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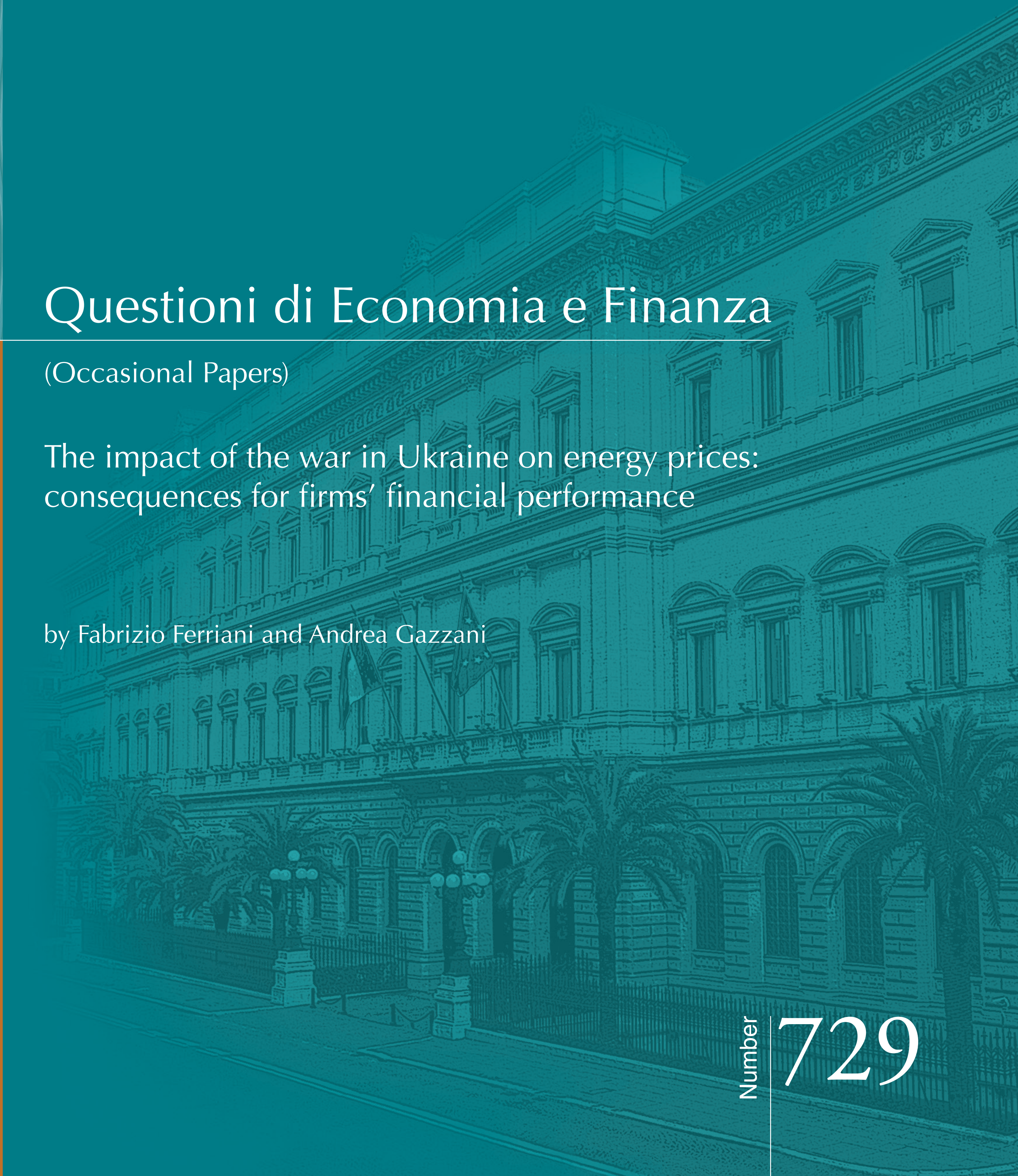

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THE IMPACT OF THE WAR IN UKRAINE ON ENERGY PRICES: CONSEQUENCES FOR FIRMS' FINANCIAL PERFORMANCE

by Fabrizio Ferriani* and Andrea Gazzani*

Abstract

We analyse the impact of the shock to energy prices induced by the war in Ukraine on the financial performance of the major European firms listed in the Eurostoxx 600 index. We find that equity returns (CDS spreads) decreased (increased) more substantially for firms characterized by high energy intensity and carbon emission intensity. We then present a method, based on a VAR model, to produce forecasts of firms' CDS spreads conditional on a 3-month stress period of high electricity prices and we document a non-negligible increase in the number of firms with a CDS-implied non-investment rating.

JEL Classification: G12, G14, G32, G33.
Keywords: war in Ukraine, energy impacts, financial performance, CDS spread.
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1 Introduction[1]

Global energy prices have been steadily rising since mid-2021 as pent-up demand spurred by the post-pandemic recovery fueled considerable tightness in the energy market. This dynamics was particularly pronounced in Europe where the Russia's invasion of Ukraine added unprecedented pressure to the European energy market: between February 23, the day before the start of the conflict, and July 31, European gas and electricity wholesale prices increased by 115% and 237%, respectively. Europe's heavy reliance on energy imports from Russia explains the marked response of energy prices to the war in Ukraine. In 2020, Russia accounted for around 29% of crude oil and 43% of natural gas imports into the European Union (EU), though dependence on Russian energy exhibits a large heterogeneity across member states, with countries in central and Eastern Europe, Germany and Italy, displaying the greatest reliance.

Since the start of the war, policy and academic contributions have mainly focused on the macroeconomic impacts of the conflict in Ukraine. In particular, the economic discussion mainly developed about recession risks and soaring inflation (Bachmann et al. 2022, Di Bella et al. 2022, Ferrara et al. 2022, Pestova et al. 2022), trade disruption and supply bottlenecks (Borin et al. 2022, Langot et al. 2022, World Bank 2022). Firm-level analysis is still scarce and mostly reliant on event studies to quantify the impact of the Russian invasion on companies' stock prices (Boungou and Yatié 2022, Boubaker et al. 2022,Deng et al. 2022).

We contribute to the debate on the implications of the war in Ukraine on the European economy by assessing the impact of higher energy prices on the financial performance of European listed firms. First, we analyze whether firms' sensitivity to energy prices, measured in terms of the energy input expenditure normalized by total revenues or, alternatively, as carbon emission intensity, has an effect on firms' post-war financial performance. We show that equity returns (credit default swap spread) decreased (increased) more substantially for firms with high energy intensity and, notably, these results are robust to the inclusion of several corporate controls as well as country and industrial sector fixed effects (FE). Second, we present a method to assess the impact of a 3-month persistence in energy prices on credit default swap (CDS) spreads and implied default probabilities. We rely on a VAR model to produce forecasts of firms' CDS spreads and we document that a non-negligible amount of firms would lose the investment-grade status should energy prices remain at the record high levels reached at the end of July 2022.

The surge in energy costs induced by the war in Ukraine is significantly hitting European firms' profits, increasing business risk, and even jeopardizing entire production sectors. Our study shows that the effects of the energy shock have already started to materialize in corporate asset prices, channeled via the extent of the energy intensity in firms' production function.

[1]We thank Paolo Angelini, Riccardo Cristadoro, and Giovanni Veronese for suggestions. The views expressed in the paper are those of the authors and do not involve the responsibility of the Bank of Italy.

2 Data and model

We empirically analyze the relationship between a firm's financial performance and its sensitivity to energy prices by means of a linear regression, based on the following specification:

$$\Delta y_i = y_{i,t} - y_{i,t_0} = \alpha + \beta x_i + \theta z_i + \gamma_s + \delta_c + \varepsilon_i \tag{1}$$

where Δy_i is the change in the financial performance of firm i computed over the period 23 February (onset of the war, t_0) and 31 July 2022 (t), x_i measures the firm's sensitivity to the war-induced energy shock, z_i are a set of controls at the firm level, γ_s are industry fixed effects, δ_c are country fixed effects, and ε_i is the error term.[2] We propose two different proxies for firms' financial performance: the equity returns (obtained from Refinitiv) and the change in the 5 Year CDS spread implied by the issuer default risk model developed by Bloomberg.[3] Also in the case of corporate sensitivity to the energy shock (x_i) we propose two alternative measures, the first being defined in terms of energy intensity as

$$Energy\ intensity = \frac{Energy\ consumption * Avg.2022\ electricty\ price}{Firm\ Revenues}$$

where firm-level energy consumption (thousands of MWh) in 2021 are converted in euros using the average electricity price recorded on the European wholesale market during the first seven months of 2022 and they are standardized by firm's revenues. The second proxy for x_i is defined in terms of emissions intensity and equals to firm's Scope 1 emissions scaled by their average equity market value in 2021.[4] This second proxy is obviously correlated with energy use, but brings an additional element into the analysis as ETS prices have spiked as well during the current energy crisis. This variable may thus capture both the increased energy costs as well as the augmented costs that have to be paid when releasing carbon emissions; the literature on climate change has typically interpreted it as firms' exposure to climate transition risk (Ilhan et al. 2021 and Bolton and Kacperczyk 2021). In our analysis we study firms listed in the Eurostoxx 600, an equity benchmark index including pan-European firms with the largest market capitalization.

[2]The analysis starts on the eve of the Russian invasion of Ukraine and terminates on July 31 as we want to shield our results from the impact of the ongoing monetary policy normalization that is likely to influence the dynamics of equity returns and corporate risk premia. Our sample period accounts for more than 150 days of conflict and for all the major episodes affecting European energy prices in the last months. It includes, for instance, several rounds of sanctions imposed by Western countries on Russia, the cut-off of Russian gas supplies to some countries following their refusal to settle gas payments in rubles, the reduction of gas flows channeled via the Nord Stream 1 pipeline to 20% of its capacity.

[3]We use the Bloomberg implied CDS spreads instead of the publicly traded CDS spreads as the latter are frequently not available for non-financial firms.

[4]Scope 1 emissions are defined in terms of CO_2-equivalent emissions caused directly by the organization's activities and originated from the combustion of fossil fuels or other releases throughout the manufacturing process. Data are obtained from Carbon 4 finance.

Energy intensity		Emission intensity	
Paper & Forest Products	96.92	Airlines	1203.99
Airlines	94.13	Construction Materials	523.13
Construction Materials	82.22	Marine	410.29
Metals & Mining	32.40	Metals & Mining	302.00
Containers & Packaging	31.26	Paper & Forest Products	270.66
Marine	27.07	Chemicals	218.24
Chemicals	24.51	Containers & Packaging	156.23
Real Estate Management & Development	14.24	Construction & Engineering	100.92
Hotels, Restaurants & Leisure	11.91	Building Products	74.28
Building Products	10.59	Air Freight & Logistics	61.68

Table 1: **Sensitivity to the energy shock**. Top 10 Most exposed industrial sectors in terms of energy intensity (left panel) and emission intensity (right panel), see the text for the definition of each measure of energy sensitivity. Energy costs are evaluated using the average electricity price recorded in the first 7 months of 2022; the huge energy shock recorded in the first part of the year explains why the share of energy costs over total revenues can be extremely large for some industries.

We focus on non-financial companies, but also exclude utilities and energy firms from the sample since they sell energy to households and other firms and may tend to pass-through the increased energy costs to their customers.[5] Based on these selection criteria and data availability, our final sample consists of more than 350 firms whose average market capitalization in 2021 was around 8.5 trillions of Euro or equivalently 33.5% of GDP of the combined geographical coverage of the Eurostoxx (EU27+ UK, Norway and Switzerland). In our sample, energy is an important input of production: the mean incidence of energy costs on total revenues was more than 8% in 2021. Table 1 displays the top 10 industries in terms of average incidence of energy costs over total revenues and carbon emission intensity: the most exposed firms, across the two different statistics, generally belong to the sectors of construction, metal and mining, transportation, paper and forest products.[6]

[5]Empirical results, available upon request, are nevertheless qualitative comparable even if we include utilities in the sample.

[6]Total energy consumption in thousands of megawatt hours (MWh) are from Bloomberg, electricity prices on the wholesale European market (EEX-Phelix base) and corporate variables are obtained from Refinitiv and refer to the 2021 fiscal year. To minimize the impact of outliers we winsorize both measures of sensitivity to the energy shock at 3% on both tails.

3 Empirical Results

Our analysis is twofold. First, we highlight the negative relationship between energy expenditures (or emissions released) and firms' financial performances. Second, we propose a method, based on a VAR model, to gauge the potential shift in firms' implied default risk due to a prolonged period (3 months) of dramatic energy costs.[7]

3.1 Regression analysis

Our analysis finds a statistically significant negative correlation between firms' financial performances since the beginning of the Ukraine war and their energy intensity and emissions intensity.

Energy intensity. Table 2 reports the results from the regression described in eq.(1) without FE (1), with industry FE (2), with country FE (3), and with industry and country FE (4). The estimated coefficient on energy intensity is always highly statistically significant and can be interpreted as follows: a 1 p.p. increase in energy intensity reduces the post-war company's equity return by approximately 0.11 to 0.17 p.p., depending on the FE specification. The distribution of firms' returns as a function of energy intensity confirms that companies characterized by greater energy intensity have performed in general worse than their counterparts (Fig. 1a, left plot). CDS provides synthetic information on corporate solvency risk, and, consistently (but with opposite sign) with the analysis on equity returns, we find a positive relationship between CDS spread variations and the energy cost share on total revenues. Table 3 reports the results of the corresponding regressions: a 1 p.p. increase in energy intensity augments CDS spreads by 0.14-0.38 p.p. depending on the FE specification. The statistical significance of the coefficient of interest drops in those specifications that include industry FE, but the qualitative results are stable across all models. The distribution of firms' CDS variations as a function of energy intensity highlights that firms characterized by high-energy costs have performed worse than their counterparts in which the incidence of energy costs is more contained (Fig. 1a, right plot).

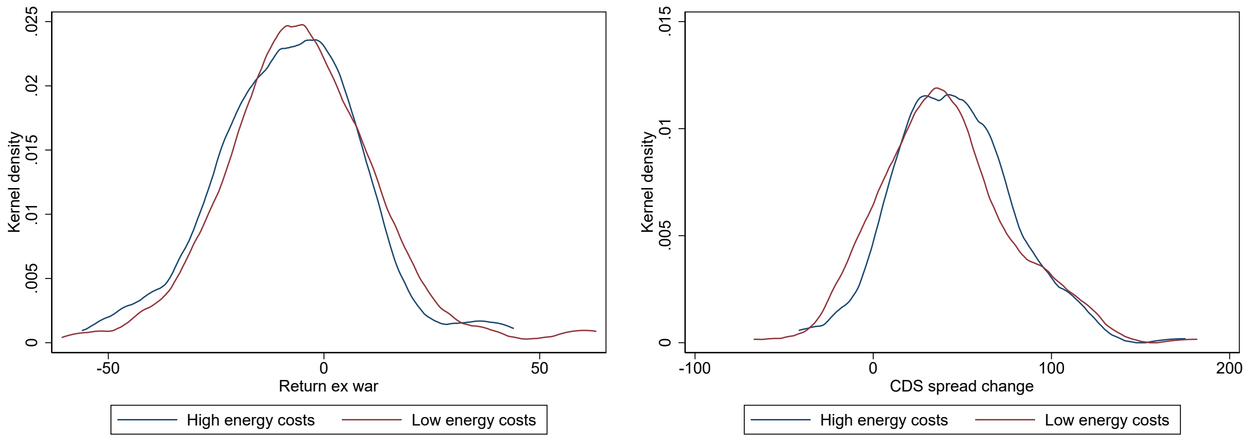
[7] We emphasize that both analyses are based on a series of simplifying assumptions and do not take into account some relevant factors that could affect both the returns and the CDS of the companies, such as government interventions to support some companies or industrial sectors, nonlinear effects of higher energy prices, episodes of systemic contagion within industrial sectors.

	(1) Returns	(2) Returns	(3) Returns	(4) Returns
Energy Intensity	-0.134***	-0.176***	-0.113**	-0.171***
	(0.051)	(0.062)	(0.052)	(0.063)
Constant	20.704	6.633	2.606	-8.674
	(18.528)	(21.625)	(20.557)	(23.672)
Controls	✓	✓	✓	✓
Industry FE	✗	✓	✗	✓
Country FE	✗	✗	✓	✓
Observations	355	355	355	355
R-squared	0.039	0.121	0.125	0.197

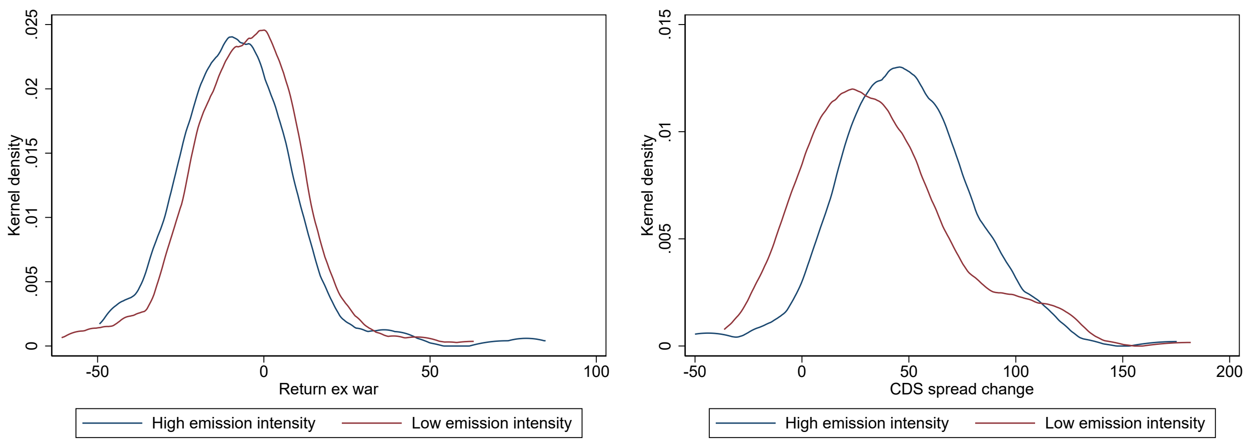
Table 2: **Equity returns and energy intensity**. Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. Dependent variable is the equity return between 23 February-31 July 2022. Energy intensity is defined as the costs of energy inputs evaluated at electricity prices in 2022 and normalized by corporate revenues. Controls include return on assets, interest coverage ratio, leverage ratio, capital, and size (log of revenues).

	(1) CDS spread	(2) CDS spread	(3) CDS spread	(4) CDS spread
Energy Intensity	0.382***	0.230*	0.307***	0.143
	(0.100)	(0.120)	(0.099)	(0.118)
Constant	59.332	58.759	75.763*	42.739
	(30.886)	(41.874)	(39.297)	(44.270)
Controls	✓	✓	✓	✓
Industry FE	✗	✓	✗	✓
Country FE	✗	✗	✓	✓
Observations	355	355	355	355
R-squared	0.083	0.195	0.219	0.314

Table 3: **CDS spread variation and energy intensity**. Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1 .Dependent variable is the change in the 5 Year CDS spread implied by the Bloomberg issuer default risk model between 23 February-31 July 2022. Energy intensity is defined as the costs of energy inputs evaluated at electricity prices in 2022 and normalized by corporate revenues. Controls include return on assets, interest coverage ratio, leverage ratio, capital, and size (log of revenues).



(a) *Kernel density of equity returns (left plot) and CDS spread variation (right plot). High energy-costs firms have an energy intensity larger than the sample median, the opposite holds for low energy-costs firms.*



(b) *Kernel density of equity returns (left plot) and CDS spread variation (right plot). High emission-intensity firms have an emission intensity larger than the sample median, the opposite holds for low emission-intensity firms.*

FIGURE 1: ***Sensitivity to the energy shock and firms' financial performance.*** *Kernel density of equity returns and CDS spread variations with respect to firms's energy intensity (upper panel) and emission intensity (lower panel).*

	(1) Returns	(2) Returns	(3) Returns	(4) Returns
Emission Intensity	-0.012**	-0.016**	-0.012**	-0.015**
	(0.006)	(0.006)	(0.006)	(0.007)
Constant	20.174	8.287	0.600	-3.428
	(20.215)	(23.043)	(22.655)	(25.580)
Controls	✓	✓	✓	✓
Industry FE	✗	✓	✗	✓
Country FE	✗	✗	✓	✓
Observations	330	330	330	330
R-squared	0.042	0.158	0.124	0.225

Table 4: **Equity returns and emission intensity**. Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. Dependent variable is the equity return between 23 February-31 July 2022. Emission intensity is defined as the amount of Scope 1 emissions over firm's market capitalization. Controls include return on assets, interest coverage ratio, leverage ratio, capital, and size (log of revenues).

	(1) CDS spread	(2) CDS spread	(3) CDS spread	(4) CDS spread
Emission Intensity	0.034***	0.024**	0.036***	0.024*
	(0.011)	(0.012)	(0.011)	(0.012)
Constant	35.436	20.045	57.749	15.650
	(38.227)	(43.195)	(41.592)	(46.267)
Controls	✓	✓	✓	✓
Industry FE	✗	✓	✗	✓
Country FE	✗	✗	✓	✓
Observations	330	330	330	330
R-squared	0.070	0.197	0.198	0.312

Table 5: **CDS spread variation and emission intensity**. Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1 .Dependent variable is the change in the 5 Year CDS spread implied by the Bloomberg issuer default risk model between 23 February-31 July 2022. Emission intensity is defined as the amount of Scope 1 emissions over firm's market capitalization. Controls include return on assets, interest coverage ratio, leverage ratio, capital, and size (log of revenues).

Emission intensity. The same results hold qualitatively if we employ emission intensity as our explicative variable of interest instead of energy intensity.[8] In the case of returns (Table 4), the estimated coefficients are statistically significant and highly stable across FE specifications: a 1 p.p. increase in emissions (per market value) reduces the post-war company's equity return by approximately 0.12 to 0.16 p.p.. The same picture is displayed in Table 5 for CDS spreads: a 1 p.p. increase in emissions (per market value) increases the default risk by approximately 0.24 to 0.36 p.p.. Figure 1b confirms this result from a graphical perspective, as carbon intensive firms underperform their peers with less emission per market value both in terms of equity returns (left plot) and CDS spread variation (right plot).

3.2 VAR analysis

In this Section, we present a method, similar in spirit to a stress test exercise, to gauge the potential impact of higher energy prices on firms' future financial soundness. We resort to firm-level VAR models, to produce forecasts of firms' CDS spreads conditional on electricity prices. We estimate a weekly VAR model for each company, with the aggregate energy price as our exogenous variable, and the Eurostoxx and Vstoxx volatility indexes as additional controls. We perform the analysis since the start of 2022 and employ a Bayesian estimation under standard Minnesota prior with four lags. We obtain VAR's forecasts for the CDS spreads over the next 3 months conditional on the assumption that energy prices remain at the peak recorded in the last week of July.

Our method allows us to estimate how firms' implied default probabilities (PDs) would change in response to a sustained period of high energy prices. We find a marginal increase in corporate PDs over the next three months in aggregate terms, but, notably the number of firms losing the investment-grade status would be non-negligible.[9] Default risk has already markedly increased since the beginning of the war, as shown by the distribution of CDS-PDs in Figure 2. In our scenario , there would be a further increase in insurance costs against rising default risk: PDs would raise on average from 1.85% at the end of July (end of our sample time span) to 2.15% after 3 months (stress test period). The implied distribution of PDs shift to the right does not appear dramatic, likely reflecting a deterioration of firms' viability due to the energy shock already internalized in default probabilities. However, looking at the firm level detail, 71 firms out of 355 would record an implied PD larger than 3%, the most affected industries being chemicals, food & staples retailing, machinery, metals & mining, real estate management & development, and automobiles.[10] As a comparison, the corresponding amount of firms with an implied PD

[8] The same holds also when we employ gas intensity revenues, albeit the sample size greatly shrinks due to data availability.

[9] The PD is approximated using the following formula: PD = CDS / (1-R), where CDS is the quotation of the CDS in basis points, R is the recovery rate set equal to 40%.

[10] The 3% PD threshold approximately corresponds to the cutoff for investment grade companies based on Moody's Risk Calc model (5-year horizon).

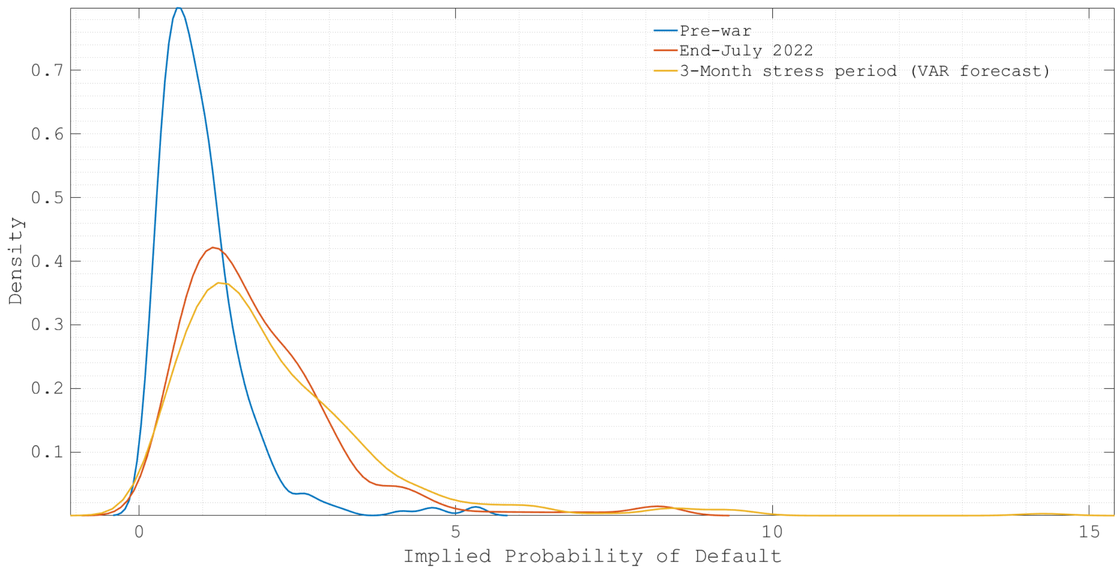


FIGURE 2: ***CDS-implied PDs***. *Density of the implied PDs extracted from corporate CDS spread at the onset of the war, at the end of July, and after a 3-month stress period of sustained electricity prices (VAR-exercise).*

larger than 3% was equal to 12 at the onset of the war and 45 at the end of July 2022.

4 Conclusions

Our empirical analysis highlights that the dramatic energy shock induced by the war in Ukraine is already reflected in firms' financial performances and may soon materialize in real terms. The larger the energy consumption or the carbon emission intensity of firms, the more negative their financial performances since the outburst of the Ukraine war. In light of the recent development in the European gas market, involving the indefinite suspension of the Nord Stream I pipeline, the channel we have identified may strengthen and hit European firms even more strongly.

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