industry sectors B-E. We find that while there was a positive and significant increase in GVA in the first phase of the ETS, the impact became non-statistically different from zero in

[3]This includes B: mining and quarrying; C: manufacturing; D: electricity, gas, steam and air conditioning supply; E: water supply

Table 2: Difference-in-differences Estimates by Phase on all NACE Activities.

	(1) log GVA Tot	(2) log Emp. Tot	(3) log PPE Tot
Phase1*log exposure	0.0030***	0.0004	0.0027***
	(0.0009)	(0.0006)	(0.0007)
Phase2*log exposure	0.0039***	-0.0015*	0.0055***
	(0.0011)	(0.0008)	(0.0011)
Phase3*log exposure	0.0029**	-0.0026***	0.0055***
	(0.0014)	(0.0009)	(0.0015)
Population	Yes	Yes	Yes
Education	Yes	Yes	Yes
Year f.e.	Yes	Yes	Yes
N	16865	16865	16612

Standard errors in parentheses. All specifications include NUTS3 fixed effects.
Sample of all NACE Rev.2 industries.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3: Difference-in-differences Estimates on all NACE Activities. One pre/post period.

	(1) log GVA Tot	(2) log Emp. Tot	(3) log PPE Tot
post*log exposure	0.0033***	-0.0016**	0.0049***
	(0.0010)	(0.0007)	(0.0011)
Population	Yes	Yes	Yes
Education	Yes	Yes	Yes
Year f.e.	Yes	Yes	Yes
N	16865	16865	16612

All specifications include NUTS3 fixed effects. Standard errors in parentheses.
Post is indicator of 2005 onwards, ETS starting period.
Sample of all NACE Rev.2 industries.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

phase 2, and negative and nonsignificant in phase 3, as shown in column 1 of Table 5. Instead, for employment, there was a close to zero non-significant impact in the first phase, while in phases 2 and 3, there was a negative and significant impact on employment. Specifically, a 10% increase in initial NUTS3 emissions lead to a 0.037% decrease in employment in the second phase, while this magnitude almost doubled to a 0.07% decrease in phase 3. Relative to total employment, the decrease of industry-level employment is larger, indicating that some (but not all) of the sector-level employment decreases were offset at the NUTS3 level.

Productivity per employee (PPE) in industrial economic activities (column 3 of Table 5 increased more in NUTS 3 regions with initially higher emissions. Particularly, a 10% increase in initial emissions leads to a PPE increase of 0.03% in phase 1, 0.055% in phase 2, and 0.046% increase in phase 3. Given no significant increase in GVA at the B-E industry level, this was mainly driven by the maintained level of GVA output with fewer employees.

Table 4: Difference-in-differences Estimates by Phase on Industry (NACE Rev.2 B-E)

	(1) log GVA Industry	(2) log Emp. Industry	(3) log PPE Industry
Phase1*log exposure	0.0035***	0.0004	0.0030***
	(0.0012)	(0.0008)	(0.0011)
Phase2*log exposure	0.0020	-0.0037***	0.0055***
	(0.0019)	(0.0011)	(0.0017)
Phase3*log exposure	-0.0022	-0.0070***	0.0046**
	(0.0026)	(0.0016)	(0.0021)
Population	Yes	Yes	Yes
Education	Yes	Yes	Yes
Year f.e.	Yes	Yes	Yes
N	16864	16865	16546

All specifications include NUTS3 fixed effects.

Sample of NACE Rev.2 B-E sectors. Balanced dataset. Pre-ETS:2000-2004.

GVA: gross value added. PPE: productivity per employee (GVA/employment)

Standard errors in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Difference-in-differences estimates on Industry (NACE B-E). One pre/post period.

	(1) log GVA Industry	(2) log Emp. Industry	(3) log PPE Industry
post*log exposure	0.0004	-0.0044***	0.0046***
	(0.0019)	(0.0012)	(0.0016)
Population	Yes	Yes	Yes
Education	Yes	Yes	Yes
Year f.e.	Yes	Yes	Yes
N	16864	16865	16546

All specifications include NUTS3 fixed effects. Standard errors in parentheses.
Post is indicator of 2005 onwards, ETS starting period.
GVA: gross value added. PPE: productivity per employee (GVA/employment)
Standard errors in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

6. Discussion and Conclusion

In this study, we estimate the impact of EU ETS exposure for European provinces (NUTS3) showing that the introduction of the policy, especially starting from Phase II, is associated with an increase in local productivity, measured as productivity per employee (PPE). In particular, this study finds that being exposed to the EU ETS, meaning being a province with a high level of initial emissions covered by the system, is associated with a general increase in PPE, driven mostly by a decrease in employment levels alongside an increased or sustained level of gross value added. Moreover, this effect is visible not only at the sector level, but also at the general local level, suggesting that the local economies have been able to compensate, when it comes to local productivity, for the externalities produced by heavy emitting industries.

As with all studies, our analysis is subject to some limitations. Given the current availability of data, we cover the period ending in 2020 (the end of Phase III) leaving de facto out the last two years, years in which the price of the CO2 allowances has dramatically increased, remaining stably above 50 euros per tonne since August 2021 and surpassing 95 euros per tonne in February and August 2022. The effects of the policy might be even more accentuated in these last two years, pointing to a potential lower-bound of the reported impact. In the future, we hope to further study the mechanisms driving our outputs and make several robustness checks to our methods and measurements.

Notwithstanding, our study sheds light on the local economic impacts of the EU ETS, and includes data on phase 3, a previously understudied phase. Following the growing literature focusing on the heterogeneous effects and the social externalities of the so-called green policies, this paper shows that, as a result of the introduction of the EU ETS, several European economies might be facing increasing economic performances but increasing unemployment. Our findings have relevant implications for both researchers and policy makers. From an academic perspective, this evidence raises several questions related to the mechanisms through which local economies have been able to react to the EU ETS. From a policy making perspective, it results clear the importance to monitor, despite an increase in productivity, the estimated decrease in employment due to this policy, especially in light of the social and political relevance of green policies in our societies.

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