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The carbon rent economics of climate policy

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ABSTRACT

By reducing the demand for fossil fuels, climate policy can reduce scarcity rents for fossil resource owners. As mitigation policies ultimately aim to limit emissions, a new scarcity for "space" in the atmosphere to deposit emissions is created. The associated scarcity rent, or climate rent (that is, for example, directly visible in permit prices under an emission trading scheme) can be higher or lower than the original fossil resource rent. In this paper, we analyze analytically and numerically the impact of mitigation targets, resource availability, backstop costs, discount rates and demand parameters on fossil resource rents and the climate rent. We assess whether and how owners of oil, gas and coal can be compensated by a carbon permit grandfathering rule. One important finding is that reducing (cumulative) fossil resource use could actually increase scarcity rents and benefit fossil resource owners under a permit grandfathering rule. For our standard parameter setting overall scarcity rents under climate policy increase slightly. While low discount rates of resource owners imply higher rent losses due to climate policies, new developments of reserves or energy efficiency improvements could more than double scarcity rents under climate policy. Another important implication is that agents receiving the climate rent (regulating institutions or owners of grandfathered permits) could influence the climate target such that rents are maximized, rather than to limit global warming to a socially desirable level. For our basic parameter setting, rents would be maximized at approximately 650 GtC emissions (50% of business-as-usual emissions) implying a virtual certainty of exceeding a 2 °C target and a likelihood of 4 °C warming.

1. Introduction

Greenhouse gas emissions from the combustion of fossil fuels are the leading contribution to anthropogenic climate change, as has been comprehensively summarized in the fourth assessment report (AR4) of the Intergovernmental Panel on Climate Change (IPCC, 2007a, p. 25), along with more recent updates (e.g. National Research Council (U.S.), 2010). Perhaps more importantly, signals of a changing climate due to anthropogenic influences are already being observed, and are projected to become more noticeable in the near- to mid-term future (IPCC, 2007b, pp. 36–45; 66–74). Since fossil fuels make up 85% of world primary energy consumption (IPCC, 2011, p. 35) and contribute more than 55% of warming potential of anthropogenic greenhouse gasses (IPCC, 2007a, p. 28), policies for climate change mitigation concentrate on the decarbonization of the energy system. Given the large amounts of fossil fuels in the earth, decarbonization implies that in the short and medium term either those fossil resources may not be extracted and burned, or that emitted carbon must be effectively captured and permanently sequestered. As the technical and geological potential of carbon capture and sequestration is limited (IPCC, 2005), the starting point of this paper is the necessity of having potential resources remain in the ground to avoid dramatic temperature increases.

We will briefly summarize estimates of the final equilibrium global temperature change that can be tolerated without inducing "dangerous anthropogenic interference with the climate system" (UNFCCC, 1992, Article 2), as well as the fraction of the fossil fuel resource that can be combusted while maintaining consistency with the final tolerable temperature change. After surveying previous related work, we use an analytical model and a slightly extended numerical application of that model to address two main questions: First, given the fact that restricting total future carbon emissions, i.e. setting a "carbon budget" for climate mitigation, amounts to creating an artificial scarcity of fossil-fuel resources, what happens to the rents for resource owners under climate policy? Second, depending on the stringency of the climate policy, and therefore on the induced scarcity of fossil fuels, is it possible for resource owners to be compensated for decreased sales of fossil fuels through potentially increasing scarcity rents? We explore the relevant parameter space of carbon budgets, discount rates, backstop technology costs and demand growth rates to determine which are the most crucial determinants for compensation. Our model combines the conventional Hotelling approach of optimal fossil resource extraction with the political-economy dimension of scarcity rents that are associated to finite resources and

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possibly induced rent-seeking behavior. While the analytical model strengthens the insights in the general dynamics of scarcity rents due to parameter variations, the numerical model application transfers these insights to a more realistic but specific real-world setting.

The focus on the supply-side and on the fossil resource owners is motivated by the green paradox of Sinn (2008).[1] The intertemporal profit maximizing behavior of fossil resource owners can render climate policy measures ineffective. One critical aspect is the occurrence of so-called supply-side leakage, when unilateral carbon pricing policies induce a re-allocation of fossil resource use via reduced (global) fossil resource prices (Eichner and Pethig, 2011). Without a globally harmonized policy, mitigation is therefore barely feasible or will be very expensive. Sinn (2008) suggests a (theoretically) feasible unilateral policy to subsidize resource stocks in situ; nevertheless, he admits that taxpayers will strongly reject a policy that transfers large amounts of money to owners of oil, gas and coal. A similar approach is to develop a market in extraction rights that recognizes the option of foregoing extraction (Harstad, 2010). The starting point for Harstad is the recognition that many countries may not willingly participate in a global scheme to reduce emissions (e.g. resource-rich countries), whereas others may be willing to pay for emission avoidance. Without providing for trade in deposit extraction rights, climate policies enacted by some set of countries have the effect, ceteris paribus, of reducing overall demand and therefore prices, potentially stimulating increased consumption by non-participant countries.

As explicit transfers to resource-rich countries may be politically difficult to implement, policies with implicit or hidden transfers might be more successful. Asheim (2011) explicitly considers the implication of climate policy that significant fractions of fossil fuel deposits must necessarily remain in the ground. He concentrates on the distributional issues of different supply-side policy instruments, assuming full participation of all actors. The model framework is a standard approach to optimal extraction of finite resources (Dasgupta and Heal, 1974; Solow, 1974; Stiglitz, 1974), with the assumption that fossil fuel extraction takes place at zero cost, and that there is no backstop technology. He illustrates how different implementations of mitigation policies influence resource owners' pay-off. As we will see in the course of this paper, it is even possible that climate policy results in net benefits for fossil resource owners (compared to a business-as-usual scenario). Hence, not only the distribution of rents may be subject to political considerations, but also the factors that determine the absolute size of rents. This insight could ultimately result in a broader political discussion about the ownership of natural resource rents as they might be a substantial fraction of the global added-value.

Our model is based on the common literature of natural resource economics, starting with Hotelling (1931) and continuing with expanded interest in the 1970s by Dasgupta and Heal (1974) and Solow (1974). We formulate the climate target as a constraint on cumulative fossil resource extraction which serves as proxy for temperature changes, as described below. The carbon budget makes fossil resources abundant (and destroys the associated scarcity rent) and the atmosphere a relatively scarce (and exhaustible) resource which in turn now receives a scarcity rent — a so-called climate rent. If fossil resource owners jointly commit to this carbon budget, they will automatically receive this rent. If governments implement an emission trading scheme, they receive this rent. By grandfathering the permits to resource owners, they can transfer this rent (without transferring money explicitly) which may compensate resource owners. Hence, resource owners might opt for an emission trading scheme that makes them better-off than without any climate policy in place.

We differ from Asheim (2011) in extending the basic Hotelling model by a backstop technology, which truncates the iso-elastic demand function if resource prices reach the backstop price. This backstop price turns out to be a crucial parameter for the possibility to compensate resource owners. Our innovations are to consider explicitly realistic carbon budgets, as introduced below, compared to actual fossil resource data, and to map out the parameter space to determine over which ranges a compensation is possible.

2. Delaying extraction vs. ceasing reserves

There are two different perspectives on fossil fuel use under climate change mitigation: The classical economic view is that fossil resource use should be slowed down and delayed into the far-distant future because (i) climate damages are discounted and (ii) CO_2 is removed from the atmosphere by biosphere and ocean uptake (Hoel and Kverndokk, 1996; Sinn, 2008) on longer time scales. If one of these two conditions holds, it can be efficient to exhaust all fossil resources in infinite time: climate policy is a question of 'timing' of fossil resource use rather than a question of the total amount of usable fossil resources.[2]

The second approach focuses on temperature and concentration targets that are considered to be achievable at moderate economic costs and that avoid the risk of "dangerous anthropogenic interference with the climate system" (UNFCCC, 1992, Article 2) as revealed by the existence of several irreversible tipping points in the Earth system (Lenton et al., 2008). The difficulty in quantifying and normatively evaluating climate damages and their intertemporal development might explain why the public discourse focuses on temperature and concentration targets rather than on the choice of an appropriate damage function.

Recent papers by Meinshausen et al. (2009) and by Allen et al. (2009) make an important contribution to the discussion linking (cumulative) emission pathways for the future and probabilities of equilibrium global average temperature change. The first key point of the recent work cited above is that equilibrium temperature changes, as determined by the results from many climate modeling comparisons, are mainly sensitive to the cumulative amount of carbon emissions, independent of the exact trajectory over time of those emissions. Therefore, one can speak of a carbon budget that corresponds to a future temperature change. A second key point is that, due to the inherent uncertainty of climate models, one must consider probabilities of exceeding a given target for temperature, given a cumulative emission quantity. Thus, the chain of logic is such that "if we emit X tons of carbon dioxide in the future, there is a Y percent chance of exceeding the temperature change target of Z°C". Over the course of the past several years, a political consensus has been emerging that a temperature-change threshold of 2 °C with respect to the early 20th century represents a planetary boundary within which it would be advisable to remain (UNFCCC, 2009).[3]

Meinshausen et al. (2009) conclude that cumulative emission of 1440 Gt of CO_2 (392 GtC) between 2000 and 2050 results in a 50% likelihood of exceeding the $T = 2$ °C threshold, and that to reduce the probability to 25%, the total emission budget is reduced to 1000 Gt CO_2 (272 GtC). To gain an idea of just how stringent these limits are,

[1] See also van der Werf and Di Maria (2011) for a survey on the green paradox literature.

[2] The first condition is subject to controversial debates on discounting (Heal, 2009; Nordhaus, 2007; Stern, 2007) and the appropriate use of cost-benefit analysis in the presence of high uncertainties (Weitzman, 2011). The second condition is only true for very long time horizons: Archer (2005) estimates that 17–33% of the emitted carbon dioxide remains in the atmosphere within approximately 1,000 years. Solomon et al. (2009) report even higher numbers: After stopping carbon emissions immediately, atmospheric carbon concentration will fall to 40% after 1000 years. Additionally, the uptake of CO_2 by oceans itself leads to acidification that might seriously damage marine ecosystems (WBGU, 2006).

[3] It should be noted that, although the link between emissions and temperature change is clear, the exact numerical conversion factor has a fairly large degree of uncertainty, with best estimates giving a range of $T = 3$ °C $\pm$ 1.5 °C for a doubling of atmospheric carbon dioxide concentration with respect to pre-industrial levels of 285 ppm. The third parameter Y, effectively the risk we are willing to accept in not meeting the temperature goal, is a subjective evaluation of risk willingness. In effect, the current generation of humans living in countries responsible for the majority of emissions will make a risk evaluation for future generations and for those currently vulnerable to impacts visible today.