

Economic Growth and the Environment

An Introduction to the Theory

Clas Eriksson

OXFORD
UNIVERSITY PRESS

"

"

— CONTENTS

• v

USTOF FIGURES	xiii
PREFACE	xv
1 Introductions	1
1.1 The fundamental question: IS SUSTAINABILITY FEASIBLE?	2
1.2 Why growth?	4
1.3 Delimitations	6
1.4 Disposition	7
1.4.1 Part I: Tools	7
1.4.2 Part II: Natural resources	8
1.4.3 Part III: Pollution	9
PART I TOOLS	
2 Production	13
2.1 Production function	13
2.1.1 Inputs	13
2.1.2 Neo-classical assumptions	15
2.2 Variables in intensity form	16
2.2.1 Per capita variables	17
2.2.2 Per unit of effective labor	20
2.2.3 The capital-output ratio	21
2.3 The elasticity of substitution	21
2.4 Income shares (output elasticities)	25
2.4.1 Kaldor facts	25
2.4.2 Defining income shares	25
2.4.3 Income shares and output growth	26
2.4.4 Some implications	28
2.5 The CES function	29
2.5.1 Income shares	29
2.5.2 Intensity form	30
2.6 Conclusion	33
2.7 Exercises	34

3 The Solow model	35
3.1 Capital accumulation	36
3.2 Solow's fundamental equation	37
3.2.1 Deriving the equation	37
3.2.2 Some implications	38
3.3 Steady state	40
3.3.1 Without technological change	40
3.3.2 With technological change	43
3.3.3 The Golden Rule	44
3.4 Transition to steady state	46
3.4.1 Without technological change	46
3.4.2 With technological change	50
3.5 Endogenous growth	51
3.6 The CES case	54
3.7 An alternative solution method	55
3.8 Conclusion	57
3.9 Exercises	58
*	
•(
4 Endogenous technological change	61
4.1 Some properties of technology	62
4.2 The extended model	63
4.2.1 The research sector	63
4.2.2 The full model	65
4.3 Four cases	67
4.3.1 Endogenous growth (Romer)	67
4.3.2 Semi-endogenous growth (Jones)	68
4.3.3 Weak limits to growth	70
4.3.4 Absolute limits to growth	71
4.4 Directed technological change	72
4.5 Steady state direction (optional)	75
4.5.1 step 1	76
4.5.2 Step 2	77
4.6 Conclusion	78
4.7 Exercises	79

PART II NATURAL RESOURCES

5 Land	f	83
5.1 The production factor land		84
5.2 The general model		85
5.2.1 Direction of technological change		85
5.2.2 ^f Implications		87

5.3 Transitional dynamics	88
5.4 The CES case	91
5.5 A Cobb-Douglas case	94
5.6 Variable population growth	97
5.6.1 Exogenous population growth	98
5.6.2 Endogenous population growth	100
5.7 Conclusion	102
5.8 Exercises	103
5.9 Appendix	103
5.9.1 balanced direction	103
5.9.2 Output growth	104
 6 Exhaustible resources	 107
6.1 The energy constraint	109
6.2 The general case	111
6.2.1 Direction of technological change	111
6.2.2 Implications	112
6.2.3 Transitional dynamics	114
6.3 Energy in the CES function	116
6.3.1 Balanced growth	116
6.3.2 Non-balanced growth	117
6.4 A Cobb-Douglas case	121
6.4.1 With technological progress	121
6.4.2 Without technological progress	123
6.5 Transition to renewable energy	126
6.5.1 Firm optimization	126
6.5.2 The full growth model	129
6.5.3 Long-run growth	131
6.5.4 Long-run energy paths	132
6.6 The resource curse	134
6.6.1 Negative and positive experiences of natural resources	135
6.6.2 Explanations of the natural resource curse	135
6.6.3 Summary on the resource curse	137
6.7 Conclusion	137
6.8 Exercises	138
6.9 Appendix	138
6.9.1 Balanced direction	138
6.9.2 Output growth	140
6.9.3 Integrating the resource constraint	140
6.9.4 Time derivative of \mathcal{L}	141
6.9.5 Growth rates of N and R	* 143

PART III POLLUTION

7 Pollution reduction by abatement	147
7.1 Scale, composition, and technology effects	148
7.2 Stock pollution	152
7.3 Production, pollution, and abatement	156
7.3.1 Specific Form I	158
7.3.2 Specific Form II	159
7.3.3 Specific Form III	160
7.4 The growth model	161
7.5 Abatement share	165
7.6 Environmental policy	166
7.7 Conclusion	167
7.8 Exercises	168
8 Pollution reduction by directed technological change	169
8.1 A model with environmental technology	170
8.1.1 Output and growth	170
8.1.2 Pollution *	171
8.1.3 The simplest case	172
8.2 Cobb-Douglas	174
8.3 CES	179
8.4 Phasing out a polluting input	182
8.4.1 Recollection of the model	183
8.4.2 Good substitution possibilities	185
8.4.3 Bad substitution possibilities	186
8.5 Conclusion	187
8.6 Exercises	188
9 Utility maximization	189
9.1 A general model	190
9.1.1 The model	190
9.1.2 Optimal time path of pollution	191
9.2 A special case	194
9.2.1 Using the formula	194
9.2.2 Using the utility-maximization condition	195
9.3 The Stokey model	197
9.3.1 Consumption and pollution	197
9.3.2 Utility maximization	198
9.3.3 Solution	201
9.4 Increasing returns to abatement	203

9.5 Empirics on the environmental Kuznets curve	205
9.5.1 Method and early results	206
9.5.2 Criticism	207
9.6 Conclusion	208
9.7 Exercises	209
BIBLIOGRAPHY	211
AUTHOR INDEX	215
SUBJECT INDEX	216
£	?