Do responsible practices lead to higher firm productivity? Evidence from Europe

Stefano Piserà
University of Essex and University of Udine

Luca Gandullia
University of Genoa

Claudia Girardone*
University of Essex

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Abstract

This study examines the combined and individual effects of the Environmental, Social, and Governance (ESG) dimensions of Corporate Social Responsibility (CSR) on firm productivity. We focus on a sample of non-financial firms operating in 15 European countries over nearly two decades (2002–2018), and provide evidence that total ESG scores, as well as their three sub-pillars, are associated with higher levels of Total Factor Productivity (TFP). We analyse the relationship through various angles addressing potential endogeneity and selection concerns. Our evidence reveals that the ESG-TFP link is stronger during the post- financial crisis economic slowdown and that the effect is mainly led by firms' environmental performance. We confirm this result in a quasi-natural experiment setting, built around the adoption of the international treaty on climate change adopted in Paris in 2015 (the 'Paris Agreement'). Our results offer precious insight to policymakers and regulators on the potential productivity advantages deriving from firm sustainable practices adoption.

Keywords: Corporate Social Responsibility; Environmental Social and Governance Scores; Paris Agreement; Total Factor Productivity European Firms.

JEL Classification Codes: G34; D24; G30; H4.

* Corresponding author: Essex Business School, University of Essex, cgirard@essex.ac.uk

1. Introduction

During the last few decades, stakeholders' attention on firms' sustainable practices has placed increasing pressure on companies' social value creation. At the same time, the scale and scope of firms' sustainable engagement has raised fundamental questions about the relationship between Corporate Social Responsibility (CSR) and Corporate Financial Performance (CFP) (e.g., Hasan et al. 2018, Margolis et al., 2009). Defining CSR practices is not straightforward; the European Commission (2001), for example, describes them as: 'the responsibility of enterprises for the impact on society […] to integrate social, environmental, ethical, human rights and consumer concerns into their business operations and core strategy in close collaboration with their stakeholders'. Consistently, Environmental, Social and Governance engagement (ESG) scores, one of the most common measures of firms' CSR performance, has been extensively used by consulting firms, asset managers and researchers to identify firms' sustainable practices.

Some studies view CSR activities as a firm's investment (Kitzmueller and Shimshack, 2012), risk hedging strategy (Cheung, 2016) or as a mean to enhance firm value (Servaes and Tamayo, 2013) and productivity (Hasan et al., 2018). Jiao (2010) explains how a positive effect of CSR on corporate performance is consistent with the view that CSR represents an investment in intangible assets, such as reputation and human capital, that contributes to enhancing firms' competitiveness. These issues are increasingly relevant, especially for firms that perceive CSR as a key factor to better allocate resources and social capital (Russo and Perrini, 2010). However, in the literature it is possible to identify two alternative outcomes derived from the relationship between stakeholder welfare and value that largely depend on the conjectures they make about the former. If stakeholder welfare is viewed as investments' intangibles such as reputation and human capital (e.g., Zingales, 2000), the relationship with value is positive; in contrast, if stakeholder welfare derives from managers' personal interests, the relationship with value is negative (Cespa and Cestone, 2007).

Several studies (e.g., Porter, 1991) show that CSR investments are actions that address environmental or social impact that at the same time can improve the quality of the private products offered, increase the productivity of related processes, and ultimately benefit a firm's or industry's competitiveness. Firm-level productivity is usually measured as Total Factor Productivity (TFP), that is defined as the firms' efficiency level to produce economic output by combining capital, labour, and intermediate inputs. A recent study by

Hasan et al. (2018) finds that TFP is one of the key drivers in explaining firms' value. Nevertheless, the literature is mixed around whether CSR impairs it or enhances it; in addition, there are different ways to measure firms' productivity. One shared reason why firms invest in CSR is that doing so enhances their profitability and value, a relationship often referred to as "doing well by doing good" (Dowell et al 2000; Guenster et al., 2011).

This study provides several important contributions to the extant literature. First, we are the first to empirically investigate the link between the environmental, social and governance components of CSR on firms' TFP. The literature on CSR and firms' TFP is scant and is mainly focused on firms' value and financial performance. To the best of our knowledge, only a handful of studies exist on the relationship between sustainability and firm total productivity, but they usually concentrate only on single aspects such as Antonietti and Marzucchi (2014) for the environment; and Parrotta et al. (2016) for labour diversity. Hasan et al. (2018) is the only study that we are aware of, that uses the CSR-TFP relationship as a moderating role in explaining the CSR-Tobin Q link, using a model where TFP mediates the relationship between corporate social and financial performances. Therefore, our study contributes to this emerging strand of literature using European firms' data to investigate the relationship between ESG, its single environmental (ENV), social (SOC) and governance (GOV) components, and TFP.

Second, this study uncovers the ESG-TFP nexus, investigating if it can be considered as a strategic factor in enhancing firms' productivity, especially during periods of relatively low economic growth. More precisely, by disentangling ESG components, we shed light on the changing impact of environmental (ENV), social (SOC) and governance (GOV) factors especially in periods of economic recession. We test if and under which conditions the relationship is valid during the post-crisis productivity slowdown that characterised the aftermath of the global financial crisis (GFC). In Europe, productivity differences across countries have amplified especially after 2012 (ECB, 2017) as the eurozone experienced the sovereign debt crisis that affected member states in different ways. Some authors (Hall, 2015; Reifschneider et al., 2015) interpret the decline in productivity as an endogenous consequence of the global financial crisis; others observe that the productivity slowdown that followed it, was a consequence of suboptimal levels of R&D that led to a contraction of demand both in the US (Anzoategui et al., 2019) and European firms (Chiacchio et al., 2018). A report by ECB (2017) reveals that, in addition to the persistent absence of adequate investment capital, the productivity slowdown post financial crisis was also due to the joint effect of a concentration of the recovery in consumer-driven sectors characterized by low capital-labour substitution and lack of liquidity. Therefore, understanding the dynamics of the CSR-TFP nexus becomes increasingly important given with recent evidence that documents a significant deceleration of TFP in the euro-area after the global financial crisis (Van Ark, 2014).

Third, the focus on the European Union (EU) countries allows us to examine in detail firms' productivity responsiveness to the adoption of the 2015 Paris Climate Agreement, a legally binding international Treaty on climate change, that aims to keep global warming well below 2 ℃. Using a Differences-In-Differences (DID) framework, we explore the environmental engagement-productivity nexus after the adoption of the 2015 Paris Agreement by firms operating in European countries. As far as we know, this has not been done before in the literature and it is of particular interest in Europe as there have been several important developments over the past few years. These include an ambitious policy agenda on sustainable finance, that encompasses an action plan on financing sustainable growth (EC, 2018) and a roadmap known as the 2019 European Green Deal. Similarly, in 2021, the European Commission adopted a broad set of policy aimed at strengthening the transition to sustainable activities to achieve a climate neutrality by 2050 (EC, 2021).

Our findings support the literature showing that ESG practices create economic value by better allocating scarce firm resources to activities addressing the demands of key stakeholders (Porter and Kramer, 2006). Specifically, by considering TFP as a collection of productive intangibles, and in the spirit of Hasan et al. (2018), it appears that CSR practices act as a channel through which firms' stakeholders enhance the accumulation of such intangibles, ultimately leading to an increase in TFP. The increase in firms' productivity through sustainable practices appears crucial during the post-crisis productivity slowdown period, confirming not only the ESG-TFP nexus but also the link between sustainability practices and resilience. Additionally, we find that environmental performance is the ESG component that is most correlated to firms' productivity, suggesting the need for more environmental engagement from EU firms. This is confirmed also by results related to the Difference-in-Difference analysis built around the adoption of the 2015 Paris Agreement; higher productivity is reached for firms more aware engaged on environmentally friendly activities.

In terms of policy implications, overall, our evidence supports the regulatory commitment on environmental and social engagement for European companies. It also provides important indications for credit institutions for their loan origination process, given their critical role in facilitating the transition of businesses towards sustainability particularly in the period of recovery from the Covid-19 pandemic.

The remainder of this paper is organised as follows: Section 2 reviews the literature and summarizes the main hypotheses. Sections 3 describes the methodology, data and variables used in the empirical analysis. Section 4 discusses the main results and section 5 provides the robustness checks. Section 6 concludes and provides the main policy implications.

2. Literature review and hypothesis development

2.1 CSR engagement and overall firm performance

The literature on the relationship between firms' CSR engagement and performance finds its roots on the dominant paradigm recognized as stakeholder theory (Margolis and Walsh, 2003) which poses its assumptions on a strong moral basis (Freeman et al., 2010). More precisely, managers receive pressure from different stakeholder groups such as customers, employees and the community, to be actively engaged on CSR activities (McWilliams and Siegel, 2011). Consistently, firms are aware that their stakeholders can affect directly or indirectly firms' revenues and therefore, returns to shareholders (Berman et al., 1999). In addition, the literature shows a positive relationship between CSR practices and the creation of moral capital (Godfrey et al. 2005) and the social legitimacy, which ultimately positively affects the stakeholder well-being, widely defined as investments intangibles such as reputation and human capital (e.g., Zingales, 2000).

A relatively large stream of research has focused on CSR's role in terms of effects on firm performance and risk, exploring its impact within and outside the firm. Cheng et al. (2014) finds that better CSR performance is associated with superior stakeholder engagement that ultimately lowers agency and transaction costs and increases the revenue or profit- generating potential of the firm. However empirical evidence is not unambiguous and is subject to several methodological limitations (Margolis et al., 2009). A rich body of literature emphasizes the implications of sustainable practices within financial (see e.g., Humphrey et al., 2012) and non–financial corporations (Margolis and Walsh, 2003), mainly in terms of risk hedging strategies (Cheung 2016), firm value maximization (Hasan et al., 2018, Zolotoy et al.,2019), cost of debt (La Rosa et al., 2018) and equity reduction (see e.g Ng and Rezaee, 2015).

Jiao (2010) argues that a positive effect of CSR on corporate performance is consistent with the view that CSR represents an investment in intangible assets, such as reputation and human capital, that contributes to enhancing firms' competitiveness. Additionally, the sustainability of an organization is strictly related to the economic, social and ecological aspects, so that they can become integrated into the design of new products, process and organization structure (Rennings, 2000). For example, considering the labour-oriented policies side of firms' CSR practices, among the main benefits derived from employees' wellbeing programmes are the greater potential of workforce loyalty, lower absenteeism, boosting firm productivity, and, finally, increasing market valuation (Falaye and Trahan 2011).

2.2 The CSR-TFP nexus

At a macro level, Total Factor Productivity (TFP) has been recognized as one of the most important variables in generating and predicting economic growth (Saliola and Seker, 2011). Specifically, TFP was found to be strongly positively connected to openness to trade and production chains (Grossman and Helpman, 1991), in the presence of foreign direct investment (FDI) and R&D investments (see e.g Chiacchio et al., 2018). During the post-crisis productivity slowdown years in Europe, and especially after 2012, the productivity differences amongst countries of otherwise similar levels of economic development have amplified (ECB, 2017). At a micro level, according to e.g., Foster et al. (2013) after the financial crisis of 2007-08, European firms engaging in innovative practices, have achieved better productivity performance. This evidence is strongly supported by the European Commission, that by adopting in 2010 the "Europe 2020 strategy" for a smart, sustainable and inclusive growth, has tried to achieve greater innovation by managing resources more efficiently (European Commission 2010).

There are several reasons why it is interesting to investigate the CSR-TFP nexus. First, if CSR practices lower the cost of capital, by reducing the agency costs and asymmetric information issues (El Ghoul et al., 2011), more CSR should lead to a better allocation of saved resources. At the same time, firms more engaged in CSR practices experienced significantly lower capital constraints (Cheng et al., 2014) by raising funds from debtholders at a lower cost (Oikonomou et al., 2014). Secondly, socially responsible practices allow firms to build strong relationships with key stakeholders, improving the capacity to create new technologies, develop new products, and explore new markets (Branco and Rodrigues, 2006) as well as enhancing workforce loyalty, lower absenteeism, and therefore boosting firm productivity (Falaye and Trahan, 2011). Thirdly, corporate sustainable practices influence demand fluctuations, stimulate consumer demand, and ultimately positively affect the firm production function (see e.g., McWilliams and Siegel, 2001), confirming the assumption by which CSR activities positively affect the trust of stakeholders at all levels (Lins et al., 2017). As argued by Sapienza and Zingales (2012) "the decision to invest in stocks requires not only an assessment of the risk-return trade-off given the existing data, but also an act of faith (trust) that the data in our possession are reliable and that the overall system is fair", making CSR of vital importance to restore, strength and improve firms' image after and during crisis periods (Lins et al., 2017). Finally, investing in social responsibility can help to increase efficiency processes, leverage fundamental intangible resources, attract better employees finally increasing firms' labour productivity (Branco and Rodrigues, 2006).

A vast amount of literature related to CSR emphasises its primary role as an effective corporate governance mechanism to alleviate conflicts among various stakeholders and reduce agency costs (Freeman, 1984, El Ghoul et al., 2011). In fact, according to the stakeholder theory, high-quality relationships with key stakeholder's positively affect firm productivity, reduce transaction costs (Cheng et al., 2014), firm's debt (see e.g., La Rosa et al., 2018) and thus firm's equity financing (see e.g., Ng and Rezaee, 2015). Falaye and Trahan (2011), studying the impact of labour-friendly policies on productivity and profitability of Fortune list US firms from 1998 to 2005, reach similar conclusions on the benefit of such policies on the measured Cobb-Douglas TFP. Moreover, the authors show the managerial self-interest reasons in firms' labour-friendly practices, concluding that firms adopting such policies are associated to higher long term TFP and positive market reactions. Cho et al. (2013), by focusing on US listed firms from 2003 to 2009, empirically prove the role played by CSR in reducing information asymmetries. Specifically, by using the bid-ask spread as a proxy, they argue that both positive and negative CSR practices seem to reduce the information asymmetry among investors. Moreover, negative CSR scores seem to be more effective in explaining the information asymmetry changes, implying that the market participants are particularly concerned about low CSR practices. Equally, investors and in general all stakeholders may leverage CSR information to avoid adverse selection problems and thus enhancing information efficiency, especially among less-informed investors (Cho et al., 2013).

Overall, thanks to its direct impact on stakeholders involved in the production process, CSR seem to act as a mean to boost firm productivity. Based on this evidence, in this paper we investigate the role of CSR and its components in enhancing firm productivity in Europe, especially during a period of productivity slowdown. To the best of our knowledge, only a handful of papers explore the role of CSR in enhancing firm productivity, but mainly focus on a single aspect of CSR. For example, Antonietti and Marzucchi (2014), focus on the pre-crisis period 2001-2006 and find a positive impact of Italian manufacturing firms' green investment strategies on productivity calculated using a Cobb-Douglas functional form. The authors argue that their results stem from the reduction of three cost factors: sunk costs related to export practices (such as compliance and regulation costs); possible stakeholders' litigation costs; material and energy use. Looking at the social aspect of the CSR principles, such as the labour diversity, inclusion and firm productivity relationship, Parrotta et al. (2016) find mixed result about ethnical inclusion issues and TFP. By investigating Danish firms' productivity from 1980 to 2005, they find a negative correlation between ethnic diversity and TFP. On the other side, they find a positive association between educational and demographic diversity and firms' productivity.

Similarly, Hasan et al. (2018) focus on productivity and CSR using a broader concept. The authors examine on the mediating role of TFP on strengthening firm value, shedding light on the commonly recognized link between CSR and firm performance. Using a sample of publicly traded US firms from 1992 to 2009, they find that firm productivity moderates the positive relationship between corporate social and financial performance. However, the authors find that the CSR-TFP link strictly depend on the firms' operating economic context.

Last but not least, Darrough et al. (2019) explore the existing relationship between corporate welfare policies and firm-level TFP measured using a semi-parametric regression model as in Olley and Pakes (1996). By focusing on listed US companies from 2003 to 2013 they reveal the pivotal role played by CSR in managing moral hazard problems connected to unemployment insurance benefits, by reducing its negative effects on firm productivity. Therefore, their results confirm the assumption that good corporate behaviour, by helping firms' employees, enhances firm productivity.

Consistent with recent findings in the literature we hypothesise a positive role played by the CSR score and its environmental, social and governance components, in enhancing the efficient allocation of production input factors, and thus firms' TFP. Our prediction is based on the stakeholder theory, which supports the creation of moral capital and social legitimacy ultimately affecting the wellbeing of firms' stakeholders. Hence our first hypothesis can be formulated as follows:

H1: Firms' ESG scores and its individual pillars positively affect firms' TFP

As discussed above, the global financial crisis impacted on consumer and investor trust on the financial system (Sapienza and Zingales, 2012). In turn, a decline in trust can impact both shareholders' and stakeholders' investments decisions, thereby leading to a contraction in consumer demand: the former are immediately affected through a reduction of the credibility of firm financial information that ultimately exacerbate asymmetries. Similarly, the lack of trust affects stakeholders (e.g., employees, customers etc.) due to their interaction with the firm through implicit or incomplete contracts that during periods of low firm trustworthiness could not be honoured (Lins et al., 2017).

Anzotegui et al. (2019) maintains that one of the interpretations leading to a productivity drop in US after the recession is the contraction in demand. Like the US, the productivity gap rose during the post-crisis period (after the 2012) in Europe (Chiacchio et al., 2018), due to a joint consequence of a concentration of the recovery in consumer-driven sectors characterized by low capital-labour substitution rate, the lack of liquidity, and an absence of adequate investment capital (ECB, 2017). According to Bernabou and Tirole (2010), stronger stakeholder engagement reduces the likelihood of short-term opportunistic behaviour by managers, restoring and improving firm reputation and credibility, ultimately addressing the demand of key stakeholders (Porter and Kramer, 2006). Similarly, Godfrey (2005) argue that CSR investment generate goodwill and moral capital among stakeholder, and that finally may preserve firms' financial performance. Specifically, the moral capital creates relational wealth among different stakeholders' groups (e.g., employees, community, and regulators) providing trust and credibility on all the economic value chain, finally increasing firms' attractiveness for investors (Godfrey 2005), allowing firms' to better allocate resources (Russo and Perrini

2010) which finally boost their productivity. Overall, in line with the literature above and within the 'stakeholder theory framework', we conjecture that a firm' commitment in socially responsible practices should lead to higher firm total factor productivity and we expect this evidence to emerge particularly during periods of productivity slowdown. Thus, the second hypothesis can be formulated as follows:

H2: The impact of firm ESG score and its single pillar, is stronger during post-crisis productivity slowdown.

With the adoption of the Paris Agreement on 12 December 2015, all 196 signatory countries are committed to limit global warming to well below 2 Celsius grades, if compared to pre-industrial levels. To reach this target they must drastically reduce the global peaking of greenhouse emissions and therefore, make pressure on the corporate sector to achieve a climate neutral position.[1] Importantly, the Paris Agreement also recognises the critical role of Climate finance, and therefore of financial and economic actors involved in the production process, because of the large-scale investments it can support. Due to its huge impact on the social and moral purposes of European financial markets (and not only), the 2015 Paris Agreement represents an unprecedented increase in public pressure on firms' climate change practices.

Godfrey (2005; 2009) argues that a socially desirable level of responsible engagement generates moral capital providing "insurance-like" protection to firms more aware of sustainability. Therefore, a government increase in socially desirable level of sustainability engagement, might have two main consequences; (i) representing a pure cost of compliance for companies and so reducing their value (Chen et al., 2018); (ii) rewarding firms more engaged in specific environmental or social practices hence enhancing their performances (Chiaramonte et al 2021). However, to the best of our knowledge, there is no empirical contribution so far emphasising the productivity consequences of such agreement among best (worst) environmental firms' practices in Europe. In this paper, we empirically test the possibility of a "rewarding

[1] The 2015 Paris Agreement is the first binding agreement requiring a common effort to fight climate change, that will likely bring about major social and economic transformations. After the first cycle of five years of national policy and plans, each of the signatory countries must communicate to the United Nations Framework Convention on Climate Change (UNFCCC) their plans for the development of nationally determined contributions (NDCs). These are non-binding national plans to take climate actions, such as climate targets for greenhouse gas emission reductions and all related public policies aimed at implementing the achievement of the global targets set out in the Paris Agreement.

effect" of the 2015 Paris Agreement on companies more engaged in environmentally friendly activities, confirming the prediction of the moral capital theory framework. Thus, the third hypothesis can be formulated as follows:

H3: The 2015 Paris Agreement yields a 'rewarding effect' in terms of productivity for firms more engaged in environmentally friendly practices.

3. Data and empirical methodology

3.1 Data sample

We select a sample of 560 European Union listed firms from 2002 to 2018 and the environmental (ENV), social (SOC), governance (GOV) scores (individual and aggregate) provided by Thomson Reuters' Refinitiv, as a proxy of the level of CSR (see e.g., Cheng et al., 2014; Liang and Renneboog, 2017). Therefore, we use a weighted average of ESG scores ranged from 0 to 100 (highest ESG level). Our dataset covers non-financial companies operating in 15 European Union countries (Table A.1). Table 1 reports the descriptive statistics and Table A.2 shows the correlation among variables, revealing no multicollinearity bias. Additionally, we employ alternative models and robustness checks that we have carried out to minimise endogeneity issues (Section 5). All results are qualitatively similar to our baseline model.

[Insert Table 1 about here]

Our sample spans a relatively long period starting in 2002 and including the global financial and the European sovereign debt crisis. In this paper, we test the role of CSR in enhancing firm productivity especially during time of lower growth and adopt the ECB definition (ECB, 2017) of post-crisis productivity slowdown period.[2] In the post-crisis years in Europe, productivity differences amongst economies of otherwise similar levels of economic development have amplified, especially after 2012. However, in the literature several hypotheses have been made trying to address the post-crisis productivity slowdown issue. For example,

[2] We also run our analysis by employing an alternative definition of post-crisis period (from 2009 to 2015) (Chiacchio et al., 2018). Results are qualitatively similar and available upon request.

Reifschneider et al. (2015) hypotheses that the decline in productivity may be due to the decline in firms' productive investments, such as fixed capital and intangible assets, interpreting it as an endogenous consequence of the recession. Nevertheless, European institutions have tried to fill the post-crisis TFP drop by adopting in 2010 the Europe 2020 strategy for a sustainable growth. Specifically, the Europe 2020 program is aimed at supporting the achievement of greater environmental and social innovation among firms through a more efficient resources management. Therefore, to test the role played by CSR during the post-crisis productivity drop, we split our sample into two periods: the pre-slowdown period (from 2002 to 2012); and the slowdown productivity period (from 2013 to 2018), testing the statistical significance of results

3.2 Firm-Level TFP

TFP is usually obtained as the residual from a Cobb–Douglas production function with capital, labour, materials as input factors and value added as output (Hasan et al. 2018). Consistently, it may be estimated by employing parametric and non-parametric techniques, with the second methods being widely recognized as more robust to endogeneity concerns. For example, parametric methods may suffer of reverse causality of inputs and high correlation with productivity components, which can be addressed by semi-parametric methods (Tsionas and Polemis 2019).

Therefore, in this paper, we estimate the TFP using two semi-parametric methods: the Wooldridge's (WD) TFP (2009) and the Levinsohn and Petrine (L-P) TFP (2003). The WD TFP estimation computes firm productivity with a Generalized Method of Moment (GMM) method. Unlike the fixed effect estimator (see Olley and Pakes, 1996) IV methods do not rely on strict exogeneity of the inputs for consistent estimation. However, the consistency of the IV estimator requires the satisfaction of three conditions on the instruments that: (i) need to be highly correlated with the endogenous regressors (in this case production inputs); (ii) must not be included in the production function; (iii) must not be correlated with the error term (Greene, 2008). Satisfying these three conditions to compute firm productivity is not a trivial process.

Following previous literature (Hasan et al., 2018, Yasar et al., 2018), we obtain both TFP measures as the residuals of the WD and L-P production functions where the firms' input factors are fixed capital (as proxy of capital factor), number of employees (labor factor), and the difference between total expenses minus labor expenses (material factor) as input factor. The descriptive statistics of estimated average TFP levels is reported in Table 1. The two measures of firm productivity show a similar standard deviation but a slightly different average level of distribution.

[Insert Table 1 about here]

Figure 1 plots the trend for our two measures of firms' productivity from the 2002 to the 2018, confirming previous findings (ECB, 2017) on the decreasing behaviour of TFP in the post-crisis years (after 2012). The TFP trend it is possible to identify two main spikes: one caused by the GFC (after 2007); and the other after the 2012.

[Insert Figure 1 about here]

3.3 CSR measurement

Corporate responsibility is commonly measured through firm Environmental (ENV), Social (SOC) and Governance (GOV) reported information, usually captured by ESG rating of listed companies (Liang and Renneboog, 2017). The ESG concept firstly appeared in the UN Principles for Responsible Investment (PRI) and in several firms' non-financial reports (Davis and Stephenson, 2006), and due to the lack of alternative valid definition, it has becoming to be widely used by researchers to proxy for CSR engagement (Liang and Renneboog, 2017, Chiaramonte et al., 2021).

More precisely, ESG scores are composed by the following firm sustainable practices: Environmental (ENV) activities, that reflect firm efforts towards sustainable use of resources, emissions, and innovation in reducing environmental footprints for customers. Social (SOC) dimension, that focuses on human capital (job satisfaction, workplace health and safety, diversity, equality). Finally, Governance (GOV) aiming at compliance with best practices in corporate governance, the equal treatment of shareholders, the integration of non–financial objectives in strategic and managerial decisions. ESG data are provided to transparently measure a firm's relative performance and practices across 10 dimensions (see Table A.3) based on company selfreported information (e.g., annual reports). Table A.3 shows the taxonomy of ESG scores, their definition, calculation, and weights used for computation. All ESG scores range between 0 and 1, with higher values indicating stronger performance. For our purposes, we expect that both aggregate and single ESG scores are positively correlated to firm total factor productivity.

Table 1 reports the descriptive statistics and shows that our target variables, the ESG, ENV, SOC and GOV score take a distribution broadly in line with previous research, both in terms of average values and variability (see e.g Liang and Renneboog 2017). More precisely, mean values range between 0.53 and 0.62 demonstrating that there is room for adopting ESG practices at firm levels and improving ESG scores further.

3.6 Empirical Methodology

Our empirical strategy is composed of two-step. The first step investigates the link between CSR practices (proxied by ESG scores) and firm TFP by employing an OLS estimator (Hasan et al., 2018) with time, industry and country fixed effects. The baseline model is shown in equation (1):

$$TFP_{it} = c + \beta_1 ESG_{i.t-1} + \boldsymbol{\beta_2}'\mathbf{X}_{i,t-1} + \boldsymbol{\beta_3}'\mathbf{Z}_{i,t-1} + \upsilon_t + \gamma_i + \delta_t + \varepsilon_{it.} \tag{1}$$

where our dependent variable is proxied by two different firm productivity variables (*TFPit)* for firm *i* at time *t* -1 (the year before). The OLS includes year, industry and country fixed effects to control for time-invariant factors. The use of fixed effects captures unobservable heterogeneity and omitted factors that are related to both ESG and firm productivity.

The second step is aimed at testing the impact of the 2015 Paris Agreement on firms' productivity employing the following difference in difference (DID) regression:

$$TFP_{it} = c + \beta_1 D\_SHOCK + \beta_2 D\_TREATED + \beta_3 D\_SHOCK{*}D\_TREATED + \boldsymbol{\beta_4}'\mathbf{X}_{i,t-1} + \boldsymbol{\beta_5}'\mathbf{Z}_{i,t-1} + \upsilon_t + \gamma_i + \delta_t + \varepsilon_{it.} \tag{2}$$

where the dummy D_SHOCK representing the adoption of the 2015 Paris Agreement, takes a value of 1 for post-treatment years (2016–2018) and 0 otherwise. The dummy D_TREATED takes a value of 1 for firms above average values of ESG scores in the year before of the shock (2015) and 0 otherwise, and D_SHOCK*D_TREATED represents their interaction. Therefore, the coefficient of D_SHOCK*D_TREATED is our target variable. We further control for a set of firm and country characteristics, as well for the same fixed effects employed in our baseline model.

Following the relevant literature (see e.g Hasan et al. 2018), we include a set of firm- (**X**) and country- (**Z**) specific control variables that may have an impact on firm TFP (see Table 1 for the descriptive statistics). Specifically: asset size, measured as the natural logarithm of firms' total assets (SIZE); asset turnover, measured as sales to total asset growth ratio (SALES_GRW); and firms' indebtedness calculated as the total debt scaled by firms' total assets (LEV). At country level, we include a measure of industry competition using the Herfindahl-Hirschman index (HHI) calculated as the sum of the squared market share value (in terms of firm sales divided by industry sales) (see, e.g., Zang et al., 2010). As the level of globalization can affect firm productivity (Min and Smyth, 2014) we also control for the Kof index (KOF) of globalization provided by ETH Zurich Swiss economic institute (2019); finally, we include a measure of country economic development with the GDP growth ratio (GDP_GRW). All non-binary explanatory variables are lagged by one year to immediately start addressing potential endogeneity concerns. Moreover, we employ standard errors adjusted for heteroskedasticity and clustered at the firm-level (Cheung 2016; Anginer et al., 2018). Finally, c is a constant term and υ_i, γ_i, δ_t, ε_{it} are, respectively, time fixed-effects, industry fixed-effects, country fixed effects and the idiosyncratic error respectively.

4. Empirical Results

4.1 Baseline results

Table 2 illustrates the joint and individual impact of ENV, SOC and GOV factors on both proxies of firm productivity (TFP WD and and TFP L-P) during the whole period under investigation estimated using equation (1). As in Becchetti et al. (2016), we interpret these results as follows: an increase of one standard deviation of ESG, is associated with an increase of 0.5 % of WD TFP and of 0.9 % of L-P TFP, with respect to their sample means. Looking at the individual CSR components, results are similar and always point to positive and significant associations. Our findings are in line with previous studies showing a positive correlation between firms' CSR and TFP (Hasan et al., 2018). We interpret the positive impact of CSR and its components on firm TFP, as a confirmation of the validity of the stakeholder theory of firm's value maximization (e.g., Edmans, 2011) as set out in our first hypothesis (*H1*).

CSR can be considered as an effective corporate governance mechanism to solve conflicts among stakeholder groups by reducing agency costs (Cespa and Cestone, 2007). Accordingly, it can be interpreted as a concrete means to align managers' objectives with the organizational process and stakeholder demand (Freeman, 1984). From the production function perspective, inputs are not easily interchangeable and require cost-effective transformation of resources into firm-specific assets (Hasan et al., 2018). Due to the large number of stakeholders involved in the production process, such as firms' employees and all actors involved in the value chain, the governance-productivity connection became highly reliant on filling up the lack of firm-specific knowledge resources (Wang et al., 2009). Therefore, our results support previous studies stressing that superior CSR performance reduces stakeholder conflicts (Becchetti et al., 2016), which, by alleviating managerial opportunism (Benabou and Tirole, 2010) allows companies to bear more productive investments and resource maximization.

Looking at the control variables, our results show that firm productivity has a positive association with the variables SIZE, SALES_GRW, and KOF index of globalization and negative for leverage (LEV). We interpret the positive sign of firm size on TFP on the spirit of Halkos and Tzeremes (2007) who argue that size exerts an indirect impact on firms' productivity due to its positive effect on firm internal factors and end efficiency maximization. As for the sales growth, our result is consistent with the literature (Hasan et al., 2018).

More profitable and more globalized firms are usually also more productive, due to greater capability and resources to allocate intermediate factors.

[Insert Table 2 about here]

4.3 Results for post-crisis productivity slowdown period

Table 3 illustrates the results obtained by splitting the sample between the pre- productivity slowdown period (2002-2012) and post-crisis slowdown period (2013-2018). We observe that the magnitude of ENV, SOC and GOV score increases significantly from pre to during productivity slowdown. Interestingly the results are the same for the two chosen measures of productivity and suggest that in both cases, a change in one standard deviation of the ENV score is linked to a change of 0.7 % in TFP. Many observed that the financial crisis leads to a wide collapse in confidence and trust among market participants (e.g., Stiglitz, 2008). We interpret these results in light of the stakeholder theory framework, by empirically stressing the relevance of CSR practices as a mean to restore firm reputation and credibility, as well as trust among stakeholders (such as employees, community etc.) and profitable inputs allocations, especially during a period of general lack of confidence such as after the global financial crisis.

[Insert Table 3 about here]

The changing relevance of CSR components between the two sub- periods, reflects the increasing perceived sensitivity of firms' environmental awareness, and thus, consistently with previous studies, environmentally friendly activities are associated with better stakeholder engagement (Bouslah et al., 2013). Overall, we find that the beneficial effect of environmental, social and governance sustainability practices, emerges especially during periods of productivity slowdown, and this can possibly be attributed to the development of new environmental technologies, managerial processes that optimize the use of resources, and most importantly, better address the demand of key stakeholders.

4.4 Effects of the 2015 Paris Agreement

To examine the "rewarding effect" of the 2015 Paris Agreement on firm TFP levels, we employ differences-in-differences (DID) regressions, over 2011–2018, considering the sub-period 2016-2018 as the post-shock years. In this setting, our target variables include the dummy shock (D_SHOCK), that takes the value of 1 for post-treatment years (2016–2018) and 0 otherwise; the dummy treated (D_TREATED), that takes the value of 1 for firms above median values of ENV, SOC and GOV in the year of the shock (2015) and 0 otherwise; and their interaction (D_SHOCK*D_TREATED). To address the potential bias arising from treated (T) and control (C) groups' heterogeneity (i.e., firms above or below median value of ESG scores), we employ a propensity score matching (PSM) procedure (Rosenbaum and Rubin, 1983) with the set of non-binary firm-level controls before running the DID regression. To identify the control group, we first run a logit model (Panel A of Table 4) to calculate propensity scores using the dummy variable D_HIGH_ESG respectively (equal to 1 for firms above the median values of ESG scores and 0 otherwise in the pre-shock years 2011-2015). For this purpose, we employ all non-binary firm-level control variables (SIZE, SALES_GRW, LEV, HHI, KOF, GDP_GRW) including baseline model fixed-effects (Bhandari et al., 2017). We then match, without replacement, each treated firm to a control firm using the Caliper 1% matching (see e.g Bhandari et al., 2017)[3]. Our final DID sample consists of 86 treated firms and 99 control firms.

Table 4 shows that the enhancing effect of ENV and GOV scores is stronger for more engaged in environmentally and managerial responsible practices, especially after the 2015 Paris Agreement. Furthermore, we do not find any significant association for the SOC score. Therefore, the results of the DID model support the rewarding effect of the recent increasing effort of Paris Agreement towards a reduction of climate pollution and externalities, especially during a period of productivity slowdown. Figure A.1 in the Appendix reveals that, in absence of the shock occurred in 2015, the trend in firm productivity is similar for both the treatment and the control groups, supporting the parallel trends' assumption.

[3] As shown in Panel B of Table 4 we find no significant difference between targets and their matches, confirming the reduction of individual differences and the related potential bias.

[Insert Table 4 about here]

Our DID results further confirm that by increasing the attention of investors on climate change risks and opportunities, the Paris Agreement has rewarded firms engaged in stakeholder-oriented activities, which leveraged their environmental and managerial strategic positions to boost productivity. More specifically, it confirms that companies more involved in ENV and GOV practices have been rewarded by stakeholders, boosting their TFP despite the period of relatively slow economic growth.

5. Additional tests and robustness checks

In this section, we test the validity of our findings, particularly concerning the behaviour of our ESG target variables, running a set of further analyses and robustness checks. Firstly, to overcome possible bias deriving from the sample selection bias, we run the Heckman (1978)'s two-step method (Wu and Shena, 2013).[4] Results in Table 5 confirm the significant and positive role of our target variable in supporting firm TFP thus corroborating the strength and unbiasedness of our baseline regression model.

[Insert Table 5 about here]

Secondly, unlike controlled experiments, because the complexity of business decisions is not random, estimators can be biased by overlooking unobservable confounding factors. For our empirical purposes, the strategic decision to reduce (increase) the ESG level (treatment) can be affected by some observable characteristics that also affect firms' profitability or risk. In such case, our conclusion about the treatment

[4] Specifically, to estimate this model: (i) in the first step we estimate the decision equation using a multinomial probit model, whose parameters are used to calculate the Inverse Mills Ratio (IMR), where the dependent variables is a dummy (D_ESG) equal to 1 from the year in which a firm started to disclose its ESG practices and 0 otherwise (Table A.5); (ii) in the second step (Table 5) estimates the Heckman model, by including the IMR among the regressors. Full results are available upon request.

effect can be biased. To tackle this issue, in line with Chen et al. (2020), we employ a propensity score matching (PSM) to control for possible confounding factors affecting firms with high ESG values (above the median value of ESG score) and firms with low ESG values (below the median value of ESG score). Therefore, we match, without replacement each treated firm (high ESG firms) to a control firm using the Caliper 1% matching (low ESG firms) (see also Bhandari et al., 2017). Using this matching method, the panel B of Table 6 confirms that the impact of ESG, ENV, SOC and GOV score on firms' productivity (TFP) is consistently positive and significant. Compared to control firms, treatment firms have a higher TFP (Panel A table 6).

[Insert Table 6 about here]

Thirdly, we check the robustness of results to potential endogeneity bias stemming from reverse causality, omitted variables and measurement error. For instance, companies with better financial performance, being more profitable, may be prone to engage more in CSR practices (Bénabou and Tirole, 2010). We alleviate these endogeneity concerns using both the instrumental variables (IV) GMM estimator (Zolotoy et al. 2019) (Table 7), and an alternative definition of ESG scores (Table 8). For the IV (Table 7)[5] we follow the relevant literature (see e.g., El Ghoul et al. 2011, Dumitrescu and Zakriya, 2021) and employ as instruments of our target variable (ESG score) the industry peers' ESG, ENV, SOC and GOV score. The rationale behind this instrument is that it is found to be correlated with ESG scores (the instrumented variable) and is unlikely to have a significant effect on individual firms' TFP (the dependent variable).

Results indicate that the Cragg-Donald F-test statistics are all higher than the critical value of 16.38, with p-values smaller than 0.01 in all specifications (Table 7). The weak instrument hypothesis test (i.e., testing for the relevance of the IV in the first stage) and the higher F-test (lower p-values) indicate a rejection of the null: our IVs is strongly correlated with our endogenous variables, supporting their relevance. Looking at the coefficients of our target variables (ESG, ENV, SOC and GOV) in Table 7, we confirm a positive and strongly statistically significant relationship for all variables of interest.

[5] To avoid the length of the paper we show the first stage of IV regressions in the appendix (Table A.6).

[Insert Table 7 about here]

Further, we test the consistency of our results using two alternative CSR score definitions, provided by Thomson Refinitiv' and Bloomberg database in our baseline econometric setting. Firstly, we employ the ESG combined score (ESG COMB) a measure of firms' sustainable engagement which considers not only firms' ESG practices, but also the controversies related to it. According to Thomson Reuters Refinitiv, the ESG combined score "overlays the ESG Score with ESG controversies to provide a comprehensive evaluation on the company's sustainability impact and conduct in near real time". The aim of this score is to 'mark down' the ESG performance score based on negative media stories related to bad firms' practices or scandals. Finally, we test our results by employing the Bloomberg ESG score (BESG) that it is mainly focused on the level of transparency of related sustainability information disclosed by reporting entities. As shown in table 8, results confirm the robustness of our results.

[Insert Table 8 about here]

As a final check, we test the impact of ENV, SOC and GOV score on three alternative productivity measures: i) the Capital productivity (Cap P) measured as the ratio between firms' value added and capital; ii) the Labour productivity (Lab P), computed as the ratio between firms' value added and the number of firms' employees; iii) the more traditional Olley and Pakes TFP (O-P TFP). As shown in table 9, results reveal a statistically positive effect of firms' ESG practices on capital productivity, and on TFP computed following Olley and Pakes' methodology suggesting the strategical importance of firms' sustainability practices on efficient capital allocation.c

[Insert Table 9 about here]

6. Conclusions

This paper empirically investigates the joint and separate effects of environmental, social and governance scores (ESG) on firm-level TFP. We focus on Europe over a relatively long period that includes the post-crisis productivity slowdown. Our robust results show that both the composite ESG score and its pillars lead to higher firm TFP. Moreover, we stress that the positive effect of ENV, SOC and GOV components strongly emerges during the European productivity slowdown-period. When we further explore the ESG scores' individual pillars, our results reveal that greater effects are attributable to the environmental score. This finding is confirmed also by the results obtained using a DID setting, built around the adoption of the 2015 Paris Agreement. More specifically, it confirms that during the productivity slowdown period firms more engaged in ENV and GOV practices, were rewarded by the sign of the Paris Agreement, confirming the moral capital theory assumptions.

Overall, our results suggest that engaging in environmental, social and stakeholder-oriented governance practices are associated with a more efficient firms' production input allocation, resource management and costs reduction. Thus, they confirm that engaging in CSR practices in the non-financial sector is not only beneficial in terms of its impact on society but can also strengthen the firm-level productivity. We also find that, in times of weak productivity, CSR practices play a pivotal role in enhancing productivity and this, in turn, is usually associated to benefits in terms of economic growth.

Furthermore, our evidence reveals that sustainability performances should be materially considered by regulatory authorities, as it is very useful especially during periods of productivity slowdown. In particular, our findings support the recent European approach towards enhanced environmental and socially responsible practices among listed firms. However, these regulations apply only to relatively large firms, so more research should be carried out on smaller unlisted firms to design ways to incentivise them to engage more in ESG practices and disclosure. Future research should also look at whether firms that score best in terms of ESG are also committed to reduce their "brown assets" and to select high ESG scorers in their supply chains.

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Table 1 - Summary statistics

This table reports the summary statistics of our variables in (1) total period of analysis (2002-2018). Variable definitions are provided in Table A.4.

	Mean	Median	Std. Dev	P25	P75
TFP WD	5.433	5.345	0.501	5.125	5.640
TFP L-P	3.082	2.969	0.403	2.808	3.242
ESG	0.589	0.598	0.161	0.483	0.711
ENV	0.614	0.633	0.200	0.473	0.778
SOC	0.618	0.632	0.199	0.478	0.780
GOV	0.528	0.533	0.207	0.365	0.691
SIZE (Log)	15.528	15.465	17.728	14.313	16.849
SALES_GRW	0.067	0.050	0.186	-0.016	0.129
LEV	0.258	0.246	0.161	0.147	0.350
HHI	0.089	0.067	0.064	0.052	0.091
KOF	0.873	0.882	0.028	0.865	0.892
GDP_GRW	0.016	0.019	0.025	0.010	0.027

Table 2 - Baseline results on total period

This table reports the estimates of OLS model during the period 2002–2018. The dependent variables are TFP WD and TFP L-P which measures firm's total factor productivity (TFP). The target variables are the ESG, ENV, SOC and GOV score. Variable definitions are provided in Table A.4.Time, industry and country fixed-effect (FE) are included in all specifications. Firm clustered standard errors (SE) are reported in parentheses. The superscripts ***, **, and * denote coefficients statistically different from zero at the 1%. 5%. and 10% levels, respectively, in two-tailed tests.

	TFP WD				TFP L-P			
Variables	(I)	(II)	(III)	(IV)	(I)	(II)	(III)	(IV)
ESG (-1)	0.201***				0.184**			
	(0.064)				(0.071)			
ENV (-1)		0.148***				0.098**		
		(0.043)				(0.043)		
SOC (-1)			0.094**				0.098*	
			(0.045)				(0.053)	
GOV (-1)				0.075**				0.087**
				(0.035)				(0.041)
SIZE (-1)	0.102***	0.105***	0.109***	0.112***	-0.005	0.001	0.001	0.003
	(0.008)	(0.007)	(0.008)	(0.007)	(0.010)	(0.009)	(0.010)	(0.008)
SALES_GRW (-1)	0.132***	0.129***	0.126***	0.126***	0.125***	0.121***	0.120***	0.121***
	(0.024)	(0.024)	(0.024)	(0.024)	(0.028)	(0.029)	(0.028)	(0.029)
LEV (-1)	-0.315***	-0.315***	-0.323***	-0.314***	-0.168**	-0.169**	-0.176***	-0.166**
	(0.061)	(0.062)	(0.062)	(0.062)	(0.065)	(0.065)	(0.065)	(0.066)
HHI (-1)	0.133	0.102	0.159	0.132	0.298	0.284	0.322	0.298
	(0.234)	(0.238)	(0.230)	(0.230)	(0.236)	(0.237)	(0.232)	(0.231)
KOF (-1)	0.022**	0.023**	0.023**	0.021*	0.027*	0.027*	0.027*	0.025*
	(0.011)	(0.011)	(0.011)	(0.011)	(0.014)	(0.015)	(0.014)	(0.014)
GDP_GRW (-1)	-0.002	-0.001	-0.002	-0.001	-0.002	-0.002	-0.002	-0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cluster S.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N. of obs.	4,182	4,182	4,182	4,182	4,182	4,182	4,182	4,182
R-squared	0.824	0.823	0.822	0.822	0.657	0.655	0.655	0.655

Table 3 - Pre and during post-crisis slowdown period

This table reports the estimates of the OLS model during the pre- slowdown period (2002–20012) and the post-crisis slowdown period (2013-2018). The dependent variables are TFP WD and TFP L-P which measures firm's total factor productivity (TFP). The target variables are the ESG, ENV, SOC and GOV score. Variable definitions are provided in Table A.4.Time, industry and country fixed-effect (FE) are included in all specifications. Firm clustered standard errors (SE) are reported in parentheses. The superscripts ***, **, and * denote coefficients statistically different from zero at the 1%. 5%. and 10% levels, respectively, in two-tailed tests.

	TFP WD						TFP L-P					
	Pre slow down	Post slow down	Pre slow down	Post slow down	Pre slow down	Post slow down	Pre slow down	Post slow down	Pre slow down	Post slow down	Pre slow down	Post slow down
Variables	(I)	(I)	(II)	(II)	(III)	(III)	(I)	(I)	(II)	(II)	(III)	(III)
ENV (-1)	0.111**	0.181***					0.071*	0.115*				
	(0.043)	(0.062)					(0.040)	(0.066)				
SOC (-1)			0.053	0.124**					0.052	0.136*		
			(0.050)	(0.060)					(0.055)	(0.073)		
GOV (-1)					0.029	0.114**					0.028	0.137***
					(0.039)	(0.046)					(0.046)	(0.051)
Controls (-1)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cluster S.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N. of obs.	2,115	2,067	2,115	2,067	2,115	2,067	2,115	2,067	2,115	2,067	2,115	2,067
R-squared	0.850	0.821	0.849	0.819	0.849	0.820	0.690	0.666	0.690	0.667	0.690	0.668

Table 4 – Effects of the 2015 Paris Agreement

This table show the results of differences-in-differences regression run to verify the effects of the 2015 Paris Agreement on TFP. Firstly (Panel A) we employ a propensity score matching (PSM) procedure (Rosenbaum and Rubin, 1983) to reduce the potential bias arising from heterogeneity of treated (T) and control (C) groups, employing all non-binary firm-level controls (SIZE, SALES_GRW, LEV, HHI, KOF and GDP_GRW). The dependent variable (D_HIGH_ESG) equals 1 for firms above the median values of ESG scores (treated) and 0 otherwise. Panel B provides the univariate statistics on the effectiveness of the matching procedure; Finally, Panel C shows the results of the DID estimation. The dependent variable are: TFP Woldridge (WD) and TFP Levinshon and Petrine (L-P), which measures firm productivity. The target variables are: D_SHOCK, that takes the value of 1 for years 2016–2018 (after the shock, i.e. the sign of 2015 Paris Agreement) and 0 otherwise; D_TREATED, that takes value of 1 for firms above median values of ENV (I), SOC (II), GOV (III)scores in the year before of the shock (2015), and 0 otherwise; the interaction term D_SHOCK*D_TREATED. Variable definitions are provided in Table 1. All non-binary independent variables are lagged by one year with respect to the dependent variable. Time, industry and country fixed-effect (FE) are included in all specifications. Firm clustered standard errors (SE) are reported in parentheses. The superscripts ***, **, and * denote coefficients statistically different from zero at the 1%, 5%, and 10% levels, respectively, in two-tailed tests.

Panel A

Variables	D_HIGH_ESG
SIZE (-1)	0.384***
	(0.017)
SALES_GRW (-1)	-0.098
	(0.094)
LEV (-1)	0.298**
	(0.133)
HHI (-1)	0.155
	(1.091)
KOF (-1)	0.017
	(0.057)
GDP_GRW	-0.011
	(0.011)
Time FE	Yes
Industry FE	Yes
Country FE	Yes
Cluster S.E.	Yes
N. of obs.	5318

Panel B

Variables	Treated (T)	Control (C)	Difference (T-C)	P-value
SIZE	14.758	14.922	-0.164	0.164
SALES_GRW	0.078	0.051	0.027	0.127
LEV	0.258	0.271	-0.013	0.388
HHI	0.078	0.085	-0.007	0.146
KOF	0.425	0.416	0.009	0.944
GDP_GRW	0.020	0.020	0.000	0.909

Panel C

	TFP WD			TFP L-P		
	ENV	SOC	GOV	ENV	SOC	GOV
Variables	(I)	(II)	(III)	(I)	(II)	(III)
D_SHOCK*TREATED	0.056**	0.025	0.054**	0.061**	0.030	0.047*
	(0.024)	(0.024)	(0.025)	(0.026)	(0.026)	(0.028)
D_SHOCK	0.018	0.029	0.007	0.001	0.040	0.002
	(0.029)	(0.029)	(0.030)	(0.032)	(0.033)	(0.036)
D_TREATED	0.613	0.625	0.592	0.752	0.779	0.747
	(0.594)	(0.609)	(0.606)	(0.574)	(0.581)	(0.583)
Controls (-1)	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Cluster S.E.	Yes	Yes	Yes	Yes	Yes	Yes
N. of obs.	1,489	1,489	1,489	1,489	1,489	1,489
R-squared	0.771	0.821	0.823	0.648	0.631	0.640

Table 5 - Heckman two-step model

This table reports the results of the second stage obtained from the Heckman two-stage model over the total period (2002–2018). The dependent variables are TFP WD and TFP L-P which measures firm's total factor productivity (TFP). The target variables are the ESG, ENV, SOC and GOV score. The IMR is the Inverse Mills Ratio generated by the first step of Heckman model and included in the second step. Variable definitions are provided in Table A.4.Time, industry and country fixed-effect (FE) are included in all specifications. Firm clustered standard errors (SE) are reported in parentheses. The superscripts ***, **, and * denote coefficients statistically different from zero at the 1%. 5%. and 10% levels, respectively, in two-tailed tests.

	TFP WD				TFP L-P			
Variables	(I)	(II)	(III)	(IV)	(I)	(II)	(III)	(IV)
ESG (-1)	0.201***				0.184**			
	(0.064)				(0.071)			
ENV (-1)		0.148***				0.098**		
		(0.043)				(0.043)		
SOC (-1)			0.094**				0.098*	
			(0.045)				(0.053)	
GOV (-1)				0.075**				0.087**
				(0.035)				(0.041)
Controls (-1)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cluster S.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N. of obs.	4182	4182	4182	4182	4182	4182	4182	4182
IMR	2.77e-05	3.26e-05	3.80e-05	3.24e-05	-3.35e-05	-2.72e-05	-2.48e-05	-3.12e-05
	(9.34e-05)	(9.34e-05)	(9.56e-05)	(9.47e-05)	(9.59e-05)	(9.62e-05)	(9.67e-05)	(9.67e-05)

Table 6 - PSM weighted regression

This table reports the results of the weighted regression obtained after running the PSM over over total period (2002–2018). The dependent variables are TFP WD and TFP L-P which measures firm's total factor productivity (TFP). The target variables are the ESG, ENV, SOC and GOV score. Panel A shows the matching estimation between Treatment (High ESG firms) and Control (Low ESG firms). Panel B shows the result of Regression estimation on matching sample. Variable definitions are provided in Table A.4.Time, industry and country fixed-effect (FE) are included in all specifications. Firm clustered standard errors (SE) are reported in parentheses. The superscripts ***, **, and * denote coefficients statistically different from zero at the 1%. 5%. and 10% levels, respectively, in two-tailed tests.

Panel A: Matching estimation. Difference in TFP between Treatment (High ESG) and Controls (Low ESG

	Treatment	Control	Difference	p-value
TFP WD	5.433	5.339	0.094***	0.000
TFP L-P	3.098	3.057	0.040***	0.000

Panel B: Regression Estimation based on matching sample

	TFP WD				TFP L-P			
Variables	(I)	(II)	(III)	(IV)	(I)	(II)	(III)	(IV)
ESG (-1)	0.208***				0.193**			
	(0.070)				(0.081)			
ENV (-1)		0.141***				0.096*		
		(0.047)				(0.049)		
SOC (-1)			0.099*				0.109*	
			(0.052)				(0.062)	
GOV (-1)				0.092**				0.096**
				(0.040)				(0.045)
Controls (-1)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cluster S.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N. of obs.	2,496	2,496	2,496	2,496	2,496	2,496	2,496	2,496
R-squared	0.821	0.820	0.819	0.819	0.662	0.660	0.661	0.661

Table 7 - IV regression

This table reports the estimates of the IV GMM model over total period (2002-2018). The dependent variables are TFP WD and TFP L-P which measures firm's total factor productivity (TFP). The target variables are the ESG, ENV, SOC and GOV score. Variable definitions are provided in Table A.4.Time, industry and country fixed-effect (FE) are included in all specifications. Firm clustered standard errors (SE) are reported in parentheses. The superscripts ***, **, and * denote coefficients statistically different from zero at the 1%. 5%. and 10% levels, respectively, in two-tailed tests.

	TFP WD				TFP L-P			
Variables	(I)	(II)	(III)	(IV)	(I)	(II)	(III)	(IV)
ESG (-1)	0.637***				0.775***			
	(0.115)				(0.120)			
ENV (-1)		0.326***				0.273***		
		(0.079)				(0.072)		
SOC (-1)			0.262***				0.303***	
			(0.074)				(0.170)	
GOV (-1)				0.265***				0.409***
				(0.048)				(0.051)
Controls (-1)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cluster S.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N. of obs.	4182	4182	4182	4182	4182	4182	4182	4182
Sargan p-value	0.990	0.977	0.640	0.585	0.751	0.603	0.219	0.476
F-Cragg Donald test	25.94***	43.94***	49.75***	22.36***	25.94***	43.94***	49.75***	22.36***

Table 8 - Alternative ESG measure

This table reports the estimates of the OLS model over the total period (2002-2018), by employing ESG Combined score (ESG COMB) and Bloomberg ESG disclosure score (BESG). The dependent variables are TFP WD and TFP L-P which measures firm's total factor productivity (TFP). Variable definitions are provided in Table A.4.Time, industry and country fixed-effect (FE) are included in all specifications. Firm clustered standard errors (SE) are reported in parentheses. The superscripts ***, **, and * denote coefficients statistically different from zero at the 1%. 5%. and 10% levels, respectively, in two-tailed tests.

	TFP WD		TFP L-P	
Variables	(I)	(II)	(I)	(II)
ESG COMB (-1)	0.054**		0.051*	
	(0.024)		(0.028)	
BESG (-1)		0.174***		0.174**
		(0.062)		(0.072)
Controls (-1)	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
Cluster S.E.	Yes	Yes	Yes	Yes
N. of obs.	3,288	2,552	3,288	2,552
R-squared	0.754	0.776	0.542	0.593

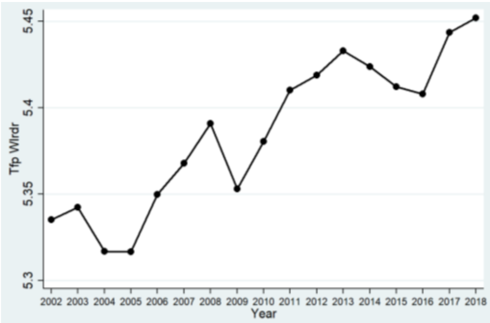
Table 9 – Alternative Productivity measure: Capital productivity, Labor productivity and Olley and Pakes TFP

This table reports the estimates of the OLS model over the total period (2002-2018), by employing alternative measure of firms' productivity: the Capital productivity (Cap P); the Labour productivity (Lab P) and Olley and Pakes TFP (O-P TFP). Variable definitions are provided in Table A.4. Time, industry and country fixed-effect (FE) are included in all specifications. Firm clustered standard errors (SE) are reported in parentheses. The superscripts ***, **, and * denote coefficients statistically different from zero at the 1%. 5%. and 10% levels, respectively, in two-tailed tests.

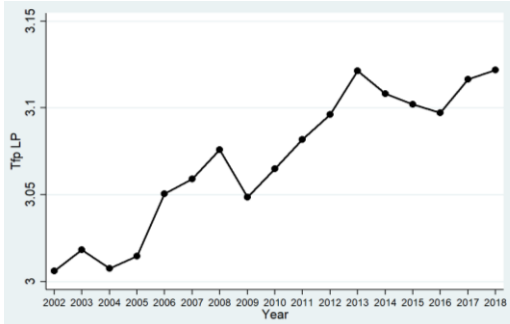
	Cap P	Lab P	O-P TFP
Variables	(I)	(II)	(III)
ESG (-1)	0.232*	-0.219	0.244**
	(0.138)	(0.162)	(0.121)
Controls (-1)	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Country FE	Yes	Yes	Yes
Cluster S.E.	Yes	Yes	Yes
N. of obs.	4,324	4,618	4,229
R-squared	0.815	0.770	0.874

Figure 1: TFP trends

Panel A: TFP WD



Panel B: TFP L-P



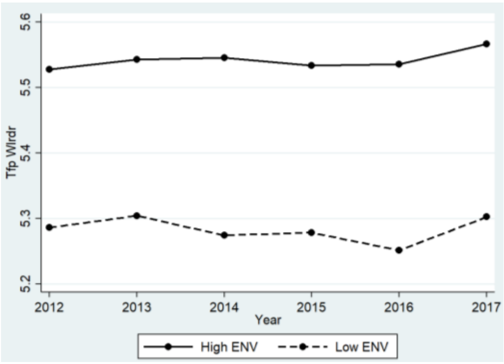
Appendix

Figure A.1 Parallel trends Paris Agreement

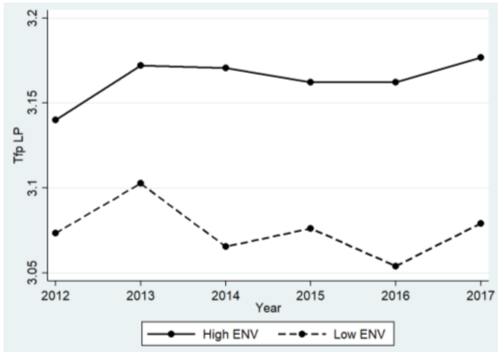
This figure illustrates the behaviour of the average TFP WD and TFP L-P before the shock or treatment (i.e., the adoption of 12 December 2015 Paris Agreement) for both the treated (High ENV, High SOC and High GOV) and the control group (Low ENV firms, High SOC and High GOV).

Panel A: High ENV vs Low ENV

TFP WD

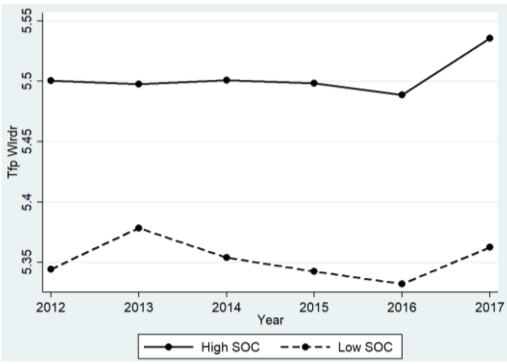


TFP L-P

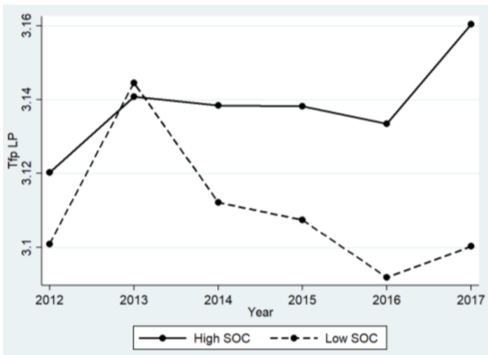


Panel B: High SOC vs Low SOC

TFP WD

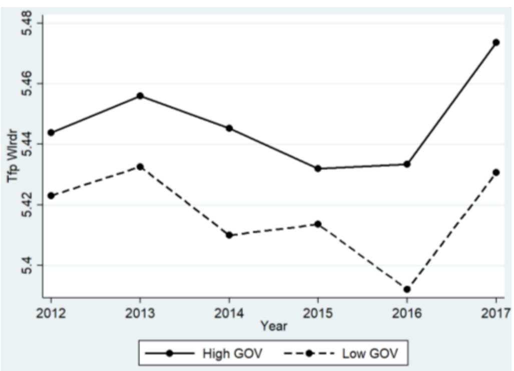


TFP L-P



Panel C: High GOV vs Low GOV

TFP WD



TFP L-P

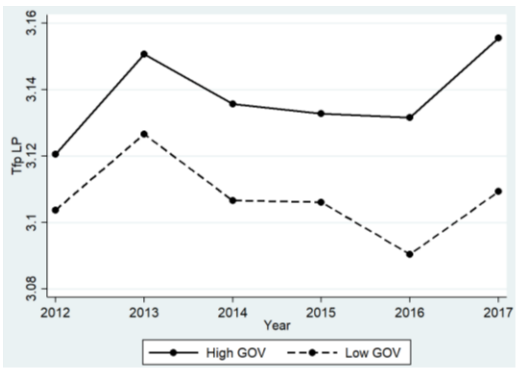


Table A.1 - Country distribution

This table presents a summary of our sample composition by country.

Country	*N. of Obs*	*%*
Austria	149	3.56
Belgium	154	3.68
Finland	211	5.04
France	215	5.13
Germany	576	13.75
Greece	56	1.34
Hungary	25	0.60
Ireland	163	3.89
Italy	226	5.40
Netherlands	292	6.97
Poland	96	2.29
Portugal	54	1.29
Spain	275	6.57
Sweden	330	7.88
United Kingdom	1360	32.62
Total	*4182*	*100*

Table A.2 - Correlation matrix

This table shows the correlation matrix of the variables used in the empirical analysis over the period 2002–2018.

	Variable	1	2	3	4	5	6	7	8	9	10
1	ESG	1									
2	ENV	0.831*	1								
3	SOC	0.858*	0.664*	1							
4	GOV	0.654*	0.266*	0.327*	1						
5	SIZE	0.526*	0.479*	0.491*	0.262*	1					
6	SALES	-0.108*	-0.108*	-0.080*	-0.064*	-0.152*	1				
7	LEV	0.041*	0.038*	0.067*	-0.015	0.183*	-0.006*	1			
8	HHI	0.046*	0.023	0.069*	0.019	0.062*	-0.011	0.079*	1		
9	KOF	0.052*	0.109*	0.038*	-0.030*	0.076*	-0.021	0.031*	-0.052*	1	
10	GDP_GRW	-0.032*	-0.069*	-0.018	0.015	0.021	0.127*	-0.056*	0.007	-0.036*	1

Table A.3 - Composition of ESG score

Pillar	Category	Category definition
Environmental (ENV)	*Resource Use score*	It reflects a company's performance and capacity to reduce the use of materials. energy or water. and to find more eco-efficient solutions by improving supply chain management.
	Emissions score	It measures a company's commitment and effectiveness towards reducing environmental emission in the production and operational processes.
	Innovation score	It reflects a company's capacity to reduce the environmental costs and burdens for its customers. and thereby creating new market opportunities through new environmental technologies and processes or eco-designed products.
Social (SOC)	*Workforce score*	It measures a company's effectiveness towards job satisfaction. healthy and safe workplace. maintaining diversity and equal opportunities. and development opportunities for its workforce.
	Human Rights score	It measures a company's effectiveness towards respecting the fundamental human rights conventions.
	Community score	It measures the company's commitment towards being a good citizen. protecting public health and respecting business ethics.
	Product Responsibility score	It reflects a company's capacity to produce quality goods and services integrating the customer's health and safety. integrity and data privacy.
Governance (GOV)	*Management score*	It measures a company's commitment and effectiveness towards following best practice corporate governance principles.
	Shareholders' score	It measures a company's effectiveness towards equal treatment of shareholders and the use of anti-takeover devices.
	CSR Strategy score	It reflects a company's practices to communicate that it integrates the economic (financial). social and environmental dimensions into its day-to-day decision-making processes.

Table A.4 - Variable definitions and data sources

Variable	Definition	Source
TFP WD	Total factor productivity derived from Wooldridge (2009) procedure	Author’s own calculation
TFP L-P	Total factor productivity derived from Levinsohn and Petrin (2003) procedure	Author’s own calculation
ESG	Total ESG score.	Thomson Reuters Refinitvì, Author’s own calculation
ENV	Environmental performance score.	/
SOC	Social performance score.	/
GOV	Governance performance score.	/
SIZE	Natural Logarithm of firm’s total asset.	/
SALES	Firms’ Sales scaled to total asset.	/
LEV	Total debt to total asset.	/
HHI	The sum of the squared market share value (in term of total asset) of all firms in the country.	Author’s own calculation
KOF	The KOF Globalisation Index measures the economic. social and political dimensions of globalisation.	ETH Zurich
GDP_GRWT	It measures the country GDP growth.	World Bank Database

Table A.5 - First Step Heckman model

This table shows the results of the first step estimation of the Heckman model (see Table 6 for the second step). This table estimates the decision equation using a multinomial probit model, whose parameters are used to calculate the Inverse Mills Ratio (IMR). In this setting the dependent variables is dummies (D_ESG) equal to 1 from the year in which a firm of our sample started to be involved in ESG practices; and 0 in the previous years (Jo and Harjoto, 2011). Variable definitions are provided in Table A.4 Time, industry and country fixed-effect (FE) are included in all specifications. Firm clustered standard errors (SE) are reported in parentheses. The superscripts ***, **, and * denote coefficients statistically different from zero at the 1%. 5%. and 10% levels, respectively, in two-tailed tests.

Variables	D_ESG
SIZE (-1)	0.660***
	(0.047)
SALES (-1)	-0.471***
	(0.108)
LEV (-1)	-0.818***
	(0.253)
HHI (-1)	-0.877
	(1.487)
KOF (-1)	21.870***
	(6.302)
GDP_GRW	-0.004
	(0.012)
Time FE	Yes
Industry FE	Yes
Country FE	Yes
Cluster S.E.	Yes
N. of obs.	6386

Table A.6 - First stage IV TSLS

This table shows the results of the first stage estimation of IV TSLS and GMM model (see Table 7 for the second stage). We instrument our target variable (the ESG score) with the firms' industry peer ESG score (Peer ESG) (El Ghoul et al. 2011, Dumitrescu and Zakriya 2021), showing its correlations with reference to the original target variable being instrumented. Definitions are provided in Table A.4. Time, industry and country fixed-effect (FE) are included in all specifications. Firm clustered standard errors (SE) are reported in parentheses. The superscripts ***, **, and * denote coefficients statistically different from zero at the 1%. 5%. and 10% levels, respectively, in two-tailed tests.

	ESG
Peer ESG (-1)	0.442***
	(0.052)
Controls (-1)	Yes
Time FE	Yes
Industry FE	Yes
Country FE	Yes
Cluster S.E.	Yes
N. of obs.	4918