
Marc Chesney • Jonathan Gheysens •
Anca Claudia Pana • Luca Taschini

Environmental Finance and Investments

Second Edition

 Springer

Contents

1	Introduction	1
2	The Issue of Climate Change	5
2.1	The Carbon - Temperature Conundrum	5
2.2	Global Warming Scenarios and Mitigation Paths	8
2.3	Environmental and Economic Impacts	11
	Bibliography	16
3	International Efforts to Tackle Climate Change	17
3.1	History and Institutions	17
3.1.1	The UNFCCC	17
3.1.2	The Kyoto Protocol	19
3.1.3	The Conference of the Parties and the Subsidiary Bodies	22
3.2	Emission Trading Schemes Around the World	26
3.2.1	European Union Emissions Trading System	26
3.2.2	Switzerland Emissions Trading Scheme	33
3.2.3	Regional Trading Schemes in the United States	34
3.2.4	Emission Reduction Programs in Canada	35
3.2.5	Kazakhstan Emissions Trading Scheme	36
3.2.6	Australia Carbon Pricing Mechanism	36
3.2.7	New Zealand Emissions Trading Scheme	37
3.2.8	Japan's National and Sub-national Schemes	37
3.2.9	Pilot Emissions Trading Schemes in China	38
3.2.10	Other Emerging Trading Schemes	38
3.3	Kyoto's Flexible Mechanisms	39
3.3.1	Clean Development Mechanism	39
3.3.2	Joint Implementation	46
	Bibliography	47
4	The Economics of Mitigation	49
4.1	Greenhouse Gas Emissions as Externalities	49
4.2	Taxes and Subsidies	51
4.3	Tradable Permits	53
4.4	Cap-and-Trade Systems and the Influence of Uncertainty	55
4.4.1	Cap-and-Trade Systems	55

4.4.2	The Influence of Uncertainty	59
4.5	Mixing Adaptation and Mitigation Strategies	66
4.5.1	A Real Options Approach to Mitigation and Adaptation	68
4.5.2	Geoengineering Strategies	69
	Bibliography	71
5	Economic Growth and the Environment	73
5.1	Introduction to the Economics of Growth	73
5.2	The Economics of Growth	76
5.2.1	Production with Non-renewable Resources	78
5.2.2	Production with Renewable Resources	79
5.2.3	Technological Innovations and the Environment	80
5.2.4	Production and the Carbon Budget	86
5.3	Beyond Growth	92
	Bibliography	100
6	The Finance of Environmental Investments	103
6.1	Introduction to Environmental Finance	103
6.2	Characteristics of Investment Projects	104
6.3	The Neoclassical Approach: The Net Present Value (NPV)	105
6.3.1	Limitations of the NPV Approach	105
6.3.2	Relationship to Option Pricing Theory	106
6.4	Investment Opportunities as Options	107
6.4.1	An Intuitive Example	107
6.4.2	From NPV to Real Options: A Second Example	109
6.4.3	Real Options and Incentives to Invest: A Third Example ...	112
6.5	Option Pricing with the Binomial Model	113
6.5.1	The One-Step Binomial Model	113
6.5.2	Multi-step Binomial Model	114
6.5.3	Multi-period Binomial Model and Option Pricing	116
6.6	The Black–Scholes Formula	118
6.6.1	Pricing European Options	118
6.6.2	Pricing American Options	122
6.6.3	How Can Volatility Be Estimated?	123
6.7	The Real Options Approach as a Decision Making Tool for Compliance with Environmental Regulation	125
6.7.1	A One-Period Model for the Emissions and Price Processes. What Is the Optimal Decision in Terms of Emission Rights Trading?	125
6.7.2	A Two-Period Model for the Emissions and Price Processes. What Are the Optimal Decisions in Terms of Emission Rights?	129
6.7.3	A One-Period Model for the Emission and Price Processes. What Is the Optimal Decision in Terms of Emission Rights Trading and Technology Changes?	138

6.7.4	A Two-Period Model for the Emission and Price Processes—What Are the Optimal Decisions in Terms of Emission Rights Trading and Technology Changes?	142
6.7.5	A One-Period Model for Emission: What Are the Optimal Decisions in Terms of Emission Rights Trading when Price Dynamics Are Endogenously Derived?	152
	Bibliography	158
7	Emission Price Dynamics	159
7.1	Econometric Analysis of the EUA Price	159
7.1.1	Key Statistics for the EUA Price	160
7.1.2	Fuel Switching	161
7.2	Deterministic and Stochastic Equilibrium Models	166
7.2.1	Deterministic Equilibrium Models	167
7.2.2	Montgomery (1972)	167
7.2.3	Rubin (1996)	171
7.2.4	Kling and Rubin (1997)	175
7.2.5	Seifert et al. (2008)	178
7.2.6	Carmona et al. (2009)	180
7.2.7	Chesney and Taschini (2012)	184
	Appendix	188
	Solving Static Optimization Problems	188
	Solving Dynamic Optimization Problems	189
	Optimality Conditions	192
	The Solution for a Representative Agent in Seifert et al. (2008)	193
	Bibliography	196