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Triggers and barriers to energy efficiency measures in the ceramic, cement and lime sectors

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ABSTRACT

Evaluating and understanding the interplay of barriers to the diffusion of energy efficiency measures is highly relevant because, if policies are effective in overcoming these barriers, CO_2 emissions can be decreased at low cost. The study aims to understand how managers make decisions to invest in energy efficiency, how perceived barriers affect these decisions and how policy can overcome these barriers. We apply neo-classical economic theory as well as insights from transaction cost economics and behavioural economics to understand why hurdle rates, even when omitted costs and risk are taken into account, are higher than the weighted average cost of capital. We find that internal capital budgeting rules and the effort of studying technical feasibility and profitability are relevant to understanding the efficiency gap. The results indicate that the voluntary agreement and the emission trading scheme are complementary, addressing different barriers in different contexts.

1. The energy efficiency paradox and the definition of barriers

Since the oil crises of 1973 and 1979, there has been an intense academic debate around the existence of non-implemented cost-effective energy efficiency measures, known as the energy efficiency gap. The International Energy Agency's World Energy Outlook (IEA, 2012) estimates that economically viable energy efficiency measures have the potential to halve the increase in world primary energy demand by 2035 compared to the present 'New Policies Scenario' which already includes the current energy efficiency policies. Note that estimating the macroeconomic effect of energy efficiency is difficult because it is partly neutralised by the feedback of an increased purchasing power, known as the rebound effect (Antal & van den Bergh, 2013). In addition to opportunities available to families and public utilities, many studies find important unrealised cost-effective investment opportunities in energy-efficiency within firms (DeCanio, 1998; Schleich, 2009; Sola and Xavier, 2007).

Understanding barriers to energy efficiency measures within firms is important because addressing these barriers may yield emission reductions at a very low cost. However, since the investment strategies of firms are typically the outcome of a complex decisional process, a better understanding of barriers to energy efficiency is critical to the successful implementation of regulatory policies and their evaluation.

There is considerable consensus on the existence of neo-classical barriers to energy efficiency such as externalities, asymmetric information and incompleteness of contracts. However, other barriers, such as organisational barriers and capital availability, and with them the size of the energy efficiency gap, has been a subject of polemical academic debate.

Neo-classical economists argue that important hidden costs (hidden to the analyst, but not to the firms), such as overall energy management costs, the cost of studying investment opportunities, foregone option values, explain a large proportion of an apparent energy efficiency gap (Stavins et al., 2007; Sutherland, 1996; Jaffe et al., 2004). Also, uncertainty is seen as inherent to the adoption of new technology and may justify a higher risk-adjusted discount rate than is typically used in calculations that suggest the existence of an efficiency gap. Limited access to capital is not seen as a barrier but as an efficient market outcome. *"Capital markets certainly constrain the allocation of capital, particularly to more risky borrowers, but this allocation is a source of efficiency, not inefficiency.*

Abbreviations: EU ETS, European Union Emission Trading Scheme; IRR, Internal Rate of Return; MNC, Multinational Corporation; NPV, Net Present Value; WACC, Weighted Average Cost of Capital.

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Furthermore, there is no reason to believe that capital markets systematically misallocate capital in ways that discriminate against energy conservation investments." (Sutherland, 1996) They conclude that policy intervention is only justified when there are neo-classical market failures, such as negative externalities and asymmetric information.

The neo-classical stance has clarified the debate by arguing that indirect but unavoidable costs or risks related to the diffusion of technology cannot be seen as economic barriers to energy efficiency. However, following Sorrell et al. (2004), we consider cost-effectiveness from different perspectives, including insights from transaction cost economics and behavioural economics.

Transaction cost economics stresses the importance of routines, rules of thumb and satisficing heuristics rather than maximising heuristics in order to reduce the cost of making complex decisions (Williamson, 1988, 2002). Transaction cost economics also emphasises that policy intervention and different institutional structures may lower transaction costs. Corporate cultures exhibit a rich diversity of forms and show large variations in performance. Managers struggle with the complicated challenge of getting the most out of the resources they deploy. Dealing with problems of agency, moral hazard, imperfect information and design of incentives is at the heart of modern management. These difficulties affect all aspects of the firm including capital structure, investment budgeting, operational control, strategic positioning as well as investment decisions related to energy efficiency. This contrasts with the assumption of the neo-classical stance that under competitive market conditions firms can be expected to rationally maximise their value and find a governance structure such that organisational barriers to profitable investments are negligible. DeCanio (1998) finds statistical evidence of organisational and bureaucratic barriers among 1400 US firms participating in an efficient lighting programme. Several other qualitative studies focused on organisational barriers to energy efficiency in firms (DeCanio, 1993; Sola and Xavier, 2007; Zilahy, 2004).

Behavioural economics departs from the assumption of rational agents, pointing at systematic biases in human decision-making (Kahneman and Tversky, 2000). Behavioural biases further increase the scope of barriers to energy efficiency and highlight barriers that could not be apparent in a neo-classical approach based on a rational actor model (Sorrell et al. 2004; Weber, 1997).

Barriers are discussed according to the taxonomy developed by Sorrell et al. (2004) (see also Fleiter et al. 2011; Schleich, 2009; Schleich and Gruber, 2006). This taxonomy has been chosen because it is particularly appropriate for our approach to different theoretical frameworks, since each barrier can be considered according to neo-classical economics, transaction cost economics and behavioural economics.

1. Hidden costs: companies may not invest in energy efficiency because there are costs that are hidden to the researcher, but not hidden to the company. Managers may not include these costs in profitability calculations because they are difficult to quantify. Certain hidden costs such as search costs, purchasing and procurement costs can be considered as barriers in the sense that they may be avoidable under an alternative organisational structure or policy. For example, the cost of information gathering, which may be seen as a hidden cost justifying the apparent efficiency gap in a neo-classical economic framework (Jaffe et al. 2004 p.84), may be reduced by subcontracting with a specialised audit bureau or by adopting a policy imposing energy efficiency labelling.
2. Risk and uncertainty: a high discount rate in profitability calculations may be a rational way of compensating for technical risk, regulatory uncertainty or energy price uncertainty. However, market design, contract structure, organisational structure, policy etc. affect the risk profile of energy efficiency investments. Or if actors treat uncertainty in investment decisions in a biased way, as highlighted by behavioural economics, then the risky nature of a project may become an economic barrier to a cost-effective outcome (Greene, 2011).
3. Imperfect information: when the technical feasibility or the profitability of an investment is not studied, cost-effective investments opportunities may remain non-implemented. Organisational barriers such as lack of managerial time may aggravate the role of imperfect information.
4. Split incentives: if the energy performance of equipment installed by a subcontractor is unobservable or difficult to enforce legally, this creates an incentive for the subcontractor to build cheaper equipment with poorer energy performance. In large organisations, different people and divisions may not be accountable for their energy consumption or savings, impeding incentives for energy-saving measures.
5. Capital budgeting: the transaction costs related to proving a firm's creditworthiness may limit access to extra loans for cost-efficient investments. Agency problems between managers and shareholders may lead to internal capital budgeting rules reducing the investment budget available to managers.
6. Bounded rationality: in contrast to orthodox neo-classical theory, transaction cost economics studies how people economise on cognitive efforts of processing information leading to satisficing rather than maximising decision heuristics. Behavioural economics stresses systematic biases in human decision–making, such as reference dependence, status quo bias and time-inconsistent discounting.

Note that these barriers may overlap, co-exist and interact, so that a phenomenon may fall under more than one barrier category.

We study barriers and motivations in the ceramic, cement and lime industries which are very energy-intensive and carbon-intensive industries. To the best of our knowledge, this is the first study of energy efficiency barriers in these sectors. Moreover, there are only a few papers on barriers to energy efficiency in energy-intensive industries (de Groot et al. 2001; Sardianou, 2008; Zilahy, 2004). Energy-intensive industries are of particular interest, not only because potential efficiency gains can be considerable, but also because many studies explain barriers by the fact that energy is not part of their core business (Sorrell et al. 2004; Schleich and Gruber, 2006), which is not the case for our sample. To the best of our knowledge, this is the first energy efficiency study covering an entire (over 95%) country-wide sector. Moreover, the bricks, cement and lime sectors are important export sectors in the Belgian economy. The companies investigated emit around 15% of Belgian emissions that are covered by the European Union Emission Trading Scheme (EU ETS).

In part 2 the methodology and data are discussed. Part 3 describes the results, structured according to the above-mentioned barriers. Next we evaluate the impact of the EU ETS and the voluntary agreement on efficiency investments.

2. Methodology and data

The study focuses on the decision-making process leading to investments in energy efficiency to address the following research questions: First, the study aims to evaluate the relative importance of different barriers and to understand why certain barriers are more important than others. Given our previous definition of barriers, it also questions to what extent insights from transaction cost economics and behavioural economics are relevant for understanding the energy efficiency gap. Next, the study investigates