Resources Policy 43 (2015) 130–142

Contents lists available at ScienceDirect

Resources Policy

journal homepage: www.elsevier.com/locate/resourpol

Environmental regulation and competitiveness in the mining industry: Permitting processes with special focus on Finland, Sweden and Russia☆

Kristina Söderholm[a], Patrik Söderholm[a,*], Heidi Helenius[b], Maria Pettersson[a], Roine Viklund[a], Vladimir Masloboev[c], Tatiana Mingaleva[c], Viktor Petrov[c]

[a] Division of Social Science, Luleå University of Technology, Luleå, Sweden
[b] University of Lapland, Faculty of Law, Rovaniemi, Finland
[c] Institute of Industrial Ecology Problems in the North, Kola Science Centre, Russian Academy of Science, Apatity, Russia

ARTICLE INFO

Article history:
Received 12 October 2014
Received in revised form
28 November 2014
Accepted 28 November 2014
Available online 6 January 2015

Keywords:
Environmental regulation
Mining industry
Competitiveness
Nordic countries

JEL classification:
D24
K32
L72

ABSTRACT

This paper investigates to what extent and under what circumstances environmental regulation can be designed and implemented to jointly achieve positive environmental outcomes and sustained competitive strength in the mining industry. First the paper provides a conceptual analysis of the impacts of environmental regulations on mining competitiveness, including a discussion of how the environmental-competitiveness trade-off can be affected by various regulatory design and implementation strategies. Methodologically we distinguish between the flexibility, predictability and stringency of the regulations, and in a second step these analytical concepts are illustrated in the empirical context of the environmental permitting processes in Finland, Sweden and Russia. An important result is that in these countries there has been a lack of timeliness and predictability in the environmental regulations (e.g., uncertainty about the interpretation of the legislation, 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 more consensus-based regulatory interactions between the mining 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.

Introduction

Background and motivation

This paper 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. 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., increased emissions abroad) and lost employment opportunities to the local and regional economy. This paper 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

☆Financial support from the Kolarctic ENPI CBC program (SUMILCERE project), the Swedish Environmental Protection Agency, and LKAB is gratefully acknowledged. The paper has also benefitted greatly from excellent research assistance from Nanna Svahn, as well as from the comments of two anonymous reviewers. Any remaining errors, though, reside solely with the authors.
* Corresponding author.

http://dx.doi.org/10.1016/j.resourpol.2014.11.008
0301-4207/

—have been designed, interpreted and implemented in practice (see further *Previous research on mining competitiveness and environmental policy*). 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 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 authorities and 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 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).

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 paper we address this challenge both conceptually but also by examining the permitting processes of mining operations in Finland and Sweden, in part also referring to experiences from the Russian mining sector.

Objectives and scope

The overall objective of this paper 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 paper provides:

- An analytical framework addressing the impacts of environmental regulations on the mining sector's competitiveness, and how the environment-competitiveness trade-off can be affected by various regulatory design and implementation strategies.
- An empirical illustration of how this framework can be employed in the empirical context of the environmental permitting processes—and the resulting pollution control requirements—in Finland, Sweden and Russia.

Mining companies are affected by several types of environmental regulations (Eggert, 1994), but in this paper we primarily focus on the pollution control requirements stipulated under 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) and Tiess (2011) for recent reviews). In addition, we also do not address the competitiveness impacts of different market-based policy instruments, such as various pollution charges and the European Union's Emissions Trading Scheme (EU ETS).

Tiess (2011) emphasizes the importance of exchange of experiences of mining regulation between different countries, and our choice of case countries should be of interest for several reasons. First, together Finland, Sweden and Russia are important suppliers of both non-ferrous minerals and iron ore, especially in a European context. For instance, over 90% of the 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 Fig. 1 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

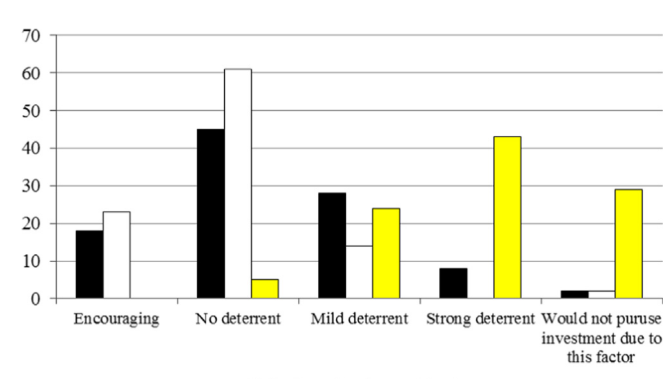

Fig. 1. Mining companies' view on the uncertainty concerning environmental regulation (percentage shares of the respondents). Source: Wilson and Cervantes (2014).

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).

Methodological approach and empirical material

Based on a review of the existing empirical literature and on a conceptual analysis of the environment-competitiveness trade-off, we develop a simple analytical framework that can be used to investigate three 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 these three analytical concepts are illustrated and exemplified in the empirical context of the environmental permitting processes—and the resulting pollution control requirements—in Finland, Sweden and Russia. This provides an opportunity to learn from both good and bad experiences.

In large the analysis relies on an investor eye-view of the legal rules; it employs both case law and analytical jurisprudence for determining the content and function of the law. This also includes analyses of specific mining permitting processes in the three countries. In addition, we rely on secondary sources, including reports by company representatives (e.g., Granberg, 2013), 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 archives of the County Administrative Board and the National Archive of Sweden. 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.

Outline of paper

The paper 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 paper contributes to this literature stream. *Theoretical remarks and analytical framework* provides a simple analytical framework addressing the impact of environmental regulation on mining competitiveness. Most importantly, it identifies and discusses a number of factors that will affect this relationship and the trade-offs involved. The next section provides a brief background to the environmental regulation systems in Finland, Sweden and Russia. *The environment-competitiveness challenge in mining permitting cases* reports our findings from illustrating the stringency, predictability and flexibility of these countries' environmental permitting processes, including examples from past and present mining cases. Finally, A final section provides a number of concluding remarks as well as some avenues for future research.

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; Rémy, 2003; Wilkerson, 2010). Often the focus has been on key differences among developed versus developing countries.

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. Similar results have been obtained in more recent research. Wilkerson (2010), McNamara (2009) Annandale and Taplin (2003) also highlight the role of political stability. For instance, Wilkerson (2010) argues that mining companies 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 companies have tended to locate in regions close to their head offices and in regions where corruption levels are low. 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 following 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.

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.[1] 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.

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 are 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, 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.

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 the 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 in these same countries.

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 maintain 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 (see also World Bank and International Finance Corporation, 2002).

Hilson (2000) argues that while the 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).

Nevertheless, while 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, this does not imply that costs and productivity of mining companies are not affected by environmental regulations. 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 authorities interact with the industry and other regulatory design issues, will be important for addressing the environment-competitiveness dilemma at the company level.

Additional lessons from the industrial pollution control literature

While 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 that the presence of negotiated policies in some countries has facilitated the environmental transformation of important 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 since the early 1970s 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).[2]

[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.

[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 (Löfstedt and Vogel, 2001).

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., Lindmark and Bergquist, 2008; 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 and emissions trading schemes (Goulder and Parry, 2008). There are, however, also important differences in the regulations typically required as a result of individual permits. For instance, emission standards that are technology- rather than performance-based will risk to force the diffusion of suboptimal 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.

Previous research also emphasizes the importance of intertemporal flexibility in the compliance process. For instance, 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 companies have time to reduce uncertainty and compliance costs by engaging in R&D and technology demonstration activities.[3]

Theoretical remarks and analytical framework

The competitiveness-environment relationship

There is no generally established definition of the competitiveness of industrial companies. In this paper we follow Tilton (1992) and relate competitiveness to the ability to gain and maintain market shares, thus suggesting that a company with a declining market share is losing its competitiveness. Tilton also notes that since mineral commodities often are relatively homogenous and standardized, the competitiveness of mining companies is largely based on costs of production. If these costs are not low enough there would be little scope for making normal long-run profits.

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. Fig. 2 shows 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 company'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).

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

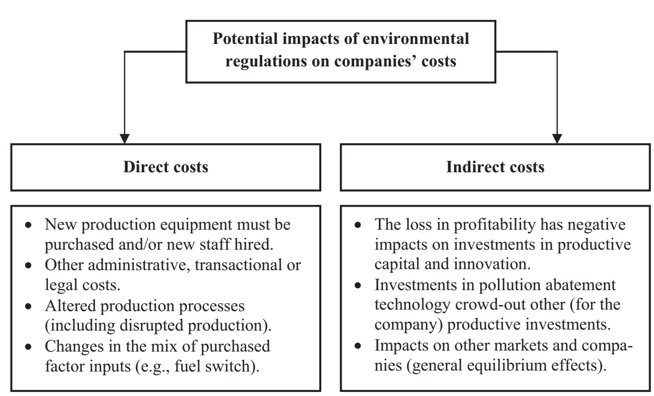

Fig. 2. Categorization of the impacts of environmental regulation on the industry's costs. Sources: based on Jaffe et al. (1995) and Brännlund and Lundgren (2009).

[3] 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.

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 may 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 paper 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.

The importance of environmental regulatory design and implementation

We identify and discuss three features of environmental regulations that could affect the prospects for addressing both environmental and competitiveness concerns in the permitting process. These are briefly summarized and exemplified in Fig. 3. 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).

Mining is a capital intensive industry and many of the concerns about competitiveness 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 delay 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.

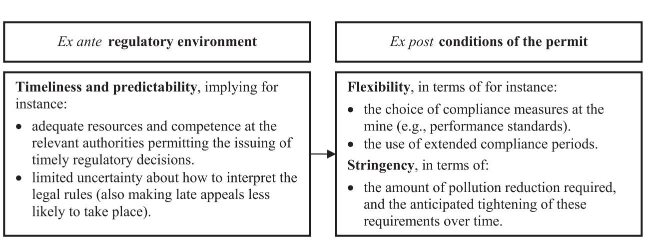

Fig. 3. Environmental permits and competitiveness: critical issues.

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 approval and acceptance of society towards these ventures that goes beyond the requirements of formal licenses. Typically this requires early and constructive dialogs 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 the 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). In the absence of clear *ex ante* guidelines mining investments risks may be significantly exacerbated.

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 under the permit conditions (Nentjes et al., 2007). For instance, the capital stock of the mining industry is durable and replacing industrial equipment will be costly and time-consuming. For this reason extended compliance periods could help to 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.[4] However, in countries relying heavily on strict environmental quality standards (e.g., the use of maximum allowable concentrations), such adjustment periods may be difficult to implement since they may lead to non-compliance in the short-run.

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.[5]

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 authority. The use of a consensus-based regulatory strategy, including regular and constructive dialogs between the regulator and the industry (e.g., concerning time plans, compliance methods etc.), could also assist in this process.

Background to pollution control legislation in Finland, Sweden and Russia

In all three case 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 paper, 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) (see also Tiess, 2011).

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.

The Swedish permitting process for industrial plants prior to the advent of the Environmental Code in 1998 is also 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 environment-competitiveness challenge in mining permitting cases* 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. 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 applications 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.

[4] 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).

[5] 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.). This is because 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, Goulder and Parry (2008).

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 limit values and environmental quality standards. The plant-specific emission limit values have typically been derived from environmental quality standards using modeling software (e.g., maximum allowable concentrations for over 200 pollutants have been prescribed) (Organization for Economic Co-operation and Development (OECD) 2006). Companies pay a fee exceeding these limit values. Still, in spite of these formal requirements the room for neglecting important pollution problems can be significant in Russia (e.g., Pettersson et al., 2014). Since 2014 the Russian Ministry of the Environment has been preparing for a fundamental change in the regulatory system, with a stronger emphasis on getting companies to invest in BAT.

The environment–competitiveness challenge in mining permitting cases

Introduction

Our 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, not the least, flexibility in terms of compliance measures, the use of compliance periods to permit demonstration and tests of new abatement technology, clear legal guidelines for how to address different conflicts of interest, and high regulatory competence. The remainder of this section investigates the regulatory approaches in Finland, Sweden and Russia under the context of these conditions.

Regulatory efficiency: timeliness and predictability

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 (BD), 2014). In all of our three 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 prespecified 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 55 years in one case) (SweMin, 2012). In Finland the waiting time at the Regional State Administrative Agency before mining development can commence has been 1–3 years (Wilson and Cervantes, 2014).

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 could be 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). Also in this case the authorities experience a lack of resources, making it harder to monitor and enforce the 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 license to operate). However, these ambitions may also clash with the demand for timeliness. Deliberations with stakeholders must often take time in order to be meaningful. In the earlier Swedish permitting process, this was in part facilitated by more limited public participation, and thus a more expert-based assessment of impacts and conditions (Lundqvist, 1980). In order to save time and avoid late appeals it has become increasingly important for the Nordic mining companies to establish close relations with important stakeholders at an early stage in the permitting process (e.g., Granberg, 2013).[6]

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 Svappavaara. 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 this caused a three-year delay in the process. In November 2013, a new permit could be issued by the 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.[7]

[6] In cases where such early deliberations are not initiated, intense conflicts 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-28547314).

[7] 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 and Russia where there has sometimes been a greater reliance on predetermined standards, e.g., for noise. While the latter adds predictability to the

Finally, the Russian regulatory system has overall lacked both timeliness and predictability. According to Behre Dolbear (BD) (2014), Russia is one of the countries where permitting delays cause some of the most significant risks to international mining ventures. Part of this problem can be found in the EIA process following the requirement to discuss critical issues with stakeholders. There are examples where companies have had to start the EIA process from scratch because of absent deliberations.

Moreover, there has been a high level of ambiguity in the distribution of competence across different levels of authority. 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).[8] In general significant consultations with regional authorities are needed, and the staff members from different authorities are not always well-coordinated. Since the regulations in this area are fairly recent and tend to be under constant revision (see also *Background to pollution control legislation in Finland, Sweden and Russia*), regulators still have not fully adapted to the new rules. In some cases the Russian authorities have been uncertain about how the environmental legislation should be implemented. There is even a need for standardization and classification of the terminology used in legal documents (e.g., Saliyeva and Popov, 2014).

In some respects, the environmental requirements for mining operations in Russia have often been stricter than in other developed mining countries such as Canada (e.g., dry-stacked gold tailings in some jurisdictions) (Cervantes et al., 2013). One reason is that the plant-specific emission limit values have been based on environmental quality standards that in turn are very stringent even making some prescribed limit values technically unfeasible (OECD, 2006). Still, in practice these strict requirements will typically not be enforced. Mining companies are expected to contribute to the social and economic development of the community (e.g., Sadykov, 2011), and for this reason the authorities may implement less stringent regulations to avoid disruptive social impacts (e.g., lay-offs etc.). For a foreign mining company these types of negotiated deals can be difficult to handle, and they also create uncertainty about future requirements once a new mine has been put into place.

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 three countries there is a relatively frequent use of performance rather than technology standards under the permitting conditions, e.g., emission limit values.[9] 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. In Sweden 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 consistently avoided technology standards in favor 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 sulfate 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 sulfate levels, then test this in the lab, do pilot testing and finally resolve the technical solutions and planning.

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 2 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—and 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 10 years. No similar or related strategy for addressing regulator–company 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.

(*footnote continued*)
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 difference in the 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).

[8] OECD (2006) notes that in Russia, the relations between the federal level and the regions have remained unclear. In the early 2000s an additional administrative layer was added, and this further increased the level of ambiguity.

[9] In Russia this is however not the case for the maximum allowable concentrations for pollutants. Equal concentrations are typically prescribed across the entire country in spite of fundamental differences in, for instance, geography, climate, landscape, geology etc. Even the reference concentrations for a particular location may exceed the maximum allowable concentrations. This adds to the problem of unattainable emission limit values, which was discussed in *Regulatory efficiency: timeliness and predictability*.

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, 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.

Reassessments 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 5-year period. Companies have also paid a fee (fine) for emissions that are above the standard, thus implying that they would have an incentive to perform beyond the predetermined limit value (Söderholm, 2003; OECD, 2006). With the planned reforms of the Russian regulatory system, though, there may be an increased emphasis on requiring investments in BAT rather than paying for excess emissions.

While the experiences of permit reassessments 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. This could help in reaching a consensus on how to interpret and implement the permit (as well as in 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.[10] 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 sometimes argued, has been devoted to the technical issues (e.g., pollution abatement technology and its costs).

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 well-developed mining countries. For instance, 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) shows 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 (and semi-governmental) authorities (e.g., the Swedish Environmental Protection Agency, the Swedish Institute for Water and Air Protection) 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. 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 the dust emissions. 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, the extended compliance periods fostered continuous environmental improvements, and permitted the companies to combine productive investments with pollution abatement measures. The regulatory system's legitimacy was also increased. 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).

A comparative summary

Table 1 shows a condensed comparison of how the flexibility, the predictability/timeliness and the stringency of environmental regulations have tended to play out in the permitting of mines in Finland, Sweden and Russia. The results revealed some important similarities and differences across the three countries, the latter even when comparing Finland and Sweden that have adopted very similar environmental legislations.

The paper has illustrated that overall in all three 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 and/or expanding mining operations. The uncertainties facing mining companies concern thus both the time it takes to get a permit, but not the least the nature of the conditions laid out in the permit (if granted). In Russia these uncertainties are overall more prevalent, and related to significant lack of coordination among different levels of authority. In Sweden and Finland the regulatory framework is significantly clearer and more stable over time. However, in these countries investment uncertainties have arisen due to a lack of: (a) *ex ante* guidelines for how to interpret specific legal rules;[11] and (b) adequate resources at

[10] 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 (Korvela, 2013).

[11] In Sweden the Swedish Geological Survey (2013) provides an in-depth description of the mining permitting process in the country. This presents some

Table 1
Comparative assessment of environmental permitting in Finland, Russia and Sweden.

	Finland	Russia	Sweden (1970–1990)	Sweden (Present)
Regulatory efficiency (i.e., timeliness) and (*ex ante*) predictability	Concerns over delays in permitting process.Regulators experience a lack of resources. Public participation important part of EIA.Some uncertainty concerning permit conditions. Some use of pre-determined emissions standards.	Permitting delays big investment barrier.Uncertainties about how to interpret rules.Public participation important part of EIA.The lack of regulatory coordination (federal vs. regional level) leads to uncertain permit conditions.	Permitting delays not considered a problem.Lack of regulatory resources not a problemPublic participation was restricted.Expert-based dialogue between regulators and the industry led to less uncertainty about permit conditions.	Concerns over delays in permitting process.Regulators experience a lack of resources. Public participation important part of EIA.Concerns about uncertain permit conditions. Less use of pre-determined emissions standards).
Flexibility in terms of compliance measures and adjustment period	BAT, and most often emissions rather than technology standards. Legislation permits extended compliance periods, but this is not used consistently.	BAT, and most often emissions rather than technology standards. No systematic use of compliance periods (but sometimes less stringent regulations for social reasons).	BAT, and consistently emissions rather than technology standards. Consistent use of extended compliance periods (2–3 years), as well as adaptation to market conditions.	BAT, and most often emissions rather than technology standards.Legislation permits extended compliance periods, but this is not used consistently.
Prospects for gradually implementing more stringent regulations without jeopardizing the competitiveness	Re-assessments of existing permits.Concerns over lack of regulators' technical competence, and calls for expert-based and consensus-seeking regulatory approach.	Permits granted for a 5-year period. Companies pay a fee for emissions above the standard. Overall, though, monitoring and enforcement have not been strict.	Re-assessments of existing permits. Substantial regulatory technical knowledge and intense exchange of information. This permitted gradually stricter regulations.	Limited re-assessment of existing permits.Concerns over lack of regulators' technical competence, and calls for expert-based and consensus-seeking regulatory approach.

the regulating authorities. In all three countries public participation is an important part of the EIA process, and this has occasionally caused delays in the permitting process (e.g., due to late appeals).

In terms of flexibility all three countries tend to provide mining companies with quite a lot of discretion in terms of choosing compliance strategy. Hence, performance rather than technology standards (based on BAT) are employed in most cases. However, there appears to be less emphasis on granting dynamic flexibility through the use of compliance periods. This is in contrast to the earlier Swedish industrial pollution control system during the 1970s and 1980s, when performance standards were consistently implemented in combination with extended compliance periods as well as with public support for joint state-industry R&D projects. In this way the earlier Swedish regulatory approach provided scope for environmental innovation and permitted the affected companies to coordinate pollution abatement measures with productive investments.

The permitting process for industrial plants in Sweden during the 1970s and 1980s could also in other ways be considered a best-practice regulation from an environment-competitiveness point-of-view. It was consensus-based, and relied heavily on substantial regulatory technical knowledge and intense exchange of information, ultimately permitting the gradual implementation of more stringent regulations without jeopardizing the competitiveness of the industry. The scope for achieving this is less favorable today, and this applies to all three countries. For instance, in present Sweden there is a lack of re-assessment of permits as well as of regulatory resources and in Russia strict monitoring and enforcement activities are generally not taking place. Both in Finland and Sweden industry representatives are frequently requesting a more expert-based and consensus-seeking regulatory approach.

An important weakness of the earlier Swedish system, though, was the limited role of stake-holders and the public in the decision-making process. On the one hand this expert-dominated process could lead to reduced uncertainties about the timing and the content of the design and implementation of the regulations, but on the other hand it could also result in a serious lack of legitimacy. For mining companies it has over time become increasingly important to acknowledge that the permitting process must take a certain amount of time in order to establish good relations with local stakeholders and address any related concerns. This therefore requires early preparations to avoid appeals, which otherwise could lead to an even more extended legal process.

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 that 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.

The main message of this paper is that the environment-competitiveness trade-off is highly dependent on the design and implementation of the regulations, and that there often is scope for achieving positive environmental outcomes without seriously jeopardizing the long-run competitiveness of the mining industry. The regulations must then address the predictability and the timeliness of the regulatory decision-making process, as well as the flexibility in terms of required pollution reduction measures and the time granted to comply with these. The problems encountered in, for instance, the Swedish and Finnish permitting processes can in part be addressed by: (a) allocating more resources and competence to the regulatory authorities; (b) introducing new governance and administrative tools for improving cooperation and information exchange between the industry and the authorities; (c) a more consistent use of stringent performance standards in combination with extended compliance periods; and (d) introducing more standardized procedures and road maps for EIAs and permit applications, as well as for how to interpret specific legal rules. These general recommendations are likely to be valid also for other developed mining countries.

(*footnote continued*)
clarifications of the legislation, but it does, however, still leave room for different interpretations of specific legal rules (e.g., the scope of the integrated environmental assessment).

Future research addressing the relationship between tougher environmental requirements and competitiveness is however needed. This research needs to go beyond the formal legal rules, secondary sources, companies' perceptions etc., and focus even more on learning from and comparing the experiences of regulatory design and implementation across countries. In addition, the environmental regulations of the mining industry 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, where the recently adopted EU Industrial Emissions Directive (IED) aims at tightening, harmonizing and clarifying the relevant BAT requirements. The competitiveness impacts of forthcoming BAT requirements require further scrutiny. Finally, additional research is also needed on the regulation of mine closure and rehabilitation. This regulation also tends to vary from country to country depending on public policies and industry practices (e.g., the use of reclamation bonds in some countries), and inter-country comparisons would be meaningful. For instance, a critical issue is how to determine the size of a reclamation bond (Gerard, 2000), and the resulting impact on environmental performance and competitiveness.

Also in the above cases, specific design and implementation issues are deemed to be important, thus making the analytical framework presented in this paper a useful tool. It provides a qualitative recognition of key issues in addressing the environment-competitiveness trade-off in regulatory decision-making, issues that could also be increasingly recognized in future econometric work attempting to operationalize environmental regulations.

References

Aaro, L-E., et al. 2012. Debatt: Ge gruvorna chansen, Dagens Industri, 30 januari.
Ambec, S., Cohen, M.A., Elgie, S., Lanoie, P., 2011. The Porter Hypothesis at 20Resources for the Future, Washington, DC (Discussion Paper 11–01).
Annandale, D., Taplin, R., 2003. Is environmental impact assessment regulation a 'burden' to private firms? Environ. Impact Assess. Rev. 23 (3), 383–397.
Ashford, N.A., Caldart, C.C., 2008. Environmental Law, Policy, and Economics: Reclaiming the Environmental Agenda. MIT Press, Cambridge, USA.
Beare, M.J., 2009. Comparison of the Russian and International Approach to Mining Project Design and Permitting. SRK, North America,. USA.
Behre Dolbear (BD), 2014. 2014 Ranking of Countries for Mining Investment, New York.
Bergquist, A-K., Söderholm, K., Kinneryd, H., Lindmark, M., Söderholm, P., 2013. Command-and-control revisited: environmental compliance and technological change in Swedish industry 1970–1990. Ecol. Econ. 85, 6–19.
Brickman, R., Jasanoff, S., Ilgen, T., 1985. Controlling Chemicals: The Politics of Regulation in Europe and the United StatesCornell University Press, Ithaca, New York.
Brännlund, R., Lundgren, T., 2009. Environmental policy without costs? a review of the porter hypothesis. Int. Rev. Environ. Resour. Econ. 3, 75–117.
Cervantes, M., McMahon, F., Wilson, A., 2013. Fraser Institute Annual Survey of Mining CompaniesVancouver, Canada (2012/2013).
Eggert, R.G., 1994. Mining and the Environment: International Perspective on Public Policy. Resources for the Future Press, Washington, DC.
Ford, J.A., Steen, J., Verreynne, M-L., 2014. How environmental regulation affects innovation in the australian oil and gas industry: going beyond the porter hypothesis. J. Clean. Prod. 84, 204–213.
Gerard, D., 2000. The law and economics of reclamation bonds. Resour. Policy 26, 189–197.
Goulder, L.H., Parry, I.W.H., 2008. Instrument choice in environmental policy. Rev. Environ. Econ. Policy 2 (2), 152–174.
Government of Canada, 2010. National Reporting to CSD-18/18-Thematic Profile on Mining, Ottawa.
Granberg, D. (2013). Environmental Permitting, Presentation at Boliden's Capital Market Days, 21 November.
Hilson, G., 2000. Pollution prevention and cleaner production in the mining industry: an analysis of current issues. J. Clean. Prod. 8, 119–126.
Humphreys, D., 2000. A business perspective on community relations in mining. Resour. Policy 26, 127–131.
Jaffe, A.B., Peterson, S.R., Portney, P.R., Stavins, R.N., 1995. Environmental regulation and the competitiveness of U.S. manufacturing: what does the evidence tell us? J. Econ. Lit. 33 (1), 132–163.
Jänicke, M., 1992. Conditions for environmental policy success: an international comparison. Environmentalist 12 (1), 47–58.
Johnson, C.J., 1990. Ranking countries for mineral exploration. Nat. Resour. Forum 14 (3), 1781–1786.
Joshi, S., Krishnan, R., och L., Lave, 2001. Estimating the hidden costs of environmental regulation. Account. Rev. 76 (2), 171–198.
Kamien, M.J., Schwartz, N.L., 1982. Market Structure and Innovation. Cambridge University Press, New York.
Kivimaa, P., 2007. The determinants of environmental innovation: the impacts of environmental policies on the nordic pulp, paper and packaging industries. Eur. Environ. 17, 92–105.
Korvela, T., 2013. The precautionary case of talvivaara: a developed legal order gone astray. IUCN Acad. Environ. Law 4, 35–38.
Lanoie, P., Laurent-Luccetti, J., Johnstone, N., Ambec, S., 2011. Environmental policy, innovation and performance: new insights on the porter hypothesis. J. Econ. Manag. Strategy 20, 803–842.
Lindmark, M., Bergquist, A.K., 2008. Expansion for pollution reduction? environmental adaptation of a Swedish and a Canadian smelter, 1960–2005. Bus. Hist. 50 (4), 530–546.
Löfstedt, R., Vogel, D., 2001. The changing character of regulation: a comparison of Europe and the United States. Risk Anal. 21 (3), 399–405.
Lundqvist, L., 1980. The Hare and the Tortoise: Clean Air Policies in the United States and SwedenThe University of Michigan Press, Ann Arbor.
McNamara, N., 2009. The Environmental Regulation of Mining: An International Comparison. School of Law of the University of Southern Queensland, Australia (Ph.D. Dissertation).
Mohr, R.D., 2006. Environmental performance standards and the adoption of new technology. Ecol. Econ. 58, 238–248.
Nentjes, A., de Vries, F.P., Wiersma, D., 2007. Technology-forcing through environmental regulation. Eur. J. Polit. Econ. 23, 903–916.
Organization for Economic Co-operation and Development (OECD), 2006. Environmental Policy and Regulation in Russia: The Implementation Challenge, Paris.
Peck, M.J., Landsberg, H.H., Tilton, J.E., 1992. Competitiveness in Metals: The Impact of Public PolicyMining Journal Books, London.
Pettersson, M., Ek, K., Söderholm, K., Söderholm, P., 2010. Wind power planning and permitting: comparative perspectives from the nordic countries. Renew. Sustain. Energy Rev. 14, 3116–3123.
Pettersson, M., Söderholm, P., 2014. Industrial pollution control and efficient licensing processes: the case of Swedish regulatory design. Sustainability 6, 5401–5422.
Pettersson, M., A. Oksanen, V. Masloboev, T. Mingaleva, and V. Petrov (2014). License to Mine: A Comparison of the Scope of the Environmental Assessment in Sweden, Finland and Russia, Report within the SUMILCERE project (Kolarctic ENPI CBC).
Porter, M.E., van der Linde, C., 1995. Toward a new conception of the environment-competitiveness relationship. J. Econ. Perspect. 9, 97–118.
Prno, J., 2013. An analysis of factors leading to the establishment of a social license to operate in the mining industry. Resour. Policy 38, 577–590.
PwC (2012). Mining in the Americas, Canada.
Rémy, F., 2003. Mining Reform and the World Bank: Providing a Policy Framework for Development. International Finance Corporation, Washington, DC.
Sadykov, R.K., 2011. On the importance of subsoil management in the regional socio-economic development. Miner. Resour. Russ.: Econ. Manag. 4, 46–49.
Saliyeva, R.N., Popov, A.A., 2014. The legislative framework for engineering and sustainable development of mineral deposits: problems and solutions. Miner. Resour. Russ.: Econ. Manag. 1, 69–73.
Sartorius, C., Zundel, S., 2005. Time Strategies, Innovation and Environmental Policy. Edward Elgar, Cheltenham.
Söderholm, P., 2003. Institutional obstacles to environmental taxation in the former soviet union. In: Milne, J., et al. (Eds.), Critical Issues in Environmental Taxation: International and Comparative Perspectives, Volume I. Richmond Law & Tax Ltd., Richmond, UK, pp. 257–268.
Söderholm, K., Bergquist, A-K., 2013. Growing green and competitive: a case study of a Swedish pulp mill. Sustainability 5, 1789–1805.
Söderholm, P., Svahn, N., 2014. Mining, regional development and benefit-sharing in developed countries. Economics Unit, Luleå University of Technology (Research Report), Luleå, Sweden.
Sorrell, S., 2002. The meaning of batneec: interpreting excessive costs in UK industrial regulation. J. Environ. Policy Plan. 4, 23–40.
Swedish Geological Survey (SGU) (2013). Vägledning för prövning av gruvverksamhet, Uppsala.
SweMin, 2012. Gruvbranschen – en tillväxtmotor för Sverige. Swedish Association of Mines, Mineral and Metal Producers, Stockholm.
Tiess, G., 2011. Legal Basics of Mineral Policy in Europe: An Overview of 40 Countries. Springer, Vienna.
Tilton, J.E., 1992. Mineral endowment, public policy and competitiveness: a survey of issues. Resour. Policy 18 (4), 237–249.
Tole, L., Koop, G., 2011. Do environmental regulations affect the location decisions of multinational gold mining firms? J. Econ. Geogr. 11, 151–177.
Viscusi, W.K., Vernon, J.M., Harrington, J.E., 2005. Economics of Regulation and Antitrust, 4th edition MIT Press, Cambridge.
Wilkerson, J., 2010. Competition and regulation in the gold industry: an American perspective. Univ. Botsw. Law J. 12, 117–129.
Williams, J.P., 2012. Global trends and tribulations in mining regulation. J. Energy Nat. Resour. Law 30 (4), 391–422.
Wilson, A., Cervantes, M., 2014. Fraser Institute Annual Survey of Mining Companies, Vancouver.

World Bank and International Finance Corporation, 2002. Mining and Development. An Asset for Competitiveness: Sound Environmental Management in Mining Countries. International Finance Corporation, Washington, DC.
Wyatt, C., McCurdy, T., 2013. 2013 Ranking of Countries for Mining Investment: "Where Not to Invest". Behre Dolbear, Greenwood Village, Colorado.
Yarime, M., 2007. Promoting green innovation or prolonging the existing technology: regulation and technological change in the chlor-alkali industry in japan and europe. J. Ind. Ecol. 11 (4), 117–139.