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Abstract

This report investigates to what extent and under what circumstances environmental regulations can be designed and implemented to jointly achieve positive environmental outcomes and sustained competitive strength in the mining industry. It provides: (a) a conceptual analysis of the impact of environmental regulations on industrial competitiveness, and on how this trade-off can be affected by various regulatory design and implementation strategies; and (b) preliminary empirical investigation of important aspects of the environmental permitting processes for mining operations in Finland, Canada, Sweden, Australia and Russia. Methodologically we distinguish between the flexibility, predictability and stringency of the regulations, and then investigate these concepts in the empirical context of the three countries’ environmental permitting processes. An important result is that in all countries there has often been a lack of timeliness and predictability in the environmental regulations (e.g. uncertainty about the implementation, delays due to appeals etc.). These problems can in part be addressed by, for instance: (a) allocating more resources to the regulatory authorities; (b) establishing a closer cooperation between the industry and the authorities; and (c) introducing more standardized procedures and road maps for environmental impact assessments, permit applications and not the least for how to interpret specific legal rules in the context of mining. The report ends by pin-pointing a number of important avenues for future research. For instance, additional comparative studies are needed on how regulations are applied and implemented in practice. Future research should also address how effective current regulations on reclamation bonds and funds are for future post-mine closure rehabilitation.
Preface

Minerals are essential for human welfare. However, their extraction is associated with both opportunities and challenges. Historical concerns around work conditions and the competitiveness of the mining sector have been complemented by a growing number of other issues. Today, an overarching goal is to find ways by which the mining sector can promote sustainable development.

Sustainable development is often defined as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” Furthermore, it is commonly agreed that this must incorporate economic, environmental and social concerns. There is a growing literature that examines the relationship between extractive industries and sustainable development, yet much research is still conducted in a siloed fashion. For this reason, the Swedish state-owned iron ore mining company LKAB and Luleå University of Technology initiated a pre-study with the aim to establish a new multidisciplinary research programme on mining and sustainability.

The pre-study was conducted from January to October 2014. One part of the pre-study was to review existing research attempting to address mining and sustainable development – the current state-of-the-art – with focus on the past, present, and future situation in Sweden, but also to put the Swedish case into a broader perspective by comparing several international examples.

One of the outcomes of the pre-study is this report. It analyses the impact of environmental regulations on competitiveness in the mining sector, and how this potential trade-off can be affected by various regulatory design and implementation strategies. Results from a number of countries show that a lack of timeliness and predictability rather than the stringency of regulations has been the greatest threat to competitiveness. The report also discusses different strategies for gradually implementing more stringent regulations without compromising with long-run competitiveness.

The report highlights a number of future research needs. Notably, more case studies are needed on how regulations are applied in practice. The interaction between current national regulations and international legislation including new EU directives needs to be considered. Future research should also address how effective current regulations on reclamation bonds and funds are for future post-mine closure rehabilitation.

Four other review reports have also been undertaken as a part of this pre-study.

- **Making Mining Sustainable: Overview of Private and Public Responses**, by Petter Hojem from Luleå University of Technology.
- **Environmental Aspects of Mining**, by Anders Widerlund and Björn Öhlander from Luleå University of Technology and Frauke Ecke from the Swedish University of Agricultural Sciences.
- **Gender, Diversity and Work Conditions in Mining**, by Lena Abrahamsson, Eugenia Segerstedt, Magnus Nygren, Jan Johansson, Bo Johansson, Ida Edman and Amanda Åkerlund from Luleå University of Technology.
- **Regional Development and Benefit-Sharing**, by Patrik Söderholm and Nanna Svahn from Luleå University of Technology.

Together these reports provide a broad picture of the challenges and opportunities created by mining.

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1. Introduction

1.1 Background and Motivation

This report addresses the relationship between environmental regulation and competitiveness in the mining industry. Mining poses significant environmental challenges. It generates large volumes of, for instance, waste rock, tailings, acid mine drainage, airborne dust and other contaminants, which are deposited on land and in the air and water (Widerlund et al., 2014). For these reasons mining is the focus of increasingly stringent environmental regulations. Still, while environmental impact assessments and permits are needed to address any negative impacts, and promote the adoption of environmentally benign production processes, these regulations may also increase the time, costs and risks associated with opening and operating mines. In this sense there appears to exist a trade-off in that while it is important to control pollution from mining operations, such regulations may also lead to less mining investments, pollution leakage (i.e., emissions increase abroad) and lost employment opportunities to the local and regional economy. This report argues, though, that in many instances this trade-off is complex and highly dependent on the specific design and implementation of the regulations.

Previous research on mining competitiveness and environmental regulations tends to suggest that the geological potential and overall political stability of host countries rank higher than environmental regulations (as well as other mineral policies) when companies are deciding on the location of exploration activities and mining development investment (e.g., Johnson, 1990; Wilkerson, 2010; Tole and Koop, 2011). Still, the majority of this previous work primarily addresses the overall impacts and/or the stringency of the regulations (e.g., comparing specific emission performance standards etc.), while less attention has been paid to the ways in which the environmental permitting processes – and the associated legal rules – have been designed, interpreted and implemented in practice (see further section 2). Other social science research on industrial pollution control has shown that a number of regulatory design issues could significantly influence the companies’ prospects for complying with stringent environmental regulations while at the same time avoiding significant negative impacts on the competitiveness of the industry.

These issues concern, for instance, the flexibility granted to the industry in terms of selecting the
appropriate compliance measures as well as the time granted to adapt to the new requirements (e.g., Bergquist et al., 2013). Different regulatory approaches also differ in the sense that some rely on cooperation and consensus between the relevant regulatory authority and the industry, while others tend to be based on more conflict-ridden frameworks (e.g., Lundqvist, 1980; Löfstedt and Vogel, 2001). Environmental permitting processes are typically based on case-by-case assessments of new mines and/or production expansions at existing ones; the outcomes of these processes may therefore be highly dependent on, for instance, interpretations of the legal rules, timely regulatory decisions as well as on the regulators’ competence concerning technological solutions and their costs. Such factors will influence the outcomes of the permitting process both in terms of the decision whether or not to allow mine development, and regarding the specific requirements of the granted permit. Any uncertainties associated with the process will in turn affect the risks faced by companies prior to investment.

The importance of the design and implementation of environmental regulations for the mining industry’s costs, risks and profitability is evident also when considering the expressed concerns of mining professionals. While the critique sometimes concerns the stringency of the regulations (i.e., permit requirements that are perceived to impose excessive costs following changes in the production process), it is more often pointing towards a lack of timely and predictable decision-making processes. For instance, in Sweden the mining permitting process has been claimed to be unpredictable, subjective, too slow, and in lack of coordination across different regulatory authorities (e.g., Aaro et al., 2012). In the USA and Canada mining managers and professionals have raised concerns that more stringent environmental regulations (e.g., the greenhouse gas regulations in California) in combination with permitting delays could induce the industry to start operations in developing countries (e.g., PwC, 2012; Cervantes et al., 2013; Wyatt and McCurdy, 2013; Mining Association in Canada, 2013).

The above suggests that there is no simple and straightforward environment-competitiveness trade-off, and that there may be scope for achieving more favorable environmental outcomes without jeopardizing the industry’s competitiveness through different policy designs and implementation strategies. In this report we address this challenge by briefly examining the permitting processes of mining operations in Finland, Sweden, Australia and Canada, in part also referring to experiences from the Russian mining industry.

1.2 Objectives and Scope

The objective of this report is to investigate to what extent and under what circumstances industrial pollution regulations can be designed to jointly achieve positive environmental outcomes as well as sustained competitive strength in the mining industry. Specifically, the report provides:

- a conceptual analysis of the impact on environmental regulations on industrial competitiveness, and on how this trade-off can be affected by various regulatory design and implementation strategies.
- an empirical investigation of to what extent the permitting processes for mining ventures in Finland, Sweden, Canada, Australia and Russia – and the resulting pollution control requirements – provide scope for combining tough environmental regulations with maintained industrial competitiveness.

Mining companies are affected by several types of environmental regulations (Eggert, 1994), but in this report we primarily focus on the pollution control requirements stipulated in the permitting conditions for new mines and/or for production expansions at existing mines. This also means that little explicit attention is devoted to, for instance, the issuance of concession permits and the regulation of land use issues (see Williams (2012) for a recent review). Moreover, we also do not address the competitiveness impacts of different market-based policy instruments, such as the European Union’s Emissions Trading Scheme (EU ETS).

Our choice of case countries is interesting for several reasons. First, together Finland, Sweden and Russia are important suppliers of both non-ferrous minerals...
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and iron ore, especially in a European context. For instance, over 90 percent of European Union’s production of iron ore stems from Sweden. In all three countries the interest in continued mining development has been high during the recent decade due to elevated price levels. Second, though, surveys of mining professionals and managers show that these actors’ perception of the investment environment – including the uncertainties surrounding the environmental regulations – differ significantly across Sweden and Finland on the one hand and Russia on the other. For instance, both Sweden and Finland are at the top of the Fraser Institute’s ranking of mining countries, while Russia is not perceived to offer particularly stable regulatory conditions for mining companies (Wilson and Cervantes, 2014). This is in part illustrated in Figure 2 showing the impact of environmental regulation uncertainty (e.g., the stability of regulations, the consistency and timeliness of the regulatory processes, and whether regulations appear to be based on scientific knowledge or not) on investment propensity in the three countries.

Third, even though Finland and Sweden both offer relatively stable environmental regulations from the perspective of global mining representatives and also have fairly similar permitting processes, our analyses will show that some design features differ. Some of these features are potentially important from a competitiveness point-of-view. Interesting changes have also occurred in the environmental permitting processes over time, and in the empirical analysis we address a number of important characteristics of the Swedish regulatory approach during the 1970s and 1980s. This approach was in large based on a policy-style seeking cooperation and consensus between the regulators and the industry (e.g., Lundqvist, 1980). For instance, the experiences demonstrate the importance of flexible standards for emissions coupled with often extended compliance periods, and taking into account parameters such as local environmental impacts, potential for technological innovation as well as long-term competitiveness. During this regulatory era the emissions of a large number of pollutants (e.g., sulfur, COD, heavy metals etc.) were radically reduced in Swedish industry, without however significantly compromising its competitiveness (e.g., Bergquist et al., 2013; Söderholm and Bergquist, 2013).

Finally, Canada and Australia are both important developed mining countries. For instance, over the time period 2000-2013 about 45 percent of all new mine openings in high-income countries took place in these two countries, and Russia accounting for 27 percent of this total (see Raw Materials Database). Moreover, in both countries the environmental permitting processes for new mines are largely regulated at the state/province level, and these regulations may therefore also differ a lot across regions within the countries. Figure 2 provides an illustration of this, and shows the share of mining executives expressing that environmental regulations are a strong deterrent to
mining investment or a factor that outright prevents such investment. Overall relatively few express concerns about the environmental regulations in these countries (compared to, for instance, to Russia), although in some states/provinces the regulations do not appear to be particularly encouraging.

1.3 Methodological Approach and Empirical Material

Based on a review of the existing empirical literature and on a conceptual analysis of the environment-competitiveness trade-offs, we first identify three potentially important features of the environmental permitting process. These include: (a) the predictability and timeliness of the regulatory decision-making process from the perspective of prospective investors; (b) the compliance flexibility in terms of required pollution reduction measures and the time granted to comply with these; and (c) the stringency of the permit conditions (e.g., emission standards), including how these may be tightened over time.

In a second step we analyze these issues in the empirical context of the three countries’ environmental permitting processes. In large the analysis relies on an investors eye-view of the legal rules; it employs both case law and analytical jurisprudence for determining the content and function of the law. This includes also analyses of specific mining permitting processes in the three countries. Moreover, we rely on secondary sources, including reports by company representatives (e.g., Granberg, 2013; McNamara, 2009; Blake and Lawson, 2011), government reports, as well as personal interviews with companies that have applied (or are about to apply) for a permit. The analysis of the early Swedish permitting process relies on permitting process documents held at the archive of the County Administrative Board and the National Archive. This material is rich in the sense that it contains: (a) the permit application of the individual company, including detailed technical descriptions; (b) reports and decisions from the relevant authorities; (c) accounts of the negotiations between the authorities and the individual company during the assessment process; and (d) subsequent reports over related tests (of various pollution abatement methods) and the nature of the regulatory requirements.

1.4 Outline of Report

This report proceeds as follows. In the next section we briefly review the empirical literature on the relationship between environmental regulation and competitiveness in the mining industry, and discuss how this report contributes to this literature stream. Section 3 provides a simple conceptual framework addressing the impact of environmental regulation on industrial competitiveness. Most importantly, it identifies and discusses a number of factors that will affect this relationship and the trade-offs involved. In section 4 we provide a very brief introduction to the environmental regulatory frameworks in each of the countries, and the reader is directed to other work for more in-depth descriptions (e.g., McNamara, 2009; Pettersson et al., 2014). In section 5 we report the findings from our preliminary empirical investigation of the environmental permitting processes in the five countries. Again, in this report we only highlight some selected experiences for the environment-competitiveness relationship in the mining industry, while more in-depth country comparisons are left for future research. Finally, section 6 provides some concluding remarks and identifies a number of important topics for future research.
2. Previous Research on Mining Competitiveness and Environmental Policy

The empirical literature on the relationship between environmental regulation and mining competitiveness tends to define competitiveness as the capacity of regions and countries to attract investment in new and/or expanded mining operations. The key question has thus been to what extent the environmental regulations (e.g., including the conditions of the permits) have affected the expected costs and revenues of mining investment, and in turn the willingness to invest in new mining ventures across the world (e.g., Tole and Koop, 2011; Wilkerson, 2010). Often the focus has been on key differences among developed versus developing countries.

2.1 Mining Investment and Environmental Regulation: Results from the Literature

Overall the empirical research on mining investment and environmental regulations shows that geological potential and political stability are the most important factors determining the locational choice of mining companies. Mineral policies also matter, although in general environmental regulations have not constituted a major impediment to investment. This was shown already by Peck et al. (1992) who surveyed 32 multi-national mining companies. Wilkerson (2010) also highlights the role of political stability. Mining companies, he argues, tend to locate in countries where government functions in a stable and smooth way, thus providing a safe business climate. Moreover, Tole and Koop (2011) use a dataset going back to 1975 in order to analyze where the world’s largest gold mining companies have chosen to locate new mines, and whether the stringency of environmental regulations has affected this decision. The authors show using econometric techniques that gold mining firms have tended to locate in regions close to their head offices and in regions where corruption levels are low. Furthermore, these companies prefer to locate in regions that can offer a low-risk, secure, transparent and stable business environment. In other words, rather than seeking out countries where environmental regulation is lax, mining firms are primarily searching for countries that provide an overall stable government.

At the same time the politically stable countries also tend to be those with the strictest environmental regulations. Thus, although environmental legislation may act as an impediment to exploration in some regions and can entail delays of the start-up process, the largest mining companies tend to be subject to environmental regulation practically in all places they choose to locate their mining operations. For this reason one is unlikely to detect a close negative empirical relationship between environmental regulation stringency and mining investment.

A number of empirical studies investigate and comment on this relationship in more detail. Annandale and Taplin (2003) address the effect of environmental permitting processes on proposed mine development projects internationally, and they present the results of a survey among 200 mining company executives in Australia and Canada. The responses indicate that a substantive majority of mining companies do not perceive the environmental permitting process...
as an impediment to investment and it may even encourage investment activity. This was particularly the case among the Australian companies, while the Canadian executives overall expressed more concern over the negative impacts of the permitting process. Tole and Koop (2011) report similar results based on their econometric analysis of the locational choice of multi-national gold mining companies. Specifically, they show that strict environmental regulation did not affect the location decisions and it could even attract investment. This is reflected in the fact that gold mining firms seem to be more inclined to invest in regions with a clean environment, although their results are less robust for this finding.

The above shows thus that rather than being intimidated by strict environmental regulation, mining companies may be looking for it, or at least for the factors that the existence of such regulation represent, such as stable political and legal institutions. Companies prefer to commence operations in countries where the environmental regulatory framework is clear and consistent as well as non-discretionary (see also Rémy, 2003). The role of regulatory stability is further accentuated in the Fraser Institute’s annual assessment of the attractiveness of different mining nations for investment. In these assessments mining professionals are asked to evaluate how uncertainty regarding environmental regulations (e.g., the stability of the regulations, the consistency and timeliness of the regulatory processes, whether regulations appear to be based on science or not, etc.) affects their willingness to invest in different regions or countries. This assessment shows, for instance, that in developed countries environmental regulations are generally less of a deterrent to investment than is the case in the developed world. This was in part illustrated also in Figure 1.

In Figure 3 we show the relationship between environmental regulation and political stability as impediments to mining investment based on data from 112 countries on the perceptions of company executives in the global mining industry. This figure shows that countries where environmental regulations are perceived to discourage investments are also countries that are deemed to be overall politically unstable.

Regulatory stability is particularly important for mining given the cyclical nature of minerals markets with widely fluctuating output prices, thus providing narrow investment ‘windows’ and forcing a certain time table for new investments. Results from the Behre Dolbear Group’s annual assessment of the performance of different mining countries add to this picture (Wyatt and McCurdy, 2013). One of the factors that they consider is the average time it takes to obtain a permit decision. According to Wyatt and McCurdy (2013) delays in the permitting process is a global problem, and it will be affected by, for instance, requirements for public consultation, adversarial trials and opposition and intervention by various stakeholder groups and NGOs. For instance, in parts of the USA delays in the permitting process have posed a substantive risk to mining operations, and lead times of 7–10 years before new mines can start operating are common.

Most previous research (including the consultancy reports), though, do not ‘decompose’ the environmental regulatory framework in order to separate between, for instance, the stringency of the imposed permit conditions (e.g., performance standards) on the one hand and other design and implementation features on the other. The latter includes, for instance, the uncertainties created by the lack of timeliness in the regulatory decision-making process. Previous research also lacks a set of comparative studies of regulatory design and implementation in different countries.

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1 McNamara (2009) argues that it is typically easier for a large multi-national mining company with its headquarter in, for instance, Australia to carry out mining activities in a similar regulatory culture with strict environmental standards, as opposed to starting businesses in a country with lax environmental regulations but completely different legal institutions and rules of conduct.
A contributing explanation for the non-existent (and sometimes even positive) relationship between environmental regulation and mining development is that differences in compliance costs across countries may be relatively unimportant to multi-national mining companies since these companies tend to adopt the same technological and environmental standards independent of where they choose to operate. This is in turn due to a number of factors, including that: (a) the most modern and cost-effective mining processes are generally the most environmentally friendly ones; (b) environmental standards are becoming stricter worldwide, it thus makes sense for the industry to adopt strict environmental standards early on, rather than having to readjust later on; and (c) international mining companies are exposed to scrutiny and pressure from the public, banks and the shareholders to pursue appropriate environmental conduct (Peck et al., 1992; Rémy, 2003). The mining technologies used also have to comply with the environmental standards adopted in countries with strict regulations since much of the market potential for metals and minerals are found there.

Furthermore, McNamara (2009) notes that multi-national mining companies, independent of their size, are affected by something that resembles an international consensus on environmental matters, and they are also increasingly influenced by various self-regulatory industry codes and standards. The companies wish to main a good corporate image, and they therefore shy away from situations that could evoke scandals that will make clients, customers and the public lose trust in them (World Bank and International Finance Corporation, 2002).

Hilson (2000) argues that while multi-national mining companies often use the same environmental standards independent of where they are operating, this is not likely to be true for small companies in the developing world. Small local mining operations in poor countries are likely to be the ones primarily affected by, and benefitting from, a lack of stringent environmental regulations. However, small mining companies are also more often dependent on credit, so this is likely to be particularly prevalent in regions and countries in which international banks, development organizations etc. are not pushing for increased environmental conduct (Rémy, 2003).

The above illustrates that it may not be an obvious advantage for countries to implement slack environmental regulations in order to attract foreign mining investment, at least not in the long-run. Still, this does not imply that costs and productivity of mining companies are not affected by environmental regulations (see further section 3). Most notably perhaps, while
companies may well adapt to stricter environmental regulations in the long-run, the intermediate period can be both long and burdensome and involve significant costs and investment in order to comply with the environmental regulations. This implies that the dynamics of the regulatory impacts, including how the responsible regulatory authorities interact with the industry and other regulatory design issues, will be important for addressing the environment-competitiveness dilemma at the company level.

2.2 Lessons from the Industrial Pollution Control Literature

As was noted above, issues relating to regulatory design and implementation have not been adequately addressed in the previous social science literature on mining and the environment. Previous research on differences in environmental regulatory systems across countries (e.g., Lundqvist, 1980; Jänicke, 1992; Bergquist et al., 2013) suggests, for instance, that the presence of negotiated policies in some countries has facilitated the environmental transformation of industrial sectors. Long-term collaborative interaction among companies and regulators can make use of decentralized knowledge and create legitimacy for the policy outcomes. In contrast, more conflict-ridden regulatory systems have tended to produce poorer results in terms of reduced industrial emissions. In this context, comparative studies have argued that the U.S. environmental regulatory approach has been largely adversarial while the corresponding regulations in many European countries have been more consensual (Brickman et al., 1985; Lundqvist, 1980).

Furthermore, previous theoretical and empirical research also suggests that environmental regulations that provide flexibility over time in identifying, developing and demonstrating new technology will stimulate innovation, and permit industrial firms to coordinate pollution prevention measures with productive investments (e.g., Bergquist et al., 2013). In the environmental economics literature a lot of attention has been devoted to the incentive-based policy instruments, such as pollution charges (Goulder and Parry, 2008). There are, however, also important differences in the regulations typically required as a result of individual permits. For instance, pollution standards that are technology- rather than performance-based will risk to force the diffusion of sub-optimal technologies. Lindmark and Bergquist (2008) compare the regulatory strategies to reduce emissions of several heavy metals from two metal smelter plants in Canada and Sweden, respectively. These authors show that the Swedish regulatory approach during the 1970s and 1980s differed from the Canadian one in that it relied exclusively on performance standards as opposed to technology standards. This made it easier for the Swedish plant to experiment with different compliance strategies and to choose the most efficient ones. In the end this resulted in both better economic and environmental performance compared to the Canadian competitor.

The research also emphasizes the importance of inter-temporal flexibility in the compliance process. Sartorius and Zundel (2005) as well as Nentjes et al. (2007) have emphasized that the regulatory ‘time-strategy’ may constitute an important issue in environmental regulation. For instance, longer compliance periods imply a less rapid emission reduction, but at the same time firms have time to reduce uncertainty and compliance costs by engaging in R&D and technology demonstration activities.

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2 The flip-side of this coin is that the transparency of the U.S. system has been – and may still be – higher than in Europe. The European model has historically been more trusting and led by centralized elites. Over time, though, the two systems have tended to converge and adopted similar features (Österled and Vogel, 2001).

4 The importance of the timing of policy and repeated regulator-firm interactions is emphasized also in Mohr (2006) and in a number of industry case studies. For instance, Kivimaa (2007) investigates the environmental policy-innovation linkages in the Nordic pulp, paper and packaging industries, and concludes that credible regulations that are gradually tightened over time will tend to encourage environmental innovation in production processes.
3. Theoretical Remarks and Framework

3.1 The Competitiveness-Environment Relationship

In general competitiveness can be defined as a company’s or an industry sector’s long-run ability to earn money in the market. In order to investigate the impact of environmental regulation on competitiveness one must therefore analyze: (a) to what extent and in what ways these regulations influence companies’ direct and indirect costs and productivity (i.e., crowd out other productive investments); as well as (b) if and how these cost increases can be passed on to the firms’ customers (so-called ‘cost pass-through’) without a resulting loss in revenues. Mining companies in the developed world typically operate in global markets with intense competition for relatively homogenous products, and they therefore have relatively limited scope for passing on increased costs to the customers. In the following we will therefore focus on the impact of regulations on mining companies’ costs and productivity.

Environmental regulations imply that the companies’ productive resources must be allocated to invest in pollution abatement at the expense of other investments. Although such requirements often can be motivated from society’s point-of-view they raise the cost of opening and operating new mines. Figure 4 summarizes different ways in which production costs may be affected, both directly and indirectly. The direct costs include the extra costs associated with, for instance, new equipment, administration (including new staff), production interruptions and the purchase of more expensive factor inputs. These costs can also be ‘hidden’ and not easily detected for an external evaluator (e.g., Joshi et al., 2001). One example of this is where the regulation leads to more frequent production stops, which in turn leads to a decrease in supply reliability. A new regulation can also imply that a mining operation needs to substitute one factor input (e.g., fuel) for another; even if the new input factor has the same price as the replaced one this may result in lower profits due to inferior product quality. The lost revenues of such impacts can be difficult to assess in advance.

The indirect costs arise since the environmental regulations may crowd out other productive investments in capital and/or innovation, and this leads to a lower long-run profitability. If a new pollution standard requires a company to make other priorities in its R&D budget and spend more money on environmental innovation, the direct effect on the firm’s costs may be negligible. Still, since less attention is now paid to conventional R&D there may be negative impacts on the competitiveness in the long-run. Another example of indirect costs is the costs that are often referred to as general equilibrium costs. For instance, if an environmental requirement is imposed on the mining industry, this may influence the costs and prices faced by other sectors (e.g., those that sell inputs to mining companies).

Figure 4: Categorization of the Impacts of Environmental Regulation on the Industry’s Costs

Sources: Based on Jaffe et al. (1995) and Brännlund and Lundgren (2009).
The notion that environmental regulation has negative impacts on industrial competitiveness has also been challenged. Much of this discussion has centered on the so-called Porter hypothesis (Porter and van der Linde, 1995), essentially arguing that ‘properly–designed’ environmental regulations will: (a) stimulate environmental innovation (the weak version of the hypothesis); and (b) increase not only the environmental performance but also the economic performance (i.e., profits, productivity etc.) of industries (the strong version). According to Porter and van der Linde (1995) properly–designed environmental regulations should adhere to three principles. First, the regulations must create maximum opportunities for compliance and innovation, leaving the specific technology choices and compliance strategies to industry and not to the regulator. Second, the regulatory process should leave as little room as possible for uncertainty at every stage. Third and finally, the environmental regulations should foster continuous environmental improvements rather than locking in any particular technology.

In general, there is strong empirical support for the weak version of the Porter hypothesis (e.g., Ambec et al., 2011, Ford et al., 2014; Lanoie et al., 2011; Söderholm and Bergquist, 2013). This is far from controversial; regulatory decisions that force companies to undertake pollution abatement investments will provide incentives to search for and develop new and cheaper abatement technology. The strong version of the Porter hypothesis is much more controversial, and contrasts with the above notion of increased costs and lower industrial productivity following the introduction of environmental regulations. However, the empirical support for this hypothesis is limited (e.g., see the review by Brännlund and Lundgren, 2009). Although there may be single cases where one ex post can observe non–insignificant productivity improvements following the implementation of stricter regulations, this does not imply that the introduction of stricter regulations is motivated ex ante. At the company level there are likely to exist several – not yet identified – productivity–enhancing measures that could be undertaken if companies allocated enough resources (e.g., staff hours) to identify these. Still, in a world of scarce resources the relevant question is not whether such search efforts generate new ideas and solutions or not, but instead whether the search efforts that are being induced by the environmental regulations generally lead to more significant productivity improvements compared to the corresponding search efforts that companies do initiate themselves (e.g., Jaffe et al., 1995).

In this report we do not provide explicit tests of the Porter hypotheses. Instead we address the issue of how environmental regulations should be designed and implemented to potentially ease up the tension between regulatory pressure and competitiveness. In this context Porter’s criteria for properly designed regulations are of significant interest, and in the next sub-section we discuss and develop these further.

3.2 The Importance of Environmental Regulatory Design and Implementation

In this sub-section we define and discuss three features of environmental regulations that could affect the prospects for addressing both environmental and competitiveness concerns in the mining permitting process. These are briefly summarized and exemplified in Figure 5. Here we distinguish between regulatory issues that arise before the permit is granted (ex ante), and the design and implementation of the regulations in the case where the permit is granted (ex post). The analytical concepts outlined and discussed in the remainder of this section constitute the basis for the empirical analysis in section 5.

Figure 5: Environmental Permits and Competitiveness: Critical Issues
Mining is a capital intensive industry and many of the competitiveness concerns associated with environmental regulations could emerge in the form of a lack of predictability and timeliness prior to the regulatory decision. For a mining company capacity expansions (or replacements) are keys to its future competitive strength. However, due to the cyclical nature of minerals markets, the mining industry has typically faced narrow investment windows, i.e., periods characterized by high prices and favorable conditions for loan financing. Moreover, the competitive environment has led to an increased demand for efficiency improvements and high capacity utilization rates. This includes, for instance, the adoption of lean manufacturing techniques and just-in-time inventory systems (Humphreys, 2000). This can in turn greatly increase the importance of a producer’s capacity to demonstrate itself as a consistent and reliable supplier. Significant delays in the permitting processes – e.g., due to a lack of staff and resources at the regulatory authorities and/or generous opportunities for local stakeholders to participate (and appeal) in the process – may threaten this reputation.

However, while the source of money, the timing of repayment of loans, the need to make a profit etc., tend to force a particular timetable (and outcome), the mining industry must also acknowledge the business risks associated with tense community relations. Over time the industry has witnessed an increased demand for a more inclusive mining sector that embraces the rights of people, and involves more direct participation in decision-making processes at the regional and local level (e.g., Söderholm and Svahn, 2014). For these reasons several companies and governments in mineral-rich countries have embraced the need for mineral ventures to gain a ‘social license’ to operate, i.e., a broad societal approval and acceptance of these ventures that goes beyond the requirements of formal licenses. Typically this requires early and constructive dialogues with important stakeholders and the local population to avoid future appeals and delays in the process (Prno, 2013).

Another issue that may influence the predictability of the outcome of the permitting processes is if the legislation provides authorities with a substantial degree of discretion to interpret how the rules should be interpreted and put into practice (e.g., concerning the conditions for obtaining a permit). For instance, if the legal rules provide very vague guidelines for how to assess specific cases, this could provide room for late appeals and lengthy licensing processes. Often the legal rules are deliberately vague; one could argue that they have been formulated so as to provide scope for promoting the interest of both economic development and environmental protection over time. However, legal rules should also aim to clarify “what applies” in a particular situation (Pettersson and Söderholm, 2014). Our empirical investigation in section 4 shows that the absence of clear ex ante guidelines for what applies has occasionally led to problems for the mining industry (e.g., in Sweden).

**Flexibility** concerns how the conditions of the permit are set, first of all to which extent they rely on technology prescriptions or on performance-based emission standards. Performance or technology standards have been the main policy instruments to regulate industrial pollution in most countries (e.g., Ashford and Caldart, 2008). However, the economic impacts of these are likely to differ significantly. Individual mines typically differ in terms of their pollution abatement costs, and these costs are not likely to be known with any certainty prior to investment. Still, mining companies normally know far better than the regulating authorities what it will cost to abate emissions at the mine. They also have few incentives to reveal this information to the regulator. This is known as information asymmetries. In such a setting performance standards are likely to be more cost-effective, since these leave it to the individual company to identify the relevant compliance measures. Technology standards instead dictate what specific processes or solutions that companies must use; by design this type of regulation provides little leeway to undertake other potentially more efficient measures.

Since the future costs of pollution abatement technology are uncertain, companies need to develop and test new and more efficient technological solutions in order to comply with increasingly stringent regulations. Given the uncertainties involved in the R&D and technology demonstration process, flexibility is important also in terms of the time allowed for
complying with the permit conditions (Nentjes et al., 2007). For instance, the capital stock of the mining industry is durable and replacing industrial equipment etc. is likely to be relatively costly and time-consuming. For this reason extended compliance periods could help ease the environmental-competitiveness trade-off. This type of dynamic flexibility provides companies with time to experiment and test new technologies, and avoid errors in the compliance process.\(^5\)

Finally, the stringency of the regulations is clearly relevant from a competitiveness perspective. In most countries the environmental permitting processes involve also an assessment of the presence of “excessive costs” (e.g., Sorrell, 2002), but there exists no well-established methodological approach to assess such impacts in individual cases. In our investigation we primarily address the issue of regulatory stringency from a dynamic perspective, and in the context of Porter’s criterion that the regulations should foster continuous environmental improvements. In the presence of firm-regulator information asymmetries, though, this is often difficult to achieve in practice, and may involve difficult trade-offs. The incentive effects of performance-based emission standards will deteriorate over time, e.g., as less costly abatement technologies are introduced. For this reason, there will be calls for a gradual tightening of the standards, but in determining the new values, the authorities require substantial knowledge about future abatement costs. If they underestimate these costs, the limit values may be very stringent with potentially detrimental effects on the economic performance of industrial activity. In contrast, if the costs are overestimated, the implemented emission standards will be too lax, thus resulting in weak incentives for mining companies to improve their environmental performance.\(^6\)

Again, an important regulatory tool for resolving this competitiveness-environment trade-off is the allowed compliance period. A longer compliance period implies a less rapid emission reduction, but at the same time firms have time to reduce uncertainty and compliance costs by engaging in R&D and demonstration activities. It may also be important for the authorities to invest in know-how on industry-specific pollution abatement technology to bridge information asymmetries between plant owners and the regulating authorities. As was noted in section 2, the use of a consensus-based regulatory strategy, including regular and constructive dialogues between the regulator and the industry (e.g., concerning time plans, compliance methods etc.), could assist in this process.

The above analytical framework pinpoints a number of conditions under which the environmental permitting can provide scope for achieving improved environmental performance with minor negative repercussions for the competitiveness of the mining industry. These include, for instance, firm flexibility in terms of compliance measures, the use of compliance periods to permit demonstration projects and tests, clear legal guidelines for how to address different conflicts of interest and high regulatory competence. The remainder of the report analyzes the regulatory approaches in Finland, Sweden, Canada, Australia and Russia in the context of these conditions.

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\(^5\) The notion that the costs of innovation can be reduced by extending the R&D period has been illustrated in, for instance, Kamien and Schwartz (1982) and Viscusi et al. (2005).

\(^6\) It can be noted that in this situation, performance standards are likely to perform worse than market-based instruments (e.g., emission charges, markets for tradable allowances etc.). The reason is that under a performance standard the company will have no incentive to perform beyond the pre-determined limit value, while market-based instruments generally induce plant owners to conduct low-cost abatement beyond this level (since this reduces charge or allowance payments). See, for instance, Goeller and Parry (2008).
4. Background to the Pollution Control Legislation in the Five Countries

In all five countries the environmental permitting of mining operations is (and has also historically been) based on case-by-case assessments. The permitting processes are however complex, typically involving the application of a large number of rules, distributed among several different laws and levels of authority, as well as environmental impact assessments and consultations with various stakeholders. In this report, though, we focus solely on the most important legal rules pertaining specifically to industrial pollution control. A more comprehensive presentation and assessment of the permitting of mining operations in Finland, Sweden and Russia are provided by Pettersson et al. (2014). McNamara (2009) reviews the environmental regulation of mining operations in several countries, including Australia (see also Blake and Lawson, 2011), while Davies (2011) covers the Canadian process.

In Sweden, besides an exploitation concession (in line with the Minerals Act) it is also necessary for mining operations to obtain an environmental permit in accordance with the Environmental Code (1998:808). An environmental impact assessment (EIA) is required, and the resulting regulations and conditions (e.g., emission standards) rely heavily on the criteria outlined in the Code, including, for instance, the precautionary principle and the requirements for Best Available Technique (BAT). The decisions concerning the specific conditions of the environmental permit (if granted) are taken by the regional Land and Environmental Courts.

As was noted in the introduction, the Swedish permitting process for industrial plants prior to the advent of the Environmental Code in 1998 is of interest from an environment-competitiveness point-of-view, and below we address a number of important features of this earlier regulatory approach. The legal rules outlined in the 1969 Environmental Protection Act were overall very similar to those of its successor (the Environmental Code). However, the 1969 Act envisaged a permitting process that was based on a policy-style seeking cooperation and consensus between the regulators and the industry (Bergquist et al., 2013; Lundqvist, 1980). The process was administrated by the Franchise Board of Environmental Protection (FBEP), and the permits had to be reassessed and renewed every 10 years on the basis of what was considered BAT at the time. In the following we illustrate how this regulatory approach relied on flexible performance standards implemented in combination with extended compliance periods. In these ways it provided scope for environmental innovation, and permitted the affected companies to coordinate pollution abatement measures with productive investments.

In Finland the permitting process is overall similar to the Swedish one (Söderholm et al., 2014). The main legal document concerning the prevention of air and water pollution is the Finnish Environmental Protection Act (EPA 86/200), and similar to Sweden it is based on general principles such as BAT, the principle of caution and care, the polluter pays principle etc. Some environmental issues are addressed also in the Finnish Mining Act (621/2011). All permit applica-
tions must include a comprehensive EIA, which is then reviewed by the Regional State Administrative Agencies. These also grant the permit and stipulate the permit conditions.

Moreover, since both Sweden and Finland are Member States of the European Union, a number of EU Directives also affect the environmental regulation of the mining industry. For instance, an integrated pollution prevention approach based on individual performance standards for industrial plants has been the core of the so-called IPPC Directive (Directive 2008//EC) and in the more recent Industrial Emissions Directive (Directive 2010/75/EC), the latter repealing the IPPC Directive as of January 1, 2014. Moreover, public participation is required in both the Swedish and the Finnish EIA procedures, but such deliberations were more limited in Sweden during the 1970s and 1980s (e.g., Lundqvist, 1980). Until the 1990s, Swedish industrial pollution regulation only involved a few networks of actors.

In Russia, the exploitation of mineral resources is based on a licensing regime, and the main legislation consists of the 1992 Subsoil law. According to this legislation any company that holds the user rights has certain obligations, including, for instance, the prevention of the accumulation of industrial or domestic waste in catchment areas and in places where groundwater is used for drinking. Moreover, the mining operations must also comply with certain technical (including environmental) standards. These should be agreed by a special committee prior to approval. This committee is established by the Federal authority for administration of the State fund of Subsoil resources, and it includes representatives of the State mining supervision and executive authorities in the field of environmental protection. Prior to the permit decision an EIA must be conducted, and this involves several other legal acts, e.g., the Environmental Protection Act. These include substantive provisions in relation to the environment, and prescribe, for instance, precautionary measures, emission standards and environmental quality standards. Still, in spite of these formal requirements there are serious indications suggesting that in practice the room for neglecting important pollution impacts can be significant in Russia (e.g., Pettersson et al., 2014).

In Australia, the environmental regulation of mining operations varies across the different states (Blake Dawson, 2011). The federal government is not formally involved in the management of mineral resources unless the Parliament (or the High Court), can justify such an involvement. This takes place in the case of the Environmental Protection and Biodiversity Conservation (EPBC) Act. State and territory environmental legislation generally regulates the management of air, water, land and noise pollution; the protection of flora, fauna and habitat; as well as the recognition and prevention of adverse impacts on indigenous areas. Blake Dawson (2011) argues that although the states’ environmental permitting processes for new mining ventures share some common characteristics, there are also important differences (see also Figure 2). One common feature is that an environmental impact assessment is required, but the exact design of this assessment is case-dependent. In the next section we pin-point some selected relevant experiences from the Australian states.

In Canada, the mining industry is regulated at three different levels – the federal level, the provincial level, and the territorial level (Davies, 2011). Permit issuance and environmental monitoring and enforcement are normally regulated and managed by the provinces, although for some operations there is interaction also with the federal level (particularly for uranium mines). The legal basis for the environmental assessment procedure at the federal level is provided by the Canadian Environmental Assessment Act (CEEA), but provincial permits are typically also required for the proposed activities (Government of Canada, 2010). Most provinces have however established cooperative agreements with the federal government so that only one environmental assessment is required for a mining project. Still, the exact set-up and requirements concerning this assessment will normally vary across provinces. Moreover, once the mining project come into operation there exist regulations that control the emissions of effluents from the mines, including the so-called Metal Mining Effluent Regulations stipulating limit values for the release of various substances such as arsenic, cyanide and copper.
In this section we depart from the theoretical framework outlined in section 3.2. We identify and discuss a number of important regulatory design and implementation issues in the empirical context of Finland, Sweden, Russia, Australia and Canada that are deemed to be relevant from an environment-competitiveness point-of-view. The analysis is structured around three issues: regulatory efficiency and predictability, compliance flexibility and the stringency of the regulatory conditions over time.

5.1 Regulatory Efficiency and Predictability
As was noted above, timeliness and predictability in the permitting process are both important issues for resolving the environment-competitiveness trade-off at the industrial level. In this sub-section we discuss these issues in turn.

Permitting delays in the mining development phase is a global concern, and the least frequent delays are typically found in developed mining countries such as Australia, Canada and Chile (Behre Dolbear, 2014). In all of our five countries, though, critique has been raised about the long timeframes involved in obtaining permits, and measures have been undertaken to shorten the permitting process. This includes allocating more resources (staff) to the relevant authorities. None of the countries have however introduced pre-specified time limits within which a decision has to be made. In Sweden the average time for mining cases administered at the Land and Environmental...
Court has been about 2 years (over the time period 2002-2011), but it has also varied a lot across single cases (reaching a maximum of 5.5 years in one case) (SveMin, 2012). In Finland the waiting time at the Regional State Administrative Agency before mining development can commence has been 1-3 years (e.g., Söderholm et al., 2014; Wilson and Cervantes, 2014). Another example is Western Australia in which the permitting process can take as long as ten years to complete, in part since approvals from the federal government may be necessary and due to overlaps in legislation and responsibilities. Finally, according to Behre Dolbear (2014) Russia is one of the countries where permitting delays cause some of the most significant risks to international mining ventures.

The impacts of such extended processes, it has been argued (e.g., by representatives of some Swedish and Finnish mining companies), include a reduced ability to supply the customers with the planned output of mineral products. In Sweden one relatively recent example of this is the permitting process for a new tailings pond at Hötjärn supporting Boliden’s mine operations (Granberg, 2013). This project was delayed several years; a permit was first granted in 2007 but then followed appeals and in November 2011 the case was brought to the Supreme Court of Sweden. The Court rejected the last appeals, and Hötjärn was taken into operation. The consequences of the delay was reduced mine output over the period. In general, the lack of timeliness could also lead to increased uncertainty about whether the mining operations will be able to benefit from high output prices (this also increasing the prospects for loan financing).

In Sweden the government has allocated more resources to the regulatory authorities with the aim to reduce permitting delays. In Finland the environmental permit is granted by regional authorities (the Regional State Administrative Agency), but these are generally not well-resourced either, making it also harder to monitor and enforce regulations (Korvela, 2013). Still, given the cyclical nature of the mining industry it may often be difficult for these authorities to plan staff requirements over extended time periods.

Public participation in the decision-making processes is an important issue in the Finnish and Swedish permitting processes, and the Nordic mining companies often have an incentive to outperform the legal requirements on this account (i.e., to gain a social
5. EMPIRICAL ANALYSES OF ENVIRONMENTAL PERMITTING PROCESSES

In Sweden the performance standards that will form part of industrial firms’ permit conditions often differ depending on the location and on the extent to which different expert authorities (e.g., Granberg, 2013). Also the EIA process in Russia can be time-consuming as a consequence of the requirement to discuss critical issues with stakeholders. There are even examples where companies have had to start the EIA process from scratch because of absent deliberations.

The timeliness of the permitting process appears not only to be a matter of having more staff at the regulatory authorities. It is also related to the predictability of the regulations in terms of how to interpret the legal rules. Vague guidelines create uncertainties, and appeals may come late in the process, thus further extending the timeframes involved in obtaining a permit. A recent example of such regulatory uncertainty is the experiences of the Swedish state-owned iron ore producer LKAB in the community of Sappavaara. In this case the company was first (in 2010) granted a permit by the Land and Environmental Court to undertake mining activities. This decision was however appealed by the Swedish Environmental Protection Agency on the grounds that the new operations had to be judged in conjunction with existing (refining) facilities. This argument was later endorsed by the so-called Environmental Court of Appeal, which thus rejected the company’s original application since, the Court argued, it was too narrow in scope. A new application had to be prepared, and overall this caused a three-year delay in the process. In November 2013, a new permit could be issued by the Land and Environmental Court.

While this type of integrated environmental assessment often is motivated for environmental reasons, the problem here is that LKAB was given little opportunity to ex ante anticipate the Courts’ views and their ultimate verdicts on the planned operations (see also Pettersson and Söderholm, 2014). In these types of assessments the Swedish legal text provides limited guidelines for how to determine the scope of the permit application. In Finland (as well as in Russia) similar requirements for integrated environmental assessments exist. However, so far this type of ruling has not caused any permitting delays in the Finnish mining sector.

In some respects, the environmental requirements for mining operations in Russia may be stricter than in other developed mining countries such as Canada (e.g., dry-stacked gold tailings in some jurisdictions) (Cervantes et al., 2013). However, as illustrated in Figure 1 the perceived uncertainty surrounding the implementation of the environmental regulations is likely to be a more significant impediment to mining investment in the country (than stringent conditions). One reason for this is that occasionally the authorities may implement less stringent regulations to avoid disruptive social impacts (e.g., lay-offs etc.), although this is more prevalent in the case of small companies. For the mining industry a more important concern is that although the regional governments have the mandate to decide on the local regulatory requirements and how these should be applied, the federal state system adds additional complexity (e.g., Beare, 2009). In general significant consultations with regional authorities are needed, and the staff members from different authorities are not always well-coordinated. Moreover, the regulations in this area are fairly recent. As a result of this, regulators still have not fully adapted to the new rules, and in some cases the Russian authorities have not been sure about how the environmental legislation should be implemented.

In Sweden, Finland, Canada and Australia there have also been calls for increased cooperation across juris-

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7 In cases where such early deliberations are not initiated, intense protests can take off. For instance, Beowulf Mining’s planned iron ore project in Kallak in the north of Sweden has seen intense protests by Sami groups and environmental activists. This conflict has even reached the news headlines in other countries. See, for instance, the article at BBC News website in July, 2014 (http://www.bbc.com/news/business-29547314).

8 In Sweden the performance standards that will form part of industrial firms’ permit conditions often differ depending on the location and on the extent to which different expert authorities (e.g., the Swedish Environmental Protection Agency) raise concerns about a particular issue or not. This is in some contrast to Finland, Canada and Russia where there is a greater reliance on pre-determined standards, e.g., for noise, arsenic etc. While the latter adds predictability to the permitting process it may however also lead to unreasonable outcomes in individual cases (i.e., too strict in some cases and non-binding in others). This type of difference in standard-setting has also been detected when comparing other industrial activities, such as the regulation of Swedish and Danish wind power plants (e.g., Pettersson et al., 2010).
dictions. In Western Australia, for instance, the lack of such coordination has led to overlaps and duplication, and the mining companies may be exposed to a complex and time-consuming permitting process (e.g., Chamber of Commerce & Industry of Western Australia, 2013). For these reasons, in 2013 a proposal for an amendment of the environmental permitting process has been put forward (i.e., the so-called Mining Legislation Amendment Bill 2013). The aim of the proposed changes is to create a process that is risk-based, transparent and clear for the applicants (Barton, 2013).

Similar reforms have been called for – and in part announced – also in New South Wales, Queensland (Heber, 2013) and in Canada (Davies, 2011). In British Columbia (Canada) the main piece of legislation regulating the environment is the British Columbia Environmental Assessment Act (BCEAA). It was introduced to complement the environmental assessment process necessary according to the CEAA at the federal level (see section 4). According to Wilson et al. (2013) this has increased the uncertainties and costs surrounding the permitting process.

5.2 Compliance Flexibility in Terms of Technology Choices and Adjustment Periods

Flexibility and firm discretion in identifying the most suitable pollution abatement technology are important prerequisites for efficient compliance and technology adoption outcomes. In all five countries there is a relatively frequent reliance on performance rather than technology standards in the permitting conditions, e.g., emission limit values. Still, technology standards may also be used. One of the Finnish mining companies expressed that a stronger emphasis on technology standards would likely have serious negative impacts on operations due to the associated lack of flexibility (Söderholm et al., 2014). In some regions the focus on compliance flexibility has grown over time. For instance, in South Australia amendments to the Mining Act (in 2013) prioritize a regulatory approach on performance and risk assessment for mining operations. In Sweden, though, the emphasis on compliance flexibility was even stronger before the advent of the Environmental Code. During the 1970s and 1980s the BAT-requirements were also then mandatory, but the FBEP regulator consistently avoided technology standards in favour of individual performance standards.

With a combination of tough performance standards and extended compliance periods, the companies may also face inter-temporal flexibility. In both Finland and Sweden there is legal room for imposing extended compliance periods, thus allowing companies to develop and demonstrate new technology. However, today this does not appear to be used consistently in any of the countries. In Finland the absence of longer compliance periods has even created problems for the mining industry. Specifically, in 2009 Agnico-Eagle Finland (AEF) started its gold production, and in 2012 the company initiated a new permitting process in order to be able to increase production. Based on the EIA the company, among other things, proposed an emission limit value for sulphate at 5000 mg/l (to be enforced in late 2016 at the earliest). However, the permit conditions stipulated a limit value of 2000 mg/l, coming into force already in 2014. Moreover, the conditions also stated that a limit value of 1000 mg/l should be used from 2017 and onwards. Due to these stringent regulations and the short compliance period, AEF has appealed the permit decision. The company argues that reaching such low emission levels will take considerable time. First it needs to identify a method with which it is possible to reach the stipulated sulphate levels, then test this in the lab, do pilot testing and finally resolve the technical solutions and planning (Söderholm et al., 2014). Again, the earlier Swedish permitting process provided greater scope for inter-temporal flexibility. This was evident in the permitting of the LKAB and Boliden operations during the 1970s and 1980s. For instance, LKAB obtained a compliance period of two years in the late 1970s in order to investigate how appropriate protective measures against the emissions of dust following the production increase at the company’s pellet plant should be carried out. The FBEP justified this decision with the argument that this question could not be answered until the rebuilt pellet plant had been tested in practical operation. Even in the presence of economic downturns, such as in 1978 when LKAB (facing the advent of the second oil crises) was forced to put a pellet plant on standby,
the company was instructed by the FBEP to continue the investigations. In this case the testing concerned the emissions of dust, fluorine and sulfur compounds from the plant. At the same time the Board also stated that given the uncertain economic prospects at the time it was not reasonable to tighten the conditions further since this could imply that LKAB made extensive investments that in the end could prove superfluous.

The compliance periods could also involve several parallel investigations regarding different pollution abatement measures. In 1974, Boliden planned to expand production at its Laisvall mine, and as part of the permitting process it investigated advanced new as well as improved existing purification of the company’s waterborne emissions. In addition, at the request of the authorities Boliden also investigated the possibility to recover the wastewater instead of letting it out. Ultimately, in 1986 when the final permit was issued, it would prove that the proposed treatment plant – based on, for instance, sulfide precipitation – in part tested and developed by the company, implied such low levels of heavy metals in the fish that it was no longer justified to consider the possible recovery of the wastewater. The total compliance period was ten years. No similar or related strategy for addressing firm-regulator interactions and the balancing act between environmental and economic outcomes over time appears to exist in the current regulatory systems in Sweden, Finland or Russia.

5.3 The Prospects for Implementing More Stringent Regulations over Time

In striking a balance between tough environmental regulations on the one hand and competitiveness on the other, one must also consider the prospects for providing continuous incentives for improved environmental performance over time. In some countries the prospects for introducing re-assessments of existing permits are limited, if not only for a lack of resources at the responsible authorities. Moreover, as noted above (see section 3.2), regulator–company information asymmetries make it difficult to implement standards that are not based on either an underestimation or an overestimation of the compliance costs. The efficient tightening of, for instance, emission standards over time may therefore require substantial investment in regulatory engineering competence. By allowing longer compliance periods, thus reducing investment uncertainty and permitting flexibility in R&D and demonstration strategies, the affected companies could also cope with the increased uncertainty associated with more ambitious standards in the future.

Re-assessments of existing environmental permits appear to take place more frequently in Finland and Russia compared to Sweden (where they are rare, primarily due to a lack of adequate regulatory resources and staff). Still, in the previous Swedish permitting processes the permits had to be reassessed and renewed every 10 years on the basis of what was considered BAT at the time. In Russia permits are granted for a five-year period. Here companies also pay a fee for emissions that are above the standard, thus implying that they will have an incentive to keep emissions below pre-determined limit value.

While the experiences of permit re-assessments are generally not well-documented one may note that there is evidence of concerns about the regulatory competence concerning industrial production processes and pollution abatement options. In Finland concerns have been raised about the need for more interaction between the supervisory and permit-issuing authorities on the one hand and the mining companies on the other (Söderholm et al., 2014). This could help in reaching a consensus on how to interpret and implement the permit (as well as identifying any necessary revisions to the permit conditions). The lack of engineering competence in the permitting process was also brought up in Finland with respect to the AEF mine and the sulfate regulations. A similar critique has been directed at the Swedish environmental authorities in connection to mining permit processes (e.g., Aaro et al., 2012; Granberg, 2013). For instance, permits may be revoked on procedural and formalistic grounds, while less attention, it is often argued, is devoted to the technical issues (e.g., pollution abatement technology and its costs).

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9 This issue was also raised in connection to the so-called Talvivaara nickel and zinc mine in the eastern part of Finland. It has experienced numerous environmental challenges since its start, and one of the most recent problems was a toxic water leak in November 2012 (Karvela, 2013).
One may note that in part the lack of competence and resources at the regulatory authorities can be attributed to the unanticipated minerals boom in the early 2000s. At the end of the 1990s the global interest in mining investment increased rapidly and regulatory authorities were largely unprepared for this. This has been evident also in other developed mining countries. In Canada the government has invested about US$ 160 million in order to improve the capacity of agents and departments that form part of the regulatory process that mining companies have to go through (Government of Canada, 2010).

Bergquist et al. (2013) show that during the 1970s and 1980s, the Swedish authorities were able to implement gradually stricter emission limit values for industrial plants (e.g., in the metal smelting industries), without this having serious negative impacts on profits and industrial productivity. This required, though, substantial investment among regulatory and other government authorities (e.g., the Swedish Environmental Protection Agency) in know-how on industry-specific pollution abatement technology to bridge information asymmetries between plant owners and the authorities. Central to this development was the exchange of information between the regulatory authorities and the companies. The Swedish Environmental Protection Agency and the County Administrative Boards (i.e., the regional governments) participated in the investigations and planned the investigation work in collaboration with the company, and then also followed the work through frequent site visits. Over time the authorities – including the FBEP – gained improved information and knowledge about the abatement opportunities and costs at the individual plants. New knowledge, e.g., developed in joint public–private research programs, was then effectively used by the regulatory authorities in upcoming permitting processes.

In the absence of clear-cut ambient environmental quality standards the FBEP also had the opportunity to alter the permit requirements as new knowledge was advanced. This typically took place when the permits were updated, and in the Laisvall (Boliden) case the abatement requirements were radically tightened during the time period 1974–1986 (see also above). In addition, although LKAB put its pellet plant on standby due to the weak market situation (in 1978) the company continued to evaluate different methods for reducing dust emissions. Through the continued investigations under the supervision of the Swedish Environmental Protection Agency during the standby period, the FBEP later on, in 1979, could tighten the requirements of the 1976 permit concerning dust emissions, from 0.9 kg/t, to 0.5 kg/t. Overall, this meant a reduction of dust emissions from 4.6 kg/t real emissions in 1975 to conditions, based on a technology that was not yet in commercial operation, of only 0.5 kg/t emissions in 1979. Finally, as was noted above, the extended compliance periods also tended to foster continuous environmental improvements, and they permitted the companies to combine productive investments with pollution abatement measures. The compliance periods also increased the regulatory system’s legitimacy. This type of flexibility in terms of compliance and time strategies has not formed part of many other countries’ regulatory approaches (see also Yarime, 2007; Lindmark and Bergquist, 2008).
6. Concluding Remarks and Avenues for Future Research

The nature of mining development requires a substantial degree of risk-taking that needs to be recognized and rewarded. At the same time the environmental impacts of mining may be significant, and there is a need for regulations, although they tend to increase the time, costs and risks associated with bringing a mine into production. Costs may arise because of expenditures on EIAs and on implementing the required changes in the production process. In addition, and perhaps even more importantly, significant risks coupled with the timeliness and the content of the permit arise from the perspective of the company prior to mining. This suggests that there is a need for extending the time horizons of the regulations as well as emphasizing a simple, rule-based process for granting permits that – as far as possible – minimize investor uncertainty and enhances predictability. For the above reasons it is important to understand how the environmental permitting of mining operations can be designed and implemented to make possible both favorable environmental and economic outcomes.

In contrast to previous research in the field we made an explicit distinction between the stringency, the flexibility and the predictability/timeliness of the environmental permitting process. We provided an analysis of how these issues tend to play out in the permitting of mines in Finland, Sweden, Australia, Canada and Russia. Our analysis concerned not only the formal legislation but also relied heavily on information from individual processes, sometimes spanning over a long time period. The results reveal some important differences between the five countries, even when comparing Finland and Sweden that have adopted very similar environmental legislations. For instance, there appears to be a stronger reliance on pre-determined performance standards in Finland (and also in Canada), something which may lead to stringent conditions in specific cases.

The empirical investigations showed that overall in all five countries – and regardless of some important differences across these – a lack of timeliness and predictability in the environmental regulations has constituted a significant obstacle to new (or expanding) mining operations. The uncertainties facing mining companies concern thus both the time it takes to get a permit, but not least the nature of the conditions laid out in the permit (if granted). These problems can in part be addressed by: (a) allocating more resources to the regulatory authorities; (b) establishing a closer cooperation between industry and the authorities (in this way reducing company–regulator information asymmetries); and (c) by introducing more standardized procedures and road maps for EIAs and permit applications, as well as for how to interpret specific legal rules.10 This could minimize the risk of the use of different legal interpretations, and ensure that potential problems can be identified and addressed at an early stage.

For mining companies it is important to acknowledge that the permitting process must take a certain amount of time in order to establish good relations with local stakeholders etc. This also requires early preparations to avoid appeals, which otherwise could lead to an even more extended legal process.

In terms of flexibility all five countries tend to pro-

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10 In Sweden the Swedish Geological Survey (2013) has published an in-depth description of the mining permitting process in the country. This provides some classifications, but it does, however, still leave room for different interpretations of specific legal rules (e.g., the scope of the integrated environmental assessment).
vide mining companies with quite a lot of discretion in terms of choosing compliance strategy. Hence, performance rather than technology standards are employed in most cases. However, there appears to have been less emphasis on granting dynamic flexibility (e.g., in Finland). This is in contrast to the earlier Swedish industrial pollution control system during the 1970s and 1980s. During this time standards were implemented in combination with extended compliance periods, as well as support for joint state-industry R&D projects. In these ways the Swedish regulatory approach provided scope for environmental innovation and permitted the affected companies to coordinate pollution abatement measures with productive investments.

In this report we have however only scratched the surface in terms of addressing the relationship between tougher environmental requirements and competitiveness, and future research is needed. Most importantly perhaps, future research needs to go beyond the formal legal rules, secondary sources, companies’ perceptions etc., and focus even more on learning from the experiences of actual cases across different countries. In addition, comparing the impacts of environmental regulations across countries is a very complex research undertaking, which requires in–depth investigations of not only the legal texts but also how the rules are applied in practice (and the scope for different interpretations etc.).

Moreover, the environmental regulations of the mining industry (and of other industries) are becoming tougher and more complex over time, in part as a result of new layers of legislation. This is perhaps particularly evident in the Member States of the European Union. First, the recently adopted EU Industrial Emissions Directive (IED) will influence pollution regulations in the Union’s industrial sectors. The IED replaces the so-called IPPC-directive and aims to tighten and clarify the relevant BAT requirements. The BAT reference documents have been interpreted rather differently in different Member States, and an important purpose of the IED is to remedy these flaws. The so-called Sevilla process (i.e., the process during which the BAT reference documents are generated) will be more formalized, e.g., through the process of establishing ‘BAT conclusions’ by a committee procedure. The BAT conclusions must be considered in the permitting process, and if they include performance standards for emissions, the regulatory authorities cannot (as a main rule) allow emission levels that exceed BAT in accordance with the BAT conclusions.
A second example is the EU Water Framework Directive, which establishes environmental quality standards for water streams etc. In these settings the liability of each individual activity will depend on the aggregate influence from the entire group of households and companies affecting the water quality. The influence from specific polluters as well as the costs of pollution abatement are however not (easily) observable due to the presence of asymmetric information (Segerson, 1988). In implementing this Directive at the Member State level, there is therefore also a risk that activities requiring a new permit (e.g., mines) will need to assume a large share of the pollution control measures to address any cumulative effects compared to other activities affecting a water stream etc. Big industrial facilities are easily targeted, and there are well-established legal frameworks for regulating these. At a general level, this also implies that the environmental requirements facing the mining industry will be affected by the extent to which other actors and activities are regulated.

Finally, additional research is also needed on the regulation of mine closure and rehabilitation. This tends to vary from country to country depending on public policies and industry practices, and intercountry comparisons would be very meaningful. The key issues for the regulation of mine closure include, for instance, the rehabilitation requirements and the nature of post-mining liability. The most common mechanism for ensuring appropriate procedures are followed is a reclamation bond or fund (Gerard, 2000). Such a bond implies that the mining industry sets aside money (e.g., into an escrow account) as a guarantee that they will perform the required reclamation work. A critical issue is how to determine the size of the bond, as well as its impact on environmental performance and competitiveness. Moreover, when bonds are required, how effectively do they promote site reclamation? Overall the research literature lacks enough theoretical and empirical investigations of these reclamation bond issues.
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