FACTORS AFFECTING FIRM PRODUCTIVITY IN TURKEY

by
YAĞMUR DENİZ ÇUFADAR

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Approved by:

Asst. Prof. Esra Durceylan Kaygusuz .....
(Thesis Supervisor)

Asst. Prof. Erdal Aydın .....

Prof. Seyit Mümin Cılasun .....

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ABSTRACT

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YAĞMUR DENIZ ÇUFADAR

ECONOMICS M.A. THESIS, JULY 2023

Thesis Supervisor: Asst. Prof. Esra Durceylan Kaygusuz

Keywords: Energy intensity, Productivity, Trade, Paris Agreement, Export

Paris Agreement is a milestone of climate change mitigation. Before the agreement there was an imbalance in emission regulations between countries which resulted in carbon leakage. It is the first legally binding agreement that gives incentives countries to reduce emissions. It also opened way for international trade regulations such as CBAM where energy incentive firms that export need to decrease emissions in order to stay competitive in the export market. We use firm level data where we constructed the energy costs of each firm. We then calculated the energy intensity of each firm and investigated the changes in energy intensity after the agreement in energy intensive sectors compared to other manufacturing firms in Turkey. We find that the differences in changes in the energy intensity differs for exporters and EU exporters. Results suggest evidence for carbon leakage for firms that had exposure to export market in the pre-reform period and low energy intensity for firms that enter the export market after the agreement.

ÖZET

TÜRKİYE'DE FİRMALARIN VERİMLİLİĞİNİ ETKİLEYEN FAKTÖRLER

YAĞMUR DENİZ ÇUFADAR

EKONOMİ YÜKSEK LİSANS TEZİ, TEMMUZ 2023

Tez Danışmanı: Dr. Öğr. Üyesi Esra Durceylan Kaygusuz

Anahtar Kelimeler: Enerji yoğunluğu, Verimlilik, Paris Anlaşması, İhracat, Ticaret

Paris Anlaşması, iklim değişikliğine karşı verilen mücadelede önemli bir kilometre taşıdır. Anlaşmadan önce, ülkeler arasında emisyon düzenlemelerinde karbon kaçağına neden olan bir dengesizlik vardı. Anlaşma, emisyonları azaltmak için ülkelere teşvik veren yasal olarak bağlayıcı ilk anlaşmadır. Ayrıca, ihracat yapan enerji teşvik firmalarının ihracat pazarında rekabetçi kalabilmek için emisyonları azaltması gereken SKD gibi uluslararası ticaret düzenlemelerinin de önünü açtı. Bu çalışmada her bir firmanın enerji maliyetlerini oluşturduğumuz firma düzeyindeki verileri kullanıyoruz. Daha sonra her bir firmanın enerji yoğunluğunu hesaplayarak, enerji yoğun sektörlerde anlaşma sonrası enerji yoğunluğundaki değişiklikleri Türkiye'deki diğer imalatçı firmalara kıyasla inceledik. Enerji yoğunluğundaki değişikliklerdeki farklılıkların ihracatçılar ve AB ihracatçıları için farklı olduğunu bulduk. Sonuçlar, reform öncesi dönemde ihracat pazarına maruz kalan firmalar için karbon kaçağı ve anlaşmadan sonra ihracat pazarına giren firmalar için düşük enerji yoğunluğu olduğuna dair kanıtlar sunmaktadır.

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To my parents

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1. INTRODUCTION

Global efforts to reduce greenhouse gas emissions have gained momentum with international collaborations. Climate change is gaining importance in the eyes of international actors such as the International Monetary Fund and World Bank. It is now discussed to change their mission and include climate change. Climate action is now considered a "public good" which indicates that the pressure on each country to do their part to mitigate climate change and take action will only increase. One of the most important milestones of climate action is the Paris Agreement. The agreement is important in the sense that it accelerated international collaboration efforts to mitigate and take action against climate change. Paris Agreement is the first global pact on climate change that also is legally binding. The agreement was signed in France at the UN Climate Change Conference (COP21) by 196 countries on 12 December 2015 and entered into force on 4 November 2016. Turkey signed the agreement on 22 April 2016. One of the most important features of the agreement is the emphasis on international collaboration and the view of climate mitigation as a shared goal.

Turkey being a developing country with very weak environmental regulation about greenhouse gas emissions and a big exporter to the EU where environmental regulations such as Emissions Trading System (ETS) are in force since 2005, raise suspicions about carbon leakage. In order to identify carbon leakage, extending the work by comparing trade flows and consumption patterns between the EU and Turkey is necessary. EU has been at the forefront of advocacy for mitigating climate change, and raising concerns about carbon leakage. Turkey is the fifth largest trade partner of the EU in 2019 and with the distinct features of being a developing country, Turkish firms that export to the EU are expected to be affected by these green initiatives significantly.

Available firm level data on pollution and emission is very limited in developing countries, and the empirical studies on this subject is scarce but growing. Since Turkey had weak environmental regulation prior to the agreement, it is not possible

to conduct research on the effects of the Paris Agreement on firm level emissions. In this paper we look at the signaling power of the agreement and how the firms in energy intensive sectors respond to it in terms of energy intensity changes in the context of a developing country. We believe that the Paris Agreement signaled a change in international trade where emissions are accounted for and the regulations exceed borders. The agreement opened the way for trade practices that ensure environmental efforts made by a country are not undermined via trade. ETS being extended as a trade regulation under the name Carbon Border Adjustment Mechanism (CBAM) is an example of this.

The literature on the energy efficiency behavior of exporting firms agrees with the statement that exporters are more productive than non-exporters which also prevails in their energy efficiency. Thus, this paper investigates the relationship between exporting behavior and energy intensity and how it changes after the global efforts on climate change accelerate after the Paris Agreement. Increasing energy efficiency is key to mitigate climate change and minimize exposure to energy prices volatility (Cevik 2022). We believe being a firm in an energy intensive sector with high export share increases the efforts to decrease energy intensity.

Self reported energy consumption and emissions data does not exist for Turkish firms does not exist at the moment. Therefore, the present paper uses NACE codes to identify the energy providers and uses the firm-to-firm transactions to calculate total energy costs of each firm. Based on the cost of sales figures from firms' balance sheets the firm level energy intensity is calculated. In the literature, energy intensity is often calculated using firm sales. Using revenues to calculate energy intensity could be an option. However, revenues include final good prices which can change dramatically due to competition and market power. Thus firms might have different revenues even though they are in the same sector with same production levels. Therefore, we use cost of sales which is less likely to be affected by competition to calculate energy intensity. Using the firm level customs data which specifies the direction and the destination of exports, export share is calculated and the specification of a firm as an exporter or an EU exporter is made. Our final data consists of 47,867 firm existed between the years 2010 and 2020 of which 25,563 are exporters and 19,286 are exporters to the EU.

Our findings in the base analysis suggest that the Agreement had a differential decreasing effect on ETS firms' energy intensity compared to non ETS firms, specially for the subsample of EU exporter firms. Further analysis show that firms' exposure to the export market prior to the Agreement had a decreasing effect on firm level energy intensity. However, the results suggest that the decreasing effect of pre-

exposure to the export market weakened for ETS firms compared to non-ETS firms after the Agreement in the exporter and EU exporter subsamples. This might indicate that the base analysis results are not dominated by the internal margin. Final analysis is concerned with the effect of being an exporter on the firm level energy intensity and results of the analysis illustrate that becoming an exporter after the Agreement resulted in a higher decrease in energy intensity for ETS firms compared to non-ETS firms. This could be a reasonable explanation where -supported by the results of the second analysis- firms that existed in the export market prior to the Agreement might be subject to carbon leakage and firms that are planning to enter the export market after the Agreement need to decrease their energy intensity.

2. LITERATURE REVIEW

Global efforts to reduce greenhouse gas emissions have gained momentum with international collaborations. One of these international collaborations is the Paris Agreement. In this paper we look at the signaling power of the agreement and how the firms in energy intensive sectors respond to it in terms of energy efficiency changes in the context of a developing country.

The literature on the energy efficiency behavior of exporting firms agrees with the statement that exporters are more productive than non-exporters which also prevails in their energy efficiency. Many studies such as Yeaple (2005), Costantini and Melitz (2007), Verhoogen (2008), Bustos (2011), Lileeva and Trefler (2010) suggest that "improved foreign market access induces innovation.". In theory, as production volume increases with trade, the average fixed costs decrease thus, the amount of investment in abatement should increase, as Forslid, Okubo, and Ulltveit-Moe (2018) also predicts. However, Batrakova and Davies (2012) disagrees with this statement by providing their own theoretical predictions and supporting it with Irish firm-level data where they show the increased production as a result of exporting activities may cause a higher demand for energy in low fuel intensity firms whereas it may even be negatively correlated with energy expenditures in high fuel intensive firms. They agree that exporting may have a positive effect on energy efficiency due to productivity but they conclude that the effect of exporting on energy efficiency is ambiguous. However, when we look at the case of developing countries we may see a different picture. Carbon leakage and pollution haven hypothesis suggest that countries with weak environmental regulation attract energy intensive production from countries where environmental regulations are more stringent. Turkey is a special case when we look at the effect of a trade policy that targets to give incentive to decrease energy consumption and carbon emissions since Turkey did not have any mechanisms, such as a government tax on carbon emissions, to promote energy efficiency.

Tran (2022) looks at the effect of exporting status on firms' energy intensity using

Vietnamese firm level data and shows energy intensity decrease after the firm starts exporting. Moreover, his results show that the decline in energy intensity is larger for firms that export to the EU. Since the signal that's effect is questioned in this paper is initiated by the EU, we also examine the effect of the EU market exposure in the analysis. The EU has the largest share of Turkey's exports by 41.3% in 2020. Due to the historically strong trade relationship between Turkey and the EU, we expect firms that export to the EU to be affected differently from the reform. This paper contributes to the literature with an unprecedented dataset constructed by the authors.

Due to lack of available data on emission intensity, Roy and Yasar (2015) use energy efficiency as their measure of environmental performance, examining the pollution abatement behavior of Indonesian exporting firms. It is also pointed out by the International Energy Agency in an insight brief, that improving energy efficiency is the most cost effective and readily available means to address concerns about climate change (IEA 2017). We take these perspectives into account when we measure how firms respond to green initiatives, by their energy intensity.

This paper contributes to the literature by examining the effects of changing world view regarding climate change on the firm level energy intensity in a developing country with an unprecedented dataset.

3. POLICY BACKGROUND

The Kyoto Protocol, adopted in 1997, operationalizes United Nations Framework Convention on Climate Change by committing industrialized countries and economies in transition to limit and reduce greenhouse gases (GHG) emissions in accordance with agreed individual targets1. To meet the Kyoto commitments, European Commission published a paper on "Greenhouse gas emissions trading within European Union" in March 2000, which introduced some of the first ideas that shaped the EU Emissions Trading System.

The EU Emissions Trading System (hereafter referred to as ETS) was introduced in 2005 as a market-based regulation to mitigate climate change. It is designed as a 'cap and trade' system where a cap on the aggregate emissions from more than 11,000 power and industrial plants in 31 countries is imposed. The EU ETS covers about 36% of the EU's total GHG emissions and issues tradable permits for each tonne of CO2 under the cap. The European wide market determines the price of these permits. This cap is set with the intention to decrease greenhouse gas emissions from energy-intensive activities such as electricity and heat production, cement manufacture, iron and steel production, oil refining, and other industrial activities. It gives an incentive to reduce emissions and sell the permit surplus to firms that are subject to the regulation2.

The Paris Agreement is an international treaty on climate change, adopted by 196 Parties, including Turkey, the EU, and its Member States on 12 December 2015. The goal of the Paris Agreement is to limit global warming to well below 2 degrees Celsius compared to pre-industrial levels. To reduce the risks and impacts of climate change, Parties to the agreement submitted nationally determined contributions (NCDs). Article 6 of the Paris Agreement further emphasizes the importance of international cooperation and that climate mitigation is a globally shared goal. Following the Paris Agreement, the EU set a binding target of achieving climate neutrality by 2050 with the European Climate Law. In line with this neutrality ambition, the EU constructed the 'Fit for 55 package' that includes several new initiatives. One of

these initiatives is the Carbon Border Adjustment Mechanism or CBAM.

The objective of the CBAM is to prevent carbon leakage, which is a result of the reallocation of carbon-intensive (as well as energy-intensive) production to countries with less ambitious climate change policies compared to the EU. This mechanism aims to prevent increased imports of carbon-intensive products or reallocation of production, which will offset the emissions reduction efforts of the EU. CBAM is designed to mirror and complement the EU ETS on imported goods and encourage partner countries to establish carbon pricing policies to fight climate change which is in line with the objectives of the Paris Agreement in terms of international co-operation. Energy and carbon-intensive sectors that will be covered by CBAM are cement, aluminum, fertilizers, electric energy production, iron and steel. In this paper we defined the sectors that will be affected by the CBAM basen on the definition of the EU's ETS sectors since at the time of the agreement they were not specified. Hence the EU's definition of ETS sectors should have received the Paris Agreement as a signal.

Since the EU ETS entered into force, carbon leakage presented a risk due to asymmetric climate policies of non-EU countries. Reallocation of production raised concerns both in terms of competition in the European market and increasing emissions outside the EU. Paris Agreement opened the way for the EU's internal fight against climate change to cross borders and affect international trade. Therefore, we take the Paris Agreement as a signal for upcoming international efforts to reduce carbon emissions and analyze its effect on the Turkish industry exporters in sectors that were likely to be affected by a possible international climate policy.

4. DATA

We combined several rich datasets provided by the Ministry of Industry and Technology of the Republic of Turkey for our empirical analyses. Entrepreneur Information System (hereafter referred to as EIS) is a project initiated by the Ministry of Industry and Technology to collect data on the economic activities of the enterprises in the administrative records of different public institutions and organizations in a database within the framework of common standards and the integration of these data. In this study, we use firm-level. Integration of inter-institutional data provides data sets such as the financial statements of more than 3 million enterprises that generate commercial gains in the economy, inter-sectoral and inter-provincial trade, foreign trade, and employment data between 2006 and 2020. Below, Table 4.1 demonstrates the main datasets and variables used in our analysis.

For our analyses, we combined firm financial statements, foreign trade, firm transactions, and firm characteristics datasets. First, we classified firms' economic activities based on their respective NACE codes using Enterprise Registry data. This enabled us to identify firms that are involved in energy generation or trade activities. Table 4.2 provides information on the specification used to identify energy providers. We create two datasets based on firm registry data, only changing the name of the variable Nace code as NACE-buyer and NACE-seller. Using 'firm identification number' we merged these two datasets with the Firm-to-firm trade transactions dataset to see each firm's 4-digit NACE code. Then, by collapsing the monetary transactions with respect to each energy provider as the 'seller firm', we managed to generate new variables that represent the energy expenses of firms based on the transactions made with the firms classified as energy providers.

Second, we identified the total number of destinations abroad, the number of destinations in the European Union, and the value of exports to the EU using country codes in the customs data. Finally, we constructed the final panel data by merging these datasets with the financial statements dataset. Panel data that we have constructed enables us to identify the field of economic activity which is identified

Table 4.1 Data

Original datasets	Content
Enterpirise Registry Data	Firm identification number Year 4-digit NACE code Number of employees(quarterly) Business start date
Firm-to-firm Trade Transactions Data	Firm identification of seller Year Firm identification of buyer Monetary amount of transaction (TL)
Customs Data	Firm identification number Year Export amount Monetary export amount(USD) Export country code
Balance Sheet Data*	Firm identification number Year Ongoing investments Revenue Cost of sales Revenue from domestic sales Revenue from export sales

Note: Balance sheet items are in terms of Turkish Lira. All datasets are in the form of panel data.

by 4-digit NACE codes, energy expenses, revenues, costs, exports, employment, EU exports, and age of the firm between 2006 and 2020.

This paper focuses on the impact of the Paris Agreement –which is treated as a signal for international trade regulations such as CBAM– on the energy intensity of firms. We define energy intensity as the ratio of energy expenses to the total costs. We expect this signal to have a differential effect on firms operating in sectors that are subject to ETS. Thus, we define a dummy variable called "etssector" indicating whether the firm is operating in a sector subject to ETS. By construction of the ETS, firms in ETS sectors are more energy-intensive than others.

By using the export data we are able to construct two additional subsamples: exporters and EU exporters. These subsamples are constructed first as generating two dummy variables for each observation stating whether the firm exported or not and whether the firm exported to the EU or not. We identify the reform year as 2015 and classify observations as subject to the reform beginning from 2016. Data construction is finalized by deleting observations with energy intensity (calculated using costs) larger than 1, export value lower than 100 USD, and employment lower than

10. Furthermore, we restrict our data to include observations between the years 2010 and 2020, and only manufacturing firms identified by 2-digit NACE codes. Later in the paper the variable "export share" is used. This variable is constructed as export value over revenues. However, due to inconsistencies in the data the export value is coming from the Export data – for reliability reasons– and it is in terms of USD. To tackle this problem we transform the export value to TL using yearly average currency rates published by Central Bank of Republic of Turkey (CBRT). In the cleaning process of the data, observations are dropped where costs and/or revenues are missing or equal to zero.

Table 4.2 Energy providers

4 Digit NACE Codes	NACE Names
3511	Electric power generation
3512	Transmission of electrical energy
3513	Distribution of electricity
3514	Electricity trading
3521	Production of gas
3522	Distribution of gaseous fuels through mains
3523	Gas trading
0510	Coal mining
0520	Lignite mining
4671	Wholesale trade of liquid and gas fuels and related products
0620	Natural gas extraction

5. BASE ANALYSIS

In order to understand the effect of green initiatives on firm-level energy intensity, we need to do multiple analyses. An in-depth analysis of how the firms that would be subject to ETS will react to these initiatives requires a difference in differences approach. We labeled firms that operate under the NACE codes that are subject to ETS as ETS-sector. Difference in differences estimation allows us to examine the differences in the change in energy intensity for ETS firms and non-ETS firms before and after the Paris Agreement. With this approach, we assume ETS firms would have followed a trend that is not significantly different than non-ETS firms before the reform. In order to validate this assumption, we constructed an event analysis to compare trends in energy intensity before and after the reform. The model for event analysis is presented below.

$$(5.1) \quad energyintensity_{ijt} = \beta_0 + \beta_1 ETS_i + \beta_2 year * ETS_i + \beta_3 year + \beta_4 X_{jt} + u_{ijt}$$

where energy intensity is defined as the ratio of a firm's energy expenses to its cost of sales. ETS is a binary variable taking the value 1 if the firm operates in the ETS sectors defined in the data section. Variable year controls for time trends, taking 2014 –the year before the reform as the base year and X denotes a vector for industry dummies to control for industry-specific effects. The variable of interest is the interaction term year*ETS. As it is shown in the Table 5.1, results suggest that ETS firms follow a significantly different track specially in the EU exporters sample which is consistent with the results of the difference in difference estimation. Thus we find enough evidence to continue our analysis using DiD and DDD methods.

Table 5.1 Base regression event study

	FE Model			OLS Model		
	All Sample	Exporters	EU Exporters	All Sample	Exporters	EU Exporters
ETS	0.00568*	-0.00450	0.00115	0.00866***	0.00755***	0.0108***
	(0.00327)	(0.00376)	(0.00447)	(0.00124)	(0.00131)	(0.00145)
2010.year_ets	0.00231**	-0.000376	-0.00220**	0.00643***	0.00160	-0.00115
	(0.00104)	(0.00104)	(0.00108)	(0.00166)	(0.00173)	(0.00190)
2011.year_ets	0.00149	-0.000517	-0.00205**	0.00327**	-0.000325	-0.00314*
	(0.000991)	(0.000991)	(0.00104)	(0.00159)	(0.00167)	(0.00185)
2012.year_ets	0.00160*	0.000169	-0.000930	0.00286*	-0.000188	-0.00293
	(0.000961)	(0.000964)	(0.00102)	(0.00155)	(0.00163)	(0.00182)
2013.year_ets	-0.000801	-6.55e-05	0.000165	-0.000837	-0.000120	-0.00105
	(0.000928)	(0.000932)	(0.000993)	(0.00153)	(0.00161)	(0.00181)
2015.year_ets	0.00291***	0.00214**	0.00229**	0.00161	0.00124	0.000544
	(0.000895)	(0.000907)	(0.000964)	(0.00148)	(0.00157)	(0.00176)
2016.year_ets	0.00109	0.000488	-0.000435	-0.000120	0.000868	-1.43e-06
	(0.000897)	(0.000913)	(0.000963)	(0.00147)	(0.00156)	(0.00174)
2017.year_ets	0.000495	-0.000490	-0.00279***	-0.00408***	-0.000433	-0.00277
	(0.000899)	(0.000920)	(0.000972)	(0.00146)	(0.00156)	(0.00173)
2018.year_ets	0.000601	-0.00185**	-0.00442***	-0.00533***	-0.00468***	-0.00620***
	(0.000897)	(0.000914)	(0.000964)	(0.00144)	(0.00153)	(0.00170)
2019.year_ets	0.00926***	0.000761	-0.00372***	0.000683	-0.00224	-0.00579***
	(0.000910)	(0.000914)	(0.000964)	(0.00144)	(0.00151)	(0.00167)
2020.year_ets	0.00785***	-0.000776	-0.00438***	-0.00109	-0.00347**	-0.00671***
	(0.000917)	(0.000929)	(0.000980)	(0.00142)	(0.00150)	(0.00166)
2010	-0.000375	0.000545	0.000361	0.00271***	0.00275***	0.00321***
	(0.000480)	(0.000464)	(0.000479)	(0.000759)	(0.000767)	(0.000831)
2011	-2.03e-05	-0.000101	-0.000228	0.00173**	0.00131*	0.00196**
	(0.000454)	(0.000441)	(0.000457)	(0.000724)	(0.000736)	(0.000803)
2012	0.00338***	0.00310***	0.00314***	0.00380***	0.00367***	0.00441***
	(0.000434)	(0.000423)	(0.000440)	(0.000698)	(0.000714)	(0.000783)
2013	-0.00108***	-0.000448	-0.000791*	-0.00103	-9.89e-05	-0.000286
	(0.000420)	(0.000407)	(0.000429)	(0.000690)	(0.000703)	(0.000778)
2015	0.000459	0.000475	0.000705*	-8.42e-05	0.000281	0.000899
	(0.000401)	(0.000394)	(0.000414)	(0.000660)	(0.000679)	(0.000750)
2016	0.000644	0.000731*	0.000556	-0.000763	-0.000304	0.000208
	(0.000401)	(0.000395)	(0.000413)	(0.000652)	(0.000672)	(0.000737)
2017	-0.000452	-0.000928**	-0.000996**	-0.00256***	-0.00270***	-0.00237***
	(0.000400)	(0.000397)	(0.000413)	(0.000643)	(0.000669)	(0.000732)
2018	0.00141***	0.000576	5.97e-05	-0.00253***	-0.00230***	-0.00231***
	(0.000395)	(0.000393)	(0.000409)	(0.000626)	(0.000651)	(0.000712)
2019	0.00681***	0.00454***	0.00390***	0.000861	0.000256	7.97e-05
	(0.000395)	(0.000391)	(0.000408)	(0.000617)	(0.000636)	(0.000696)
2020	0.00893***	0.00457***	0.00376***	0.00202***	-0.000303	-0.000373
	(0.000398)	(0.000397)	(0.000414)	(0.000603)	(0.000632)	(0.000692)
Constant	0.0255***	0.0280***	0.0226***	0.0339***	0.0273***	0.0270***
	(0.00236)	(0.00305)	(0.00381)	(0.000555)	(0.000629)	(0.000733)
Observations	206,978	106,924	78,537	206,978	106,924	78,537
R-squared	0.016	0.009	0.011	0.099	0.123	0.130
Number of Firms	48,155	25,720	19,394			

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

We then start our firm-level analysis by the following equation to understand whether firms in the ETS sectors are affected differently in terms of their energy intensity compared to non-ETS firms post-reform.

$$(5.2) \qquad energyintensity_{ijt} = \beta_0 + \beta_1 ETS_j + \beta_2 Reform_t * ETS_j + \beta_3 X_{jt} + u_{ijt}$$

The dependent variable energy intensity denotes the firm-level ratio of energy expenditure to and cost of sales. Reform is a binary variable that takes the value 1 if the year is after 2015, and 0 otherwise, X denotes a vector of control variables which are year controls and industry controls based on 2 digit NACE codes. Industry dummies should drop out in the presence of firm fixed effects. However in the sample we see firms that switch sectors which leaves residual industry fixed effects that are not captured by firm fixed effects. The variable of interest in this equation is β_3 which explains how the firms in ETS sectors are affected differently from the reform compared to non-ETS firms. β_3 demonstrates the average effect of the Paris Agreement on ETS-sector firms relative to non-ETS firms between 2010-2020.

We conducted the analysis in 3 samples. Full sample includes all firms in the constructed and cleaned data. We use fixed effects methods to eliminate firm specific effects that cannot be observed. However, exporting firms are by nature different than non-exporting firms. Average energy intensity differences between ETS sector firms and non-ETS sector firms through the period in question are shown in the figures 1 through 3. It is extensively studied in the literature and shown that they are more productive and efficient than non-exporting firms– see Yeaple (2005), Costantini and Melitz (2007), Verhoogen (2008),Bustos (2011), and Lileeva and Trefler (2010). Only using the full sample where non-exporters are also included may cause non-exporters results to shadow the effect of the reform on exporters. Thus, we decide to conduct the analysis in a reduced sample where only firms that export in the specified year are included. This subsample is labeled as exporters. Furthermore, the most prevalent supporters of international trade regulations are EU members. CBAM is an example of their enthusiasm regarding these types of regulations. Carbon leakage being an important topic of discussion since the introduction of EU ETS, it is likely that Turkish EU exporters reacted to the Paris Agreement more. Therefore the last subsample includes firms that are declared EU exporters if they exported to at least one EU member country in the specified year. In the data, there are 25,563 firms that exported at least once and 19,286 that exported

to the EU at least once between 2010 and 2020.

Figure 5.1 Average energy intensity differences between ETS and Non-ETS firms (All Firms)

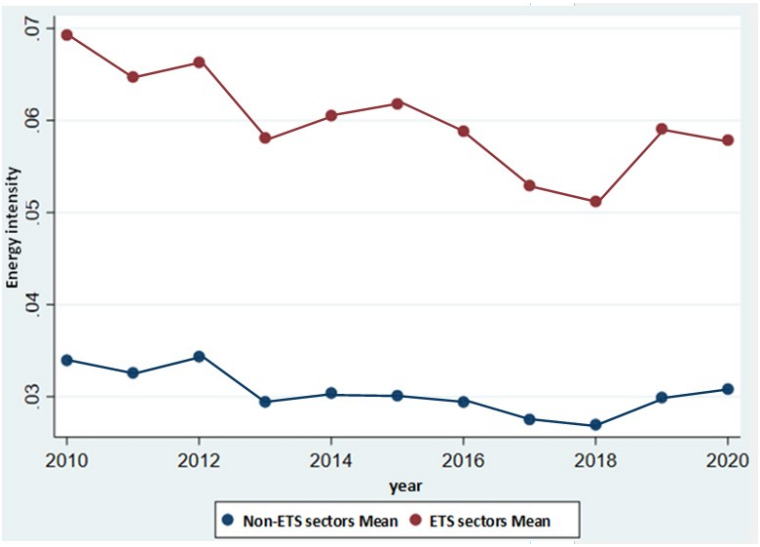


Figure 5.2 Average energy intensity differences between ETS and Non-ETS firms (Exporters)

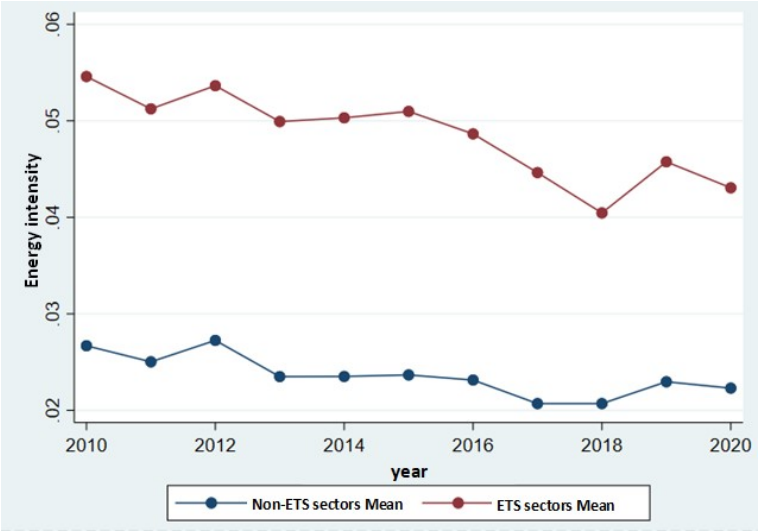


Figure 5.3 Average energy intensity differences between ETS and Non-ETS firms (EU Exporters Firms)

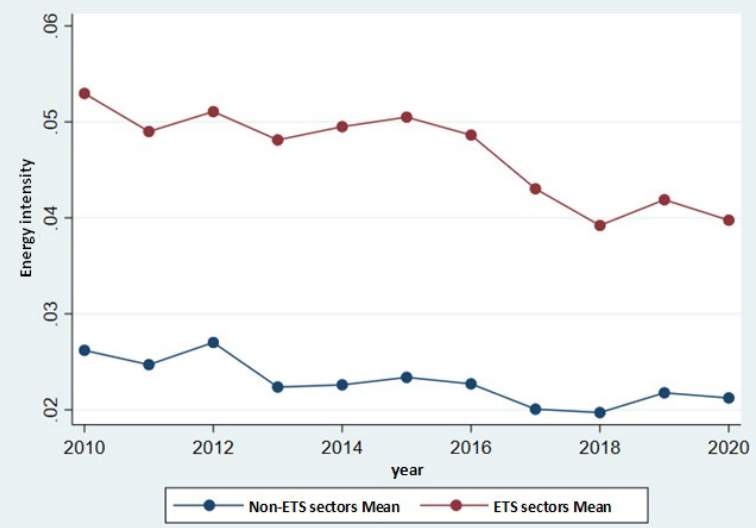


Table 5.2 Base regression

	FE Model		
	All Firms	Exporters	EU Exporters
ETS	0.00950***	-0.00268	0.00181
	(0.0033)	(0.0039)	(0.0047)
$ETS * Reform$	0.00214***	-0.00087*	-0.00303***
	(0.0005)	(0.0005)	(0.0005)
$SizeGroup3$	-0.00262***	-0.00101***	0.000001
	(0.0004)	(0.0004)	(0.0004)
$SizeGroup4$	-0.00430***	-0.00122*	-0.000511
	(0.0007)	(0.0006)	(0.0006)
constant	0.0237***	0.0277***	0.0222***
	(0.0025)	(0.0032)	(0.0041)
Year Dummies	YES	YES	YES
Insustry Dummies	YES	YES	YES
R^2	0.015	0.009	0.011
Observation	204,564	105,690	77,620
Number of Firms	47,867	25,563	19,286

Note: Dependent variable is energy intensity. $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

The coefficient of the ETS represents the effect of being a firm in the ETS sectors on the energy intensity before the reform and it is positive and significant in the full sample as expected. The coefficient of the interaction term ETS*Reform represents the difference in differences term. The interaction coefficient being significant indicates that the reform had a differential impact on the firms in ETS sectors. For the full sample we can observe that the reform had a stronger effect on the ETS firms –the energy intensity increased significantly more for ETS firms after the reform compared to the increase for the non-ETS firms. Looking at the subsample where we observe the exporters, it can be seen that the difference in differences coefficient is significant and negative. Exporter ETS sector firms increased their energy intensity by 0.004 after the reform. However when we look at the significantly negative DiD coefficient we can see that the increase in energy intensity due to the reform is smaller for ETS sector firms compared to non-ETS sector firms. Results can be interpreted as in ETS sector firms the increase in energy intensity of the firms after the reform is 0.002 higher in the full sample, whereas it is 0.009 lower in exporters and 0.003 lower in EU exporters compared to the increase in energy intensity due to reform in non-ETS sector firms. This result can be interpreted as exporter (and EU exporter) firms are trying to decrease their energy intensity since they will be affected by international regulations such as CBAM.

The analysis demonstrates that energy intensity differed significantly in the ETS sector firms after the date of the agreement specifically for the firms that export to the EU. After the agreement energy intensity increases for all firms in the data however the increase is lower for the firms that export and firms that export to the EU. These results are most likely due to exporting firms being larger in scale and more productive. It is known in the literature that exporting firms are more productive. Tybout et al using plant-level data that more efficient firms become exporters and there is a positive association between exporting and efficiency (Clerides, Lach, and Tybout 1998). Other papers support these results suggesting that exposure to trade will induce more productive and efficient firms to enter the export market (Melitz 2003). Another important result is that the increase in the energy intensity after the reform is lower for the ETS sector firms in the exporter and EU exporter samples compared to non-ETS firms. This can be interpreted as ETS firms that export understood the agreement as a signal for change and worked on decreasing the pace of increase in their energy intensity. One other explanation is that ETS firms that export outsourced some of their energy intensive operations to firms in Turkey that do not export, to decrease their emissions on paper. This explanation is supported by the fact that in the base regression the increase in the energy intensity for ETS firms is much higher in the full sample compared to non-ETS firms. In the fur-

ther studies this scenario can be examined in detail using firm to firm transactions. However, since it includes inter-firm dynamics, it is not in the scope of this paper. These results align with the starting hypothesis of this paper. To understand the mechanism behind this behavior of ETS-firms, we conducted two additional analyses. These analyses are aimed to understand the dynamics of internal and external margin.

6. EXPORT SHARE ANALYSIS

The net effect of exporting on energy intensity is still ambiguous and heavily discussed in the literature. Batrakova and Davies (2012) theoretically show that increase in the scale of production due to increasing export behavior might increase demand for energy, indicating a negative effect of exporting on energy efficiency. Forslid, Okubo, and Ulltveit-Moe (2018) predicts that abatement increases with trade due to larger scale of production decreasing average costs. However, in the Turkish manufacturer's case, we need to be more careful. Since 2005 after EU ETS was in force, carbon leakage has been a major concern for the policymakers. Carbon leakage raises not only environmental concerns but also concerns about the competitiveness of regulated EU firms and unregulated Turkish firms. One of the biggest concerns is energy-intensive Turkish firms increasing their exports. In this matter, further analysis is needed to fully understand the differentiated effect of the Paris Agreement on Turkish firms based on their exporting activities. From here, we follow DDD approach which is widely used in the recent policy evaluation literature. (see Angrist and Pischke (2009) and Wooldridge (2010)). This allows us to understand if these environmental initiatives had a different effect on firms with higher volumes of export activity. To further understand the dynamics that affect firms' decision making regarding their investments towards decreasing energy intensity, we conduct an analysis that includes firms' export share in 2014 – before the reform. With this methodology we avoid endogeneity which could result from firms changing their export share as a response to their energy intensity or vice versa.

(6.1)

$$energyintensity_{i,j,t} = \beta_0 + \beta_1 exportshare_{i,j,2014} + \beta_2 exportshare_{i,j,2014} * ETS + \beta_3 exportshare_{i,j,2014} * ETS * Reform_t + \beta_4 exportshare_{i,j,2014} * Reform_t + \beta_6 ETS_j + \beta_7 Reform_t * ETS_j + \beta_8 X_{ijt} + u_{ijt}$$

The data is constructed in a way where export share value of each firm in 2014 is repeated in later years exactly. Thus, this analysis includes firms that only existed in 2014. If the firm did not export in 2014 – meaning it did not have exposure to the export market prior to the reform, the export share is treated as 0.

Table 6.1 Export market exposure analysis

	FE Model		
	All Firms	Exporters	EU Exporters
$exportshare(2014)$	-0.050***	-0.00918***	-0.00835***
	(0.0017)	(0.0014)	(0.0015)
$exportshare(2014) * ETS$	0.00142	-0.00348	-0.00354
	(0.0037)	(0.0029)	(0.0031)
$exportshare(2014) * ETS * Reform$	-0.00982***	0.00285	0.00550**
	(0.0027)	(0.0023)	(0.0023)
$exportshare(2014) * Reform$	-0.000173	0.00216**	0.00244***
	(0.0010)	(0.0009)	(0.0009)
ETS	0.00997***	-0.00134	0.00427
	(0.0038)	(0.0044)	(0.0051)
$ETS * Reform$	0.00328***	-0.00165***	-0.00426***
	(0.0006)	(0.0006)	(0.0007)
$constant$	0.0290***	0.0323***	0.0261***
	(0.0028)	(0.0036)	(0.0044)
Year Dummies	YES	YES	YES
Insustry Dummies	YES	YES	YES
Size Dummies	YES	YES	YES
R^2	0.012	0.009	0.012
Observation	143,088	79,939	59,940
Number of Firms	25,720	15,559	12,132

Note: Dependent variable is energy intensity $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

These results can be interpreted as even though in the full sample ETS sector firms did not decrease their energy intensity compared to non-ETS firms, the reform has a differential effect on energy intensity with respect to firms' export share in 2014. The significant negative coefficient of the triple interaction term demonstrates the

change in the effect of export share in 2014 on the energy intensity due to the reform for ETS firms compared to non-ETS firms. It represents the differential effect of the reform on ETS sector firms based on their export share. Based on the results we can say that reform caused a higher decrease in energy intensity for firms with higher export share in 2014. Let's interpret the effect of export share before the shock on the energy intensity starting with the coefficient of 'export share (2014)'. The coefficient being significant and negative implies that regardless of the sector or the subsample, as the export share in 2014 increases by one percentage point the energy intensity of the firm decreases by 0.05 percentage points in all firms, 0.0092 percentage points in exporters, and 0.0084 in EU exporters. The coefficient of export share (2014)*Reform represents the effect of pre-shock export share changing after the reform for non-ETS firms. From the table it can be seen that the coefficient is positive and significant for exporter and EU exporter subsamples. This means for these subsamples, the negative effect of export share on energy intensity is weakened after the reform for non-ETS firms. The coefficient of interest in this analysis is the export share (2014) * Reform * ETS coefficient, which is also the DDD coefficient. DDD term represents the differential effect of change in pre shock export share after the reform on the energy intensity of ETS firms. The effect of export share changes for ETS firms after the reform and this change can be calculated as the sum of the coefficients of Reform * export share(2014) and the triple interaction term. Thus, all else being equal, firms with one percentage point higher pre shock export share decreased their energy intensity by 0.01 percentage points in the full sample. For the sample with only EU exporters, we see that the export share's negative effect is weakened for ETS firms after the reform. As we already explained, the changing effect of export share on energy intensity in non-ETS firms after the reform is represented by the coefficient of export share (2014) * Reform term. Hence the difference between the changes of the export share effect after the reform for ETS and non-ETS firms is given in the triple interaction term. First analysis provided sufficient reason to suspect that export share – or the exposure to the export market can influence firms' decisions regarding their energy intensity. In order to address the concerns about endogeneity each firm's existing pre-reform exposure is used in the analysis. Results show that export share had a negative effect on energy intensity for all firms and all subsamples before the reform and this negative effect was not significantly different for ETS firms compared to non-ETS firms. This result supports the hypothesis made in the first analysis – export market exposure affects firm energy intensity. Since this result is for the pre-reform period and true for all firms, it can be argued that this is due to international competition.

Analysis also quantifies the change in the effect of export share after the reform.

Results illustrate that after the reform, export share's negative effect on the energy intensity is weakened for the non-ETS firms in the exporter subsamples and did not significantly change for the non-ETS firms in the all sample. Being a firm in the ETS sector differentially changed the effect of export share on energy intensity after the reform. For the firms in the ETS sector, the negative effect of export market exposure on the energy intensity strengthened after the reform in the full sample. This can be a result of positive spillover. The differential effect of being an ETS sector firm becomes significantly positive in the EU subsample. Meaning that the negative effect of pre-reform export share has on the energy intensity weakened more for ETS sector firms compared to non-ETS firms. This can be explained by (i) the energy intensity decrease is due to international competition and the effect is not solely concentrated on the energy intensive sectors, (ii) some ETS firms that used to export before the reform, decreased or even stopped exporting after the reform and hence did not have an incentive that arises because of the reform to decrease their energy intensity. Hence, the negative effect of the pre-shock export market exposure on their ongoing energy intensity is lower than the non-ETS firms. A completely different story that might explain these results is that ETS sector firms that export do not decrease their energy intensity more based on their export market exposure because the more exposure and connections to the markets with high energy regulations, increases the chance of carbon leakage. The reason behind the significantly positive triple interaction term in the EU exporter sample might be that exporting ETS firms are subject to carbon leakage after 2015. This raises serious suspicion around leakage however this hypothesis requires further research and detailed data to understand the true mechanism behind these results. This analysis provided evidence on the behavior of firms that already exist in the export market– thus gives us the insight of the movement in the internal margin.

7. EXPORT STATUS ANALYSIS

Understanding the behavior of firms that are planning to enter the export market in the light of new regulations signaled by the Paris Agreement gives us the external margin. To strengthen the assumptions behind the analysis of the effect of exporting status on the energy intensity, we conducted an event study.

Table 7.1 Exporter event study

	FE Model	OLS Model
	exporter status	exporter status
ETS	-0.0811***	0.291***
	(0.0271)	(0.0106)
2010.year_ets	0.0214**	-0.00438
	(0.00862)	(0.0141)
2011.year_ets	0.0151*	-0.00194
	(0.00823)	(0.0135)
2012.year_ets	0.0141*	0.00332
	(0.00797)	(0.0132)
2013.year_ets	0.0160**	0.00595
	(0.00770)	(0.0130)
2015.year_ets	0.00354	0.00834
	(0.00743)	(0.0126)
2016.year_ets	0.00518	0.00231
	(0.00745)	(0.0125)
2017.year_ets	0.0103	0.0172
	(0.00746)	(0.0124)
2018.year_ets	0.00646	0.0298**
	(0.00745)	(0.0122)
2019.year_ets	0.00122	0.0442***
	(0.00756)	(0.0123)
2020.year_ets	0.0133*	0.0606***
	(0.00761)	(0.0121)
2010	-0.0271***	0.0213***
	(0.00398)	(0.00645)
2011	-0.0223***	0.00769
	(0.00377)	(0.00616)
2012	-0.0175***	-0.00401
	(0.00360)	(0.00594)
2013	-0.00984***	0.00245
	(0.00349)	(0.00586)
2015	-0.00397	-0.0179***
	(0.00333)	(0.00561)
2016	-0.00141	-0.0197***
	(0.00333)	(0.00554)
2017	-0.0141***	-0.0405***
	(0.00332)	(0.00547)
2018	-0.00234	-0.0460***
	(0.00328)	(0.00532)
2019	0.0238***	-0.0250***
	(0.00328)	(0.00524)
2020	0.00597*	-0.0667***
	(0.00330)	(0.00513)
Constant	0.582***	0.338***
	(0.0196)	(0.00472)
Observations	206,978	206,978
Number of Firms	48,155	
R-squared	0.003	0.093

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Results show that the probability of being an exporter for ETS firms differed significantly before the reform and there were no such difference between ETS and non-ETS firms after the reform when unobserved firm-specific effects are accounted for. This change in the trends gives sufficient evidence that the reform changed the likelihood of being an exporter, thus enabling us to further the analysis.

Table 7.2 Export status analysis

	FE Model
Exportstatus	0.0106
	(0.00951)
Exportstatus*Reform	-0.0982***
	(0.00970)
ETS	0.192**
	(0.0813)
ETS*Reform	0.00907
	(0.0245)
Exportstatus*ETS	0.0301
	(0.0215)
Exportstatus*Reform*ETS	-0.125***
	(0.0216)
Constant	-4.588***
	(0.0591)
Year Dummies	YES
Insustry Dummies	YES
Size Dummies	YES
Observations	204,564
Number of Firms	47,867
R-squared	0.038

Note: Dependent variable is log(energy intensity)
*** p<0.01, ** p<0.05, * p<0.1

Export status is an important indicator of a firm's performance in many areas. It is expected that an exporter firm is more likely to be efficient. However this might not be the case when we consider energy intensity in terms of share of total costs when the concept of carbon leakage is considered. Carbon leakage might cause firms with high energy intensity and hence costs to export more to countries with strict environmental laws. In order to understand how exporting status might

factor into our analysis, we run the DDD regression with the exporting status. Table 7.2 summarizes the results for this analysis where the dependent variable is the log of energy costs over total costs. By the results we understand that being an exporter before reform did not imply higher energy intensity for non-ETS firms since the coefficient of exporter variable is not significant. However for non-ETS firms since the coefficient of exporter*reform is negative and significant and this entails that for non-ETS firms, exporter status began to have a negative effect on energy intensity after the reform. The change in the export status effect on the energy intensity for ETS firms after the reform is represented by the sum of the coefficients of exporter*reform and exporter*ets*reform which are both significant and negative. The difference between the change in the effect of export status on ETS and non-ETS firms after the reform is represented by the triple interaction – it is negative and significant.The differential effect of being an exporter has on energy intensity is represented by the triple interaction term. This means that being an exporter has a more negative effect on energy intensity after the reform compared to non-ETS firms.

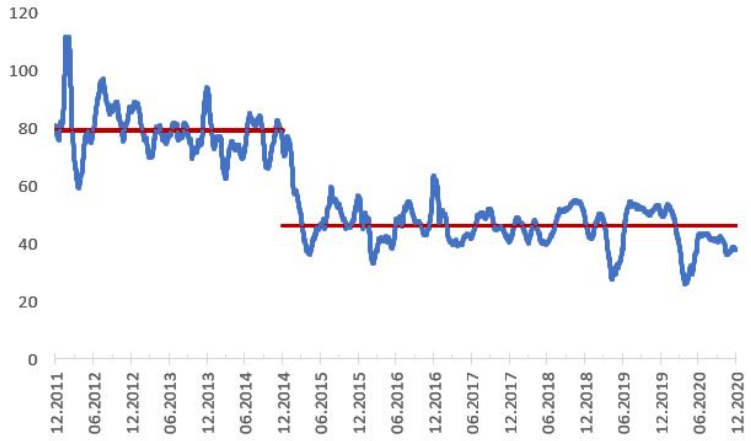
Previous analyses raise the question whether being an exporter has an effect on the energy intensity and does the effect change after the reform differently for ETS firms. This gives an insight of the behavior of firms that enter the export market after the reform and whether it changes depending on the sector. Variable of interest explains how becoming an exporter affects the energy intensity of the firm after the reform differentially for ETS firms compared to non-ETS firms.

Results indicate that after the reform, exporting has an energy decreasing effect on all firms even though no such relationship existed before the reform. More interestingly, exporting ETS firms have a higher tendency to decrease their energy intensity after the reform compared to non-ETS firms. This raises suspicion around the scenario where ETS firms that are planning to enter the export market have to be prepared for international regulations to come thus needs to have lower energy intensity. This scenario is consistent with the findings of Bernard et al. (2007) suggesting that exporters are more productive "not as a result of exporting, but because only the most productive firms are able to overcome the costs of entering export markets.". Whereas ETS firms that already exist in the export market can hang on to existing connections and be subject to carbon leakage. A supporting scenario might be that in order to be an exporter, the firms' energy intensity should be very low compared to non-exporters. It can be that for ETS sector firms, increasing export share might cost more in terms of their energy intensity in the light of international trade partners looking for firms that are prepared for the changes to come when building new agreements.

8. DISCUSSION

One might be concerned that this differential effect of reform on ETS firms is caused by increased energy prices during the same period as the reform period. To be more precise, if energy prices increased after the reform, ETS sectors which are energy intensive by nature might have decreased their energy intensity as a response to prices. To address this concern we looked at energy prices and observed energy prices decrease after 2014. Energy prices in the market decrease significantly after the reform in terms of USD.

Figure 8.1 Energy prices in terms of USD from Energy Exchange Istanbul Transparency Platform (Market clearing price in Turkey)



In light of the results of this study, if ETS firms that exist in the market actually are subject to carbon leakage and ETS firms who enter the export market after the reform decrease their energy intensity to enter the export market; most effective policy would be supporting energy intensive firms that are planning to export and regulate the existing exporters heavily.

9. CONCLUSION

Climate change's importance becomes more pronounced everyday and as all aspects of life, economy and international trade are also affected by climate change. International agreements and national policies undergo a green transition. This paper contributes to the literature by providing an insight look on how firms in a developing country react to these changes. The unprecedented dataset conducted in this paper provides meaningful information on industry and firm dynamics that are affected by the Paris Agreement. Lack of firm level data availability on emissions hamper the efforts of researchers to understand the effects of international trade regulations about climate change on firms in developing countries. Increasing energy efficiency being one of the most cost effective and fast ways to decrease emissions, enables this study to confidently use energy intensity as the explained variable of which the effect of the agreement is observed. Results suggest that after the agreement, exporting ETS firms decrease their energy intensity more compared to non-ETS firms. This result is investigated further to understand the mechanisms of internal and external margins. It shows that for ETS firms that already exist in the export market, export market exposure's negative effect on energy intensity slows down and becoming an exporter after the reform results in a higher decrease in energy intensity for ETS firms after the reform. This concludes the paper by demonstrating that external margin dominates the internal margin which implies the higher decrease in the energy intensity in ETS firms is caused by firms that enter the export market after the reform. However the questions raised and possible scenarios explained in the paper require further research.

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APPENDIX A

Uncleaned data consists of 1,569,910 observations and 471,072 firms over the 10 year period between 2010 and 2021. These are the firms of which we can identify the energy expenditure of. These firms pay at least 5000 TL to an energy provider. Of these, 367,834 observations and 100,224 firms are manufacturers. 252,291 observations belong to 56,891 firms that have the previous criteria and have more than 10 employees. When firms of which the energy expenditure is identified from firm transactions data but the balance sheet data is not available dropped, we have 56,466 firms and 250.818 observations. There are 428 observations where export value is lower than 100 USD, which are dropped because the value is too small to have an effect on decision making, nevertheless grants exposure to the export market to label those firms as non-exporters. Furthermore, observations where costs and /or revenues appear as missing or zero are regarded as data error and dropped from the sample – 1,956 observations. After energy intensity is calculated as energy costs over total costs, the observations where energy intensity is larger than 1 are dropped, 247,989 observations and 55,876 firms are left in the sample. Observations where capital, RD and investments are dropped and year 2021 is also dropped due to the concerns over COVID-19 pandemic affecting results. Data is also trimmed according to first and last percentile of energy intensity (calculated according to revenues) distribution to eliminate outliers.