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Climate change, fossil fuel prices and depletion: The rationale for a falling export tax

Creina Day[a,*], Garth Day[b]

[a] Arndt-Corden Department of Economics, Crawford School of Public Policy, The Australian National University, Australia
[b] Research School of Economics, The Australian National University, Australia

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ABSTRACT

This paper examines how world prices affect depletion of exhaustible fossil fuels for export and the role of an export revenue tax in curbing depletion. Both effects are studied for a small open economy affected by climate change. We find that setting an export revenue tax rate to fall over time at the marginal social cost of depletion due to lower productivity from climate change encourages a resource exporter to leave an optimal stock in the ground – unextracted and unburnable. Growing prices during the past decade similarly curb depletion. Falling prices bring forward extraction. Because production is independent of consumption, the marginal social cost is independent of utility parameters which are difficult to estimate. Slowing fossil fuel extraction and the effective export of emissions is a contemporary challenge for climate policy. Our findings identify both why an export revenue tax should decline over time and an estimable target rate of decline to help meet this challenge amid changing world prices.

1. Introduction

The combustion of fossil fuels is by far the largest human source of greenhouse gas emissions. A contemporary challenge for climate policy is how to discourage fossil fuel rich economies from in effect exporting emissions. Policies to reduce demand for fossil fuels, which focus on the point of combustion, have yet to put emissions on a course consistent with climate change targets under the Paris agreement. Supply-side polices, which aim to slow extraction of fossil fuels, have recently gained attention. The purpose of this paper is to explore the role of a resource export revenue tax, along with world price trends, in curbing extraction of fossil fuels for export and combustion overseas.

Rapid growth in industrializing Asia has driven growth in global demand and an upward price trend for fossil fuels, which are plentiful in several small open economies, but exhaustible. At current extraction rates, proven coal and oil reserves worldwide could last around 110 and 50 years, respectively (World Coal Association, 2016). To put this in perspective, if human civilization as we know it was scaled to fit in a 24 hour day, these resource stocks will run out in less than 30 minutes.

Fig. 1 depicts the upward trend in fossil fuel prices. Prices increased significantly between 2000 and 2008, slumped during the global financial crisis, but increased again between 2009 and 2011, remaining steady until 2014. In contrast to episodes of increasing prices during the previous century, recent increases are uniquely exponential. Rapid industrialization and urbanization sustained growth in China's demand for coal and oil, the latter almost doubling between 2002 and 2012 (World Trade Organization, 2014).[1] The collapse of world prices since 2014 reflects not only surging oil export volumes but also slowing demand trends.[2]

Referring to Table 1, the world's leading exporters of fuels and mining products are mostly small open economies which, although not large carbon emitters in absolute terms, are adversely affected by climate change. Oil exporters, such as Kuwait, with its low-lying coastal areas and the world's lowest per capita natural water supplies, are vulnerable to rising temperatures and sea levels. Australia, set to resume its position as the world's largest coal exporter in 2017, faces severe impacts to agricultural production, natural-resource based tourism and water supply (Garnaut, 2011). Emerging evidence suggests that small open economies face significant costs of climate change. Elshennawy et al. (2016) find that, in the absence of policy-led climate change adaptation, Egypt's real GDP by 2050 could be 6.5 per cent lower than in a hypothetical baseline without climate change.

If the global temperature rise is to be kept under the 2 °C limit of the Paris agreement, one-third of the world's oil reserves, more than 90

* Corresponding author.
E-mail addresses: creina.day@anu.edu.au (C. Day), garth.day@anu.edu.au (G. Day).

[1] In comparison, demand for oil in OECD countries fell by 5.5 per cent over the same period.
[2] China is decoupling its coal usage from economic growth, which in 2015 was the slowest in 25years, and demand for oil has slowed as the economy moves away from heavy industry.

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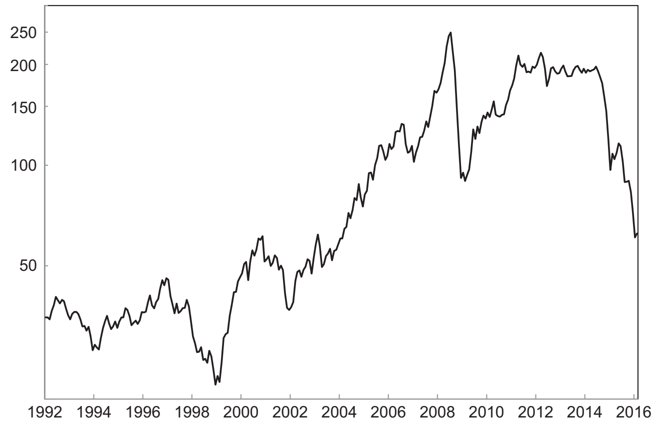

Fig. 1. Commodity Fuel Price Index (Crude Oil, Natural Gas and Coal), 2005=100, log scale. *Source*: International Monetary Fund, 2016, Commodity Price Indices Database.

Table 1
Leading exporters of fuels and mining products, 2014, US$ at current prices.

Country	Value ($ billion)	Share of world exports (%)	Share of economy's exports (%)
Russian Federation	349.8	9.2	70.3
Saudi Arabia	286.5	7.6	81.0
United States	201.7	5.3	12.4
Canada	160.3	4.2	33.8
Australia	153.0	4.0	63.4
Qatar	114.3	3.0	86.7
United Arab Emirates	111.4	2.9	31.0
Norway	99.7	2.6	69.3
Kuwait	94.7	2.5	90.8
Venezuala	78.2	2.1	97.1
Nigeria	77.5	2.0	79.9
Algeria	61.4	1.6	97.6
Iran	55.3	1.5	62.3

Source: World Trade Organization, 2016, World Trade Statistics.

per cent of Australia's coal reserves, and virtually all Canada's oil sands must be left in the ground (McGlade and Ekins, 2015). A growing literature therefore proposes supply-side climate policies aimed at slowing the extraction of resources (Sinn, 2008; Harstad, 2012; Faehn et al., 2017). Supply-side policies can be categorized as government provision of fossil fuels or funds, whereby the government acquires production rights or compensates resource owners to leave reserves undeveloped (Harstad, 2012) and price-based economic instruments (fossil fuel capital income tax (Sinn, 2008), resource production tax (Faehn et al., 2017), and resource export tax).

Export taxes are twice as likely for natural resources than for other sectors.[3] World price trends, the vulnerability of small open economies to climate change and the prevalence of resource export taxes raises three questions. First, how do price trends affect the depletion of fossil fuels for export? Second, what is the optimal depletion rate for a small open economy adversely affected by climate change? Third, how could we set a resource export revenue tax rate to attain the optimal depletion rate? These questions have relevance for resource-rich small open economies that face rising or falling world prices and seek a supply-side policy on climate change.

Supply-side policies could offer important benefits in the context of climate change strategy. First, curbing output of one's own export has a positive terms of trade effect, which could encourage participation in climate treaty negotiations (Cai et al., 2013). Second, Faehn et al. (2017) find that introducing a tax to reduce oil extraction achieves Norway's 2020 emissions target, but at one-third of the cost of using only demand-side measures. Third, slowing extraction could help avoid fossil fuel over-production and the associated carbon lock-in, whereby fossil-fuel based technologies dominate carbon-free alternatives.

A resource export revenue tax rather than a tax on resource use levied by an importing country would shift some of the rents from regulation of emissions to the government of the exporting country. Mattauch et al. (2015) show how a carbon tax could fund a learning subsidy for renewables technology to overcome carbon lock-in and ease the transformation to a low-carbon economy. Similarly, a resource export revenue tax could generate funding for investment in non-renewable resources as part of a broader solution to climate change.

The analysis in this paper connects two streams of economic modelling literature related to fossil-fuels. One is the recent literature which proposes supply-side solutions to climate change. The other is a well-established literature on the depletion of non-renewable resources. While the former overlooks how exhaustibility affects the decision to extract fossil fuels, the latter overlooks the effect of climate change on a small open economy.

Theoretical literature on socially optimal depletion of non-renewable resources is founded in the seminal work of Stiglitz (1974) and Dasgupta et al. (1978) where the exhaustibility of resources plays an important role in potential economic growth. Dasgupta and Heal (1979) show that a constant ad valorem tax rate on an exhaustible resource which is costless to produce does not distort the extraction rate in partial equilibrium.

Recent literature incorporates these insights to analyze optimal taxation in a general equilibrium framework where resource depletion contributes to climate change and impedes productivity (Sinclair, 1994; Ulph and Ulph, 1994; Groth and Schou, 2007). Taking the lead of Stiglitz (1974), these models assume a closed economy. This literature finds that the optimal depletion rate depends on utility parameters which are difficult to estimate, and a constant social time preference rate, which is a sensitive assumption (Guest, 2014). Useful implications for global agreements on demand-side policies, such as a carbon tax, are readily obtained by interpreting these models as applying to the world as a whole. However, the closed economy assumption precludes analysis of world price trends and supply-side policies on climate change from the perspective of a small open economy.

Dasgupta et al. (1978) show that Hotelling rule can be applied to the optimal management of non-renewable resources in a small open economy. Despite this, the bulk of recent literature overlooks questions pertaining to small open economies. An emerging literature develops a general equilibrium framework along the lines of Dasgupta et al. (1978) to analyze the role of anticipated capital gains and rent seeking in the depletion rate of resources for export (van der Ploeg, 2010). The framework analyzes the decision making of a social planner, but overlooks the negative effect of climate change on productivity analyzed in closed economy models.

This paper contributes to the literature by analyzing how a resource export revenue tax should be set over time to slow extraction, taking into account world price trends, fossil fuel exhaustibility and the effect of climate change on a small open economy. We develop a model which incorporates a negative externality from climate change whereby depleted resource stocks impede domestic productivity growth. The optimal tax setting renders resource depletion under decentralized decision making of the mining and household sectors equivalent to that of a social planner who internalizes the social cost of depletion.

Two particularly interesting results of the analysis in this paper are, firstly, that growth in world prices imposes similar effects to a downward trend in a resource revenue tax rate. Both confer an incentive to defer extraction and reduce the depletion rate of non-renewable resources for export. Secondly, socially optimal extraction can be attained by setting an export revenue tax rate to fall over time at the marginal social cost of depletion, measured as the foregone marginal

[3] Eleven per cent of world trade in resources is covered by export taxes, while five per cent of total world trade is covered by export taxes (World Trade Organization, 2014).