Optimal de-risking strategies for breakthrough technologies: Risk allocation in green industry transitions

Darius Sultani*[1, 2], Jules Welgryn[1, 3, 4], Michael Pahle[1], and Michael Jakob[5]

[1]Potsdam Institute for Climate Impact Research

[2]Department of Energy and Environmental Management, Europa University Flensburg

[3]Chaire Economie du Climat, Université Paris-Dauphine

[4]EconomiX, Université Paris-Nanterre

[5]Climate Transition Economics, Berlin

This version: January 2026

Abstract

Even with carbon pricing in place, investment in low-carbon technologies have remained below socially optimal levels with additional market failures in place. In this work, we develop a two-period partial equilibrium model to evaluate the welfare effects of de-risking policy instruments when learning externalities occur, future carbon prices are uncertain and risk markets are incomplete. Focusing on the risk transfer away from the producer and into the fiscal budget, we account for the regulator's exposure to carbon price risk and the opportunity cost of earmarked funds associated with long-term, contingent liabilities such as carbon contracts for difference (CCfDs). This framework allows us to characterise optimal risk sharing between the producer and the regulator when fiscal risk is itself socially costly. For this second-best setting, we show analytically that - even in the absence of private hedging markets - a full transfer of carbon price risk into the public budget is generally not optimal. Our numerical results imply that risk-transferring instruments can play an important role in narrowing the welfare gap to first-best, but that excessive public risk absorption may generate large fiscal costs of risk, hence reducing welfare even below a no-policy benchmark.

Keywords: carbon pricing, fiscal cost, incomplete markets, carbon contracts for difference, partial equilibrium model, risk, technology learning, welfare analysis

*Corresponding author at darius.sultani@pik-potsdam.de. The authors would like to thank Marie-Louise Arlt, Mario Liebensteiner, Pao-Yu Oei, and participants at the Kiel Institute Workshop on "The role of public research and innovation measures on mitigating climate change" (May 2023) for valuable comments on an earlier version of this study.