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Do credit constraints favor dirty production? Theory and plant-level evidence

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ABSTRACT

This paper explores the effect of credit constraints on production-generated pollution emissions. I develop a theoretical model wherein polluting firms borrow externally to finance investment in various assets, subject to a credit constraint. The main insight of the model is that credit constraints distort the composition of assets towards over-investment in tangible assets, which can be pledged as collateral, thereby increasing the intensity of emissions. The predictions of the model are tested using a unique dataset consisting of plant-level measures of pollution emissions and creditworthiness. The empirical results indicate that credit constraints significantly increase pollution emissions (even after accounting for the scale effect), and the results withstand multiple robustness checks. Moreover, the effect of credit constraints is particularly acute in industries with greater reliance on external credit. Finally, I demonstrate that firm-level credit constraints distort the composition of assets and that the composition of assets influences pollution emissions.

Introduction

External credit is indispensable to financing firm investment. Accordingly, credit intermediation entails overcoming a number of obstacles, such as contractual incompleteness and asymmetric information.[1] One approach to overcoming these credit constraints, elucidated by the incomplete contracts literature, is to invest in physical assets that can be pledged as collateral (Williamson, 1988; Hart and Moore, 1994). Specifically, tangible assets, such as buildings and structures, equipment, and natural resources, retain greater residual value to lenders in the case that the firm defaults or repudiates the contract (Braun, 2003; Manova, 2012).[2] Conversely, intangible assets, such as human capital (worker and manager training), product and process innovation (research and development), and marketing, tend to be inalienable and firm specific in nature and therefore have less residual value to lenders.[3] Credit constraints therefore bias investment towards tangible assets at the expense of intangible assets. Because pollution emissions are linked to the composition of assets in production (this paper demonstrates that emissions are positively related to the share of tangible assets), credit constraints have negative repercussions for the environment.

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[1] The literature is vast, see Hubbard (1998) and Stein (2001) for survey articles. Empirical studies document that credit constraints bear on firm investment and performance. For example, Midrigan and Xu (2012) find that credit frictions reduce total factor productivity by up to 40%, and Hennessy and Toni (2007) find that credit frictions represent 13 and 25% of financing costs for large and small firms.

[2] Retaining greater residual value implies that shifting control from firms to creditors is less costly, or equally, that a greater fraction can be pledged as collateral (collateralized debt).

[3] Intangible assets are considered broadly to include all factors contributing to total output not caused by tangible assets.

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While significant attention has been given to the role of credit constraints in firm investment and performance, far less attention has been given to the role of credit constraints in environmental performance. The contribution of this paper consists of two related parts. First, this paper develops a theoretical model incorporating external borrowing and endogenous asset composition to analyze the link between credit constraints and pollution emissions. Second, the predictions of the model are tested using a unique dataset that matches plant measures of creditworthiness and pollution emissions. Both the theory and empirics attest that credit constraints increase pollution emissions.

While several studies have explored the relationship between various measures of financial performance and environmental performance, few studies have attempted to theoretically link financial status and environmental outcomes.[4] Earnhart and Kathleen (2012) (henceforth E&S) is the first paper, to my knowledge, to theoretically assess various dimensions of financial status on environmental performance, focusing on the effect of profitability, solvency risks, and liquidity, on the efficacy of environmental regulations in reducing emissions.[5] Andersen (2016) investigates the role of endogenous technology upgrading and industry composition in the link between economy-wide credit constraints and aggregate environmental performance using a general equilibrium model with heterogeneous firms. This paper contributes to the literature by focusing on external borrowing, which is the primary financing source for most firms (Fazzari et al., 1988),[6] and the role of credit constraints in investment in tangible and intangible assets.

On the empirical side, E&S conduct an empirical analysis for wastewater discharges of 508 “major” publicly held chemical manufacturing facilities using indirect measures of liquidity and solvency risks. This paper takes advantage of a recently-released dataset containing data for both privately and publicly-held plants in all manufacturing industries (nearly 30,000 in total) that includes a plant-level measure of credit constraints, which is a direct measure of the parameter in the theoretical model, and a comprehensive measure of pollution emissions.[7] This paper finds significant effects of credit constraints on pollution emissions, and documents direct evidence of the mechanisms linking credit constraints and emissions.

More broadly, this paper adds to the literature investigating the relationship between various measures of environmental performance and financial constraints. Using proxies for credit constraints (e.g., cash flow), Hong et al. (2012) find that less constrained corporations have better corporate social responsibility, while Amore and Bennedsen (2016) find that good corporate governance promotes green innovation, especially among corporations in industries that rely on external borrowing. At the country level, Andersen (2016) finds that credit market reforms, which reduced credit constraints, significantly improve country-level air pollution concentrations. The results of this paper are therefore consistent with the broader literature that documents various environmental benefits of reducing credit constraints. Finally, this paper is also related to studies in corporate finance that investigate the relationship between credit constraints and asset structure, which document that pledgeable (tangible) assets facilitate lending (Almeida and Campello, 2007; Campello and Giambona, 2013), and that credit constraints distort investment decisions (Garmaise, 2008; Pérez-Orive, 2016).[8]

This paper develops a conceptual model focusing on the partial equilibrium analysis of a representative firm that produces a homogeneous final good using intermediate factors of production–tangible and intangible assets. Financing production of tangible and intangible assets requires external lending, which entails satisfying a participation constraint (credit constraint) with a risk-neutral lender. Due to price and production risks, as well as contractual incompleteness and asymmetric information, lenders assign a positive probability to the event that the firm defaults, in which case a fraction of the investment is recovered by the lender. The participation constraint requires that the lender's expected return must exceed an exogenous reservation return. The model demonstrates that greater assigned probability to the default state strengthens the credit constraint and increases the incentive to invest in tangible assets, which retain greater residual value in default states. Thus, credit constraints increase the intensity of pollution emissions whenever the intensity of pollution emissions is positively associated with the share of tangible assets in production.

The empirical analysis explores the impact of credit constraints on pollution emissions for a panel of manufacturing plants, using the Environmental Protection Agency's Risk-Screening Environmental Indicators and the National Establishment of Time Series, among several other datasets. Specifically, I investigate the impact of credit constraints, using measures

[4] For example, Gray and Mary (1996) and Shadbegian and Wayne (2005) find that more profitable firms are not more likely to comply with environmental standards, whereas Maynard and James (2001) find that more profitable firms are more likely to invest in a clean technology. Using industrial firms in the Czech Republic, Earnhart and Lizal (2006) find that profits are positively associated, whereas Earnhart and Lizal (2010) find that value added is negatively associated, with air pollution emissions.

[5] E&S develop a “crime and punishment” (Becker, 1968) model examining optimal pollution abatement for compliance with an emissions standard in the presence of liquidity and solvency constraints, focusing on the conditional effect of expected punishments on compliance, which is not considered in this paper.

[6] Fazzari et al. (1988) report that for manufacturing firms the majority of funding is long-term bank debt, except for large firms with over 250 million in assets, which use around 60% retained earnings.

[7] E&S use the firm's current ratio as a measure of solvency and the year end cash stock as a measure of liquidity. The empirical analysis also departs from E&S by using a more comprehensive measure of emissions (releases to air, water, landfill) and employing multiple emissions measures capturing both pounds and the health risk of emissions. One drawback of using only major publicly-held companies is that publicly held companies have unique capital structures, financing investments mostly through retained earnings and equity, and are therefore less affected by credit and liquidity constraints.

[8] More precisely, Almeida and Campello (2007) find that, among financially constrained firms, an increase in pledgeable assets supports greater borrowing; Campello and Giambona (2013) find that an increase in asset tangibility increases firm leverage; Pérez-Orive (2016) finds that firms respond to credit constraint shocks by investing in short-run projects that confer assets to pledge; and Garmaise (2008) finds that financially constrained firms employ more labor than capital.