On Optimal Extraction under Asymmetric Information over Reclamation Costs

BY PAULI LAPPI

Motivation

Currently, a problematic feature of exhaustible resource production in many countries in the world including the U.S. and Canada is that there is too little funds for reclamation of the production site.[1] This means that either tax payer money must be used for reclamation or the reclamation is not properly conducted, which may result in environmental problems such as acid mine drainage, loss of forests, grasslands and recreational benefits. The regulator, who would like to save public funds and improve the state of the environment, does not know the future reclamation costs, and must often ask the firm to report them. But the firm cares about its profits, and has incentives to misreport. The regulator must take these incentives into account when it offers a contract to the firm.

Research questions

The focus is on the optimal regulation of a polluting exhaustible resource firm, whose extraction generates a valuable good and a stock pollution that causes environmental damages. The stock is regulated with a pollution tax designed for an optimized production horizon and with a reclamation requirement at the end of production, where a part of the stock is reclaimed. The regulation is designed under firm's private information over the reclamation costs and the main research questions are:

1. How should the regulation be designed to obtain maximal benefits for the society from the extraction operation, when the firm has private information over reclamation costs?
2. What kind of properties does the optimal regulation have? In particular, how is the pollution tax affected by private information?

Model

These questions are analyzed using a two-stage model, where extraction stage is followed by reclamation. Many pollutants related to exhaustible resource extraction are stock pollutants, like the pollutants in the tailings ponds in oil sand extraction (Heyes et al. 2018), and they are accumulated on or nearby the extraction site. It is this stock that forms the object to which the reclamation operations are targeted. Without regulation the pollution stock is not reclaimed at all, which means that the pollution stock and the production horizon are sub-optimal from the society's point of view. To avoid this possibility, the regulation in the paper's model consists of an optimal pollution tax on the extracted good, an optimal shut-down date for the extraction operation, a requirement for the firm to pay the present value reclamation costs before extraction commences and an optimal reclamation contract.

To find out the relevant properties of this regulation, the model is analyzed backwards beginning from the reclamation stage. The regulator wants to induce the firm to choose an optimal reclamation effort, that is, the effort that maximizes the net social benefits given the inherited pollution stock from the extraction operation. The complication is that the regulator does not know the size of the reclamation costs, but the operating firm knows them. Because the firm is required to pay the present value reclamation costs to the reclamation fund or trust (or as a bond), he has incentives to say that the costs are high in order to make the effort low and the payment to the reclamation fund small. This means that the regulator has to design a mechanism to induce truth-telling about the reclamation costs. In the extraction stage, the regulator wants the firm to choose the socially optimal extraction rate while understanding how the reclamation stage optimum depends on extraction stage choices.

Pauli Lappi is Marie Sklodowska-Curie fellow at Ca' Foscari University of Venice and CMCC Foundation - Euro-Mediterranean Center on Climate Change, Italy. E-mail: pauli.lappi@unive.it.

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See footnote at end of text.

Results

The reclamation contract consists of reclamation effort and transfer payment to the firm. It is found that optimal second-best reclamation effort deviates from the first-best reclamation effort, that is, from the optimal effort without information problems. This deviation is increasing in the cost-type of the firm, and the optimal contract dictates the lowest reclamation effort for the highest-cost type firm. This contract is also designed in a way that the monetary transfer for the highest-cost firm type equals the difference between the reclamation cost and the (current value) extraction profits; in other words, it extracts all of the profit from the highest-cost type firm. The contract leaves positive profits for the more efficient firm types.

Regarding the extraction stage regulation, it is shown that the extraction decision is distorted away from the first-best solution. Furthermore, given the

reclamation contract, an optimal shut-down date and optimal pollution tax are characterized. In particular, a waiting rule and a pollution tax formula are derived, and it is shown that the pollution tax under asymmetric information can be lower or higher than the pollution tax under complete information. This is intuitive: suppose for example that the firm's reclamation cost is low so that any pollution stock generated can be cheaply reclaimed. If the regulator knows this, he can allow higher pollution generation compared to the case where the cost is private information. But under asymmetric information the regulator bases his tax decision on expected values and must constrain the pollution generation with a higher tax compared to the complete information case.

In addition, it is possible that the regulator may wish to exclude some firm types by not offering them a contract at all. More specifically, this can happen to those types who have high enough reclamation costs. The cut-off type is the type for which the society's total present value of extraction payoff equals the present reclamation stage value. Every extraction firm with a cost type higher than the cut-off value should not be allowed to extract the resource.

Conclusions

Taking into account firm's private information over reclamation costs and designing the optimal reclamation contract and the regulation can yield three kinds of benefits:

1. It can save public funds since the reclamation operation does not fall on the society;
2. It improves the state of the environment;
3. It allows to exclude those cost types whose extraction operation would not produce benefits for the society.

However, the relevant information problems do not stop at reclamation costs. Exhaustible resource producers often have private information regarding other parameters of the extraction operation, such as extraction costs (Gaudet et al. 1995, Osmundsen 1995) and initial resource stock (Osmundsen 1998, Martimort et al. 2018). Furthermore, in practice, even the firm may have difficulties estimating these parameters. These dimensions should also be taken into account, when designing optimal regulation.

Footnote

[1] In British Columbia, the shortfall is estimated to be over one billion (Hoekstra 2017). The problem is at least as severe in the U.S. coal sector: According to an actuarial report for the West Virginia Department of Environmental Protection and Olalde (2018), the bond amounts in the state add up to about total $150 million or $3,200 per acre (bond limit for new permits is $5,000), but reclamation costs are estimated to range from $7,840 to $28,460 per acre. In Alberta, the amount of securities is about $1 billion, which is significantly short of the estimated $20.8 billion reclamation cost (Heyes et al. 2018)

References

Gaudet, G., & Lasserre, P. (2015). The Management of Natural Resources Under Asymmetry of Information. Annual Review of Resource Economics, 7, 291-308.

Heyes, A., Leech, A., & Mason C. (2018). The Economics of Canadian Oil Sands. Review of Environmental Economics and Policy, 12, 242-263.

Hoekstra, G. (2017). Underfunding for Mine Cleanups Rises to More than $1.27 billion. The Vancouver Sun, 27.1.2017; accessed 16.3.2018.

Martimort, D., Pouyet, J., & Ricci, F. (2018). Extracting Information or Resource? The Hotelling Rule Revisited under Asymmetric Information. RAND Journal of Economics, 49, 311-347.

Olalde, M. (2018). US Coal Hasn't Set Aside Enough Money to Clean up its Mines. Climate Home News, 14.3.2018; accessed 20.9.2018.

Dual Plenary Session 8: Carbon Markets

SUMMARIZED BY JUSTIN LARSON, PHD STUDENT, RESEARCH ECONOMIST AT RTI INTERNATIONAL

Ian Parry presented on the impacts of carbon pricing and the tradeoffs associated with other approaches. In his presentation, Ian showcased results of a spreadsheet model that calculated the costs and benefits of a carbon price policy. Additionally, Ian discussed complements to a carbon price policy as well as potential substitutes. The choice of type of policy, or mix of policies, also varied from country to country.

Augusta Wilson discussed the legal barriers and implications in the United States of linking a carbon market (i.e. RGGI) to other markets abroad. The potential legal conflicts exist at the constitutional level but have yet to be acted upon, despite the linkages between California's cap-and-trade program and the WCI. Moving forward, state legislators will need to be mindful of the potential implications at the Federal level of linking carbon markets.

Onil Bergeron continued the discussion on linking of carbon markets, with a focus on Quebec's cap-and-trade program. In his discussion, Onil detailed the process of linking, the obstacles markets face in linking, as well as the benefits and reasons for linking markets.

After the presentation, questions were fielded from the audience. Questions shared a common theme, feasibility. Given the political hurdles carbon price policies face, what policies or mix of policies are political feasible?