

# Index

---

The index contains references to subjects covered in the book. Comprehensive treatment of a subject is indicated by underlined page references; figures, tables, and notes are referenced in *italics*.

- abatement cost, 92, *100*
- acid rain, 79, 94, *220*, 328–331, *331*,  
332, 336, *337*, *338*
- acidification, 94, 330, 331, 338
- ambivalence, 12, 22, 162, 177, 292,  
302, 328, 335–337, 342
  - and environmental damage, 172–  
173
  - and innovation, 170
  - and preferences, 171, *171*
  - and technical progress, 170, *171*
  - and uncertainty, 173
  - modelling, 164–170
  - of sulphurous substances, 327,  
332–335
  - of waste paper, 273–275, 279–  
281, 285, 288–289
  - over time, *174*, 169–174, 243,  
302, 342
  - potential, 166, 168–169
- axiomatisation, 152, 156–158, *160*
  
- biodiversity loss, 99, 146
- blast furnace slag, 310, 313, 316, 321,  
325
  
- calcium sulphide, 294, 295, 302, *304*
- capital
  - accumulation, 186, 295, 311, 313,  
314
  - homogeneity of, 49, *66*, 82
  - neo-Austrian theory, 82, 200–216
  - stock, 81–82, 184, 201, 209, 211,  
295, 302, 303, 307, 311, 324,  
325
  - theory, 81, 183, 185–187, 195,  
342
- case study
  - cement production, 53, 163, 307–  
326
  - soda and chlorine industry, 170,  
172, 176, 292–305, 325
  - sulphuric acid, 170, 176, 327–337
  - waste paper, 163, 164, 170, 174,  
177, *181*, 243, 273–290
- cement, 308–310
  - aggregates, 309, 310
  - clinker, 309–312
  - shipment, *314*
- cement industry, 283, 307–326, 336
  - economic development, 312–314,  
317, 318, 324–326
  - economic relevance, 307
  - interrelation with other indu-  
stries, *312*, *315*, *316*, 313–316,  
320–322, *323*, 325
- cement manufacture, *309*, 310
  - CO<sub>2</sub> emission, 318, 319, *321*, 324
  - dust emission, 318, *319*
  - energy efficiency, 318, 319
  - fuels, 312, 313, *322*, 318–325
  - history, 310–318

- joint production, 308, 310, 318, 322, 324
- SO<sub>2</sub> emission, 319, 320
- Chance process, 296, 296, 302, 303
- chemical industry, 32, 43, 59, 115, 147, 172, 176, 292, 293, 299–303, 327, 328, 333, 333–336
- chlorine, 8, 170, 172, 176, 251, 298, 292–303, 306
  - economic significance, 305
  - environmental impact, 292
- chlorine-alkali electrolysis, 298, 298–299
- choice of production techniques, 136, 137, 184–185
- climate change, 80, 91, 146, 244, 320
- CO<sub>2</sub> (carbon dioxide), 51, 56, 79, 162, 188, 191, 318, 319, 332
- CO<sub>2</sub> emissions, 2, 62, 67, 67, 319, 320, 321, 326
- co-evolution, 301–303, 326, 327, 341
- complexity, 12, 86, 225, 229, 245, 247, 271, 307, 341
  - and responsibility, 230–233
  - due to joint production, 86–87, 233, 236, 248, 327, 335, 339
  - of concomitants, 230, 233, 235, 251, 258, 265, 266, 340
  - of ecological-economic systems, 2, 69, 195, 196, 218, 232, 241, 245, 341
- consequences of an action
  - and joint products, 232, 343
  - as basis of moral judgement, 233, 240, 251, 259
  - chance-, 230, 238, 241, 245, 255, 259
  - concomitants, 230, 231
  - intended and unintended, 90, 231
  - necessary, 238, 241, 244, 245, 255
- critical load, 330
- crude oil refining, 2, 176, 328, 334, 335
- Deacon process, 295, 296, 302, 303, 306
- degradation rate of pollutants, 78, 79, 173, 184, 188, 189, 192, 194, 195, 210
- discount rate, 189, 196, 200, 217
- dry deposition, 329–331
- duality principle, 22, 47–49, 129, 130, 144, 150, 158, 159
- dynamics, 35, 69–84, 186, 196, 199, 208, 213, 245, 271, 324, 340
  - deterministic d. and stocks, 69, 71, 87
  - economic, 123
  - of ecological-economic systems, 12, 40, 184, 218, 327, 341
  - of environmental problems, 94, 97, 98, 93–99, 302–303, 304
- ecological economics, 3–6, 9, 49, 62, 177
- economic development, 317, 340
  - ambivalence and, 332
  - joint production and, 123, 300, 301, 327, 337, 339
- economic growth, 129, 130, 183, 317
  - limits, 5, 6
- economic theorising
  - axiomatisation, 156, 160
  - formalisation, 157–159
  - problem-oriented and theorem-oriented, 153, 152–155, 157, 159
  - scientific realism, 153, 160
  - structuralism, 155, 157, 159
  - subjective elements, 29, 33
- economies of scope, 141, 149
- ecosystem, 5, 67, 76, 89–94, 98, 99, 295, 330, 336, 338
  - as sink for pollutants, 1, 67, 92, 93, 97, 162, 331
  - functions, 71, 93
- end-of-pipe abatement, 40, 97, 205, 218, 318
- entropy, 4, 5, 10, 12, 46, 50–65, 67, 68, 188
  - e. 'theory of value', 66
  - specific, 51, 51, 52–53, 56, 65, 66

- environmental and resource economics, 3, 11, 43, 48, 50, 92, 105, 108, 139, 145, 189, 340
- environmental impact, 27, 32, 33, 38, 89, 99, *100*, 147, 162, 173, 175, 190–192, 264, 324, 332
- assessment, 342
  - irreversible, 98
  - of cement manufacture, 308, 318–323
  - of chlorinated substances, 292
  - of SO<sub>2</sub>, 329–332
  - reversible, 97
- environmental Kuznets curve, *101*
- environmental policy, 40, 175, 195, 223, 227, 228, 263, 273, 339, 341, 343–345
- ambivalence of joint products, 178, 336
  - general aims of, 92
  - instruments, 264
  - joint externalities, 336, 337
  - role of knowledge, 344
- environmental problems, 89
- causes of, 91, 96
  - due to sulphurous substances, 295, 328, 335
  - economic analysis of, 99, 105
  - joint production as cause, 50, 61, 95, 99, 339
  - solution by re-use of joint outputs, 335
  - substitution of, 98, 303, 335, 342
  - temporal pattern of, 93, *94*, 96, *97*, *98*, 293, 302, *304*, 331–332, 345
- epistemology, 3, 8, 223
- ethics, 3, 8, 12, 100, 146, 223–267, 339–344
- evolution, 17, 27, 36, 83, 89, 173, 324, 326, 332, 337, 338
- industrial, 176, 271, 293, 301–304, 315, 325, 334
  - of economic methodology, *148*, 152
- exergy, 49–52, 54, *55*, *56*, 54–62, *66*, *67*
- law of Gouy and Stodola, 54
- externality, 7, 11, 23, 43, 48, 50, *99*, 105, 131, 140, 145, 337, 340, 342, 344
- hidden, 175, 336, 337, 342
  - joint, 176, *177*, 328, 335–337, 342
  - joint production and, 23–24
  - Pigouvian approach to, 46, 139
  - theory of, 140
- flow pollution, 80, 188, 190, 195, 199, 204, 208, 213, 214, 303, 331
- flows of input and output, 37
- forest die-back, 330, *331*, *338*
- fossil fuel, 91, 101, 162, 191, 308, 318, 320, 321, 328, 329
- free disposal, 7, 44, 122, 132–134, 137, 138, 144, 145, 159
- free riding, 7, 145
- freedom to act, 225, 226, 229, 231, *237*, 239, 264, 340, 344
- creativity, 2, 344
  - knowledge as a prerequisite, 239
- general equilibrium analysis, 130, 143, *148*
- modern, 131–134
  - neo-Ricardian, 134–138, 144
  - of joint production, 7, 123–124, 128, 130, 144, 163, 175
  - of public goods, 139
  - role of free disposal, 133, 138
  - structuralism, 155
- good life, 235
- heuristic of fear, 241, 247, 250, 253
- homo economicus, 2, 261, 340, 343, 344
- homo politicus, 261, 340, 343, 345
- hydrochloric acid, 170, 295, 300, 305, *306*
- hydrogen chloride, 239, 241, *251*, 294–296, 300, 303, 305
- industrial ecology, *146*

- industrial evolution, 271, 302, 334
  - ambivalence and, 332
  - interaction of stocks, 325, 326
  - joint externalities as a result, 336
  - joint production and, 176, 293, 300–302, 308, 311, 324, 327, 337
- industrial metabolism, 47
- industrial organisation literature, 21, 105, 131, 141, 142, 145, 159, 342
- innovation, 123, 173, 271, 306
  - and joint production, 123, 170, 293, 300, 301, 303, 325
  - delay, 210, 211, 216
  - of production techniques, 122, 184–186, 188–196, 199–219, 301, 303, 313, 318, 342
- interdisciplinarity, 1, 3, 62, 69, 339
- investment decision, 105, 183, 184, 189, 190, 195, 196, 296, 306, 342
- irreversibility, 2, 5, 60–63, 98, 100, 132, 173, 251, 258, 266, 310
  - due to joint production, 87
  - thermodynamic cause, 55, 57
- joint production, 2, 23–25, 38, 339, 345
  - asymmetric, 39, 237
  - business literature, 6, 24–25, 342
  - epistemology, 8
  - externality and, 23–24
  - fixed proportions, 20, 21, 112, 118–121, 125–128, 132, 143, 169, 204–206, 214
  - flexible proportions, 20, 113, 120–128, 132, 143
  - general principle of, 84–86, 230, 307
  - in ecological systems, 5
  - industrial evolution, 176, 293, 300–303, 308, 311, 324, 327, 337
  - intersectoral link, 333, 334–337
  - irreducible ignorance, 247
  - joint products and j.p., 39
  - modelling as single prod., 126
  - modern production theory, 21–23
  - principle of, 84, 85, 188, 232, 339
  - private and public goods, 6
  - responsibility, 8, 40, 232, 343
  - services and material outputs, 85
  - source of innovation, 122–123, 148, 300, 303, 325
  - stocks and, 70, 83–84, 292
  - systems of production, 21, 25
  - thermodynamic cause, 4, 53, 64–65, 188
  - time structure, 20, 26, 40–41, 42
  - traditional notion, 19
  - ubiquity of phenomenon, 12, 223, 232, 339, 341
  - universal concept, 10, 340
- joint products, 25, 37
  - ambivalent, 162–163, 292, 302
  - and joint production, 39
  - as a waste, 4, 51, 50–53, 114–116
  - desired and undesired, 39, 113–114, 117, 131, 162–163, 200, 242–245, 251, 342
  - in basic industries, 337
  - intended and unintended, 8, 86
  - re-use in production, 116, 146, 302, 303, 333
  - substitution of, 96–97
  - thermodynamic properties, 60, 61
  - unidentified, 243
  - valuation by marginal demand, 116–118
- justice, 156, 235, 255, 257, 262
- knowledge, 2, 8, 22, 30, 83–86, 94, 153, 173, 177, 218, 223, 224, 236, 238–250, 260, 305, 310–312, 322, 325, 340–344
  - as an obligation, 250, 343–345
  - factual and normative, 145, 240, 242–245
  - joint production as a source, 247

- observer's, 32, 33
- perfect, 158, 173, 344
- unidentified joint products, 243
- Leblanc process, 239, 293, 294, 296, 293–302, 304
  - production share, 299
- lifetime, 26, 41, 44, 78, 76–81, 188
  - of capital goods, 188
  - of pollutants, 79, 188–195, 342
- Lindahl equilibrium, 140, 141, 146, 154
  - problem of free-riding, 141
- market, 8, 11, 21, 22, 45, 48, 90, 109–113, 119, 123, 126, 131, 139–142, 145, 149, 181, 189, 231, 264, 273–275, 288, 310–318
  - failure, 46, 139, 140, 189, 198
  - waste paper, 273–290
- morality, 223
- MUSCOD-II, 219
- nature, 1, 43, 94, 199, 231, 232, 233, 236, 245, 262–266, 318, 343
- observer's interest, 27–37, 43, 72, 77
- ozone 'hole', 146, 244, 303
- Pareto efficiency, 7, 133, 138, 141, 145, 146, 189
- partial equilibrium analysis of joint production, 120, 123, 128
- permanency, 70–72, 72, 74–76, 80, 83
- persistence, 81
- pH-value, 338
- philosophy of economics, 152, 153
- phronesis, 236, 237, 249, 263
- political activity, 223, 256, 262, 265
- political power, 226, 228, 256, 258, 262
  - and joint production, 258
- Porter hypothesis, 306
- precautionary principle, 11, 12, 247, 247–250, 251, 252, 342, 345
- prediction, 36, 45, 69, 77, 87, 153, 160
- price, 23, 109, 109–144, 161, 165, 187–190, 273, 295, 316, 317, 333
  - ambivalence of waste paper, 273–275, 279–281, 285, 288–289
  - equilibrium-, 118–121, 127, 133, 147
  - market-, 46, 109, 110, 121
  - natural, 109–112
  - non-negativity, 130, 133, 137, 144, 150, 158, 159
  - p. taker, 22, 126
  - relative, 112
  - shadow, 163, 167–173, 178, 181
  - soda, 294, 297, 298
  - waste paper, 163, 165, 274, 275, 279, 281, 286, 279–290, 290
- principle of hope, 241, 247, 250, 251
- production, 4
  - cost function, 21–22
  - function, 21–23, 165, 175
  - fundamental factors, 4, 49–50
  - industrial, 51, 51–53, 55
  - input-output relation, 10
  - jointness of inputs, 5
  - material description, 33–34, 39, 43, 49, 175, 177, 341
  - modern theory, 22–23
  - multi-output, 21, 141–142
  - primal and dual description, 22
  - process, 4, 25, 38, 51, 55, 164, 169
  - system, 20, 25, 38
  - technique, 184, 186, 202
  - thermodynamic efficiency, 54–62
  - thermodynamic notion, 51, 50–53, 55, 341
  - time structure, 199, 201
  - vector, 125
- public good, 48, 84, 91, 139–141, 145, 154, 231
  - impure, 84
  - theory of, 50
- purpose of an action, 229, 238
- railway, 121, 313, 315, 315, 316, 324, 325

- recycling, 100, 115, 116, 162, 170, 281–283, 286–288, 291
- responsibility, 8, 12, 146, 223, 225, 225–267, 287, 304, 340, 344
- as a pre-ethical category, 233
  - as a virtue, 235–236, 249, 253, 261–263, 345
  - ascription, 226–227, 229, 233, 305
  - based on consequences of an action, 230
  - ethics of, 223, 233, 234, 250, 258, 259
  - freedom and, 226
  - homo politicus, 261–263
  - imperative of, 223, 233, 241, 250
  - individual and collective, 259, 266, 343, 345
  - joint production and, 232, 250, 340, 343, 344
  - knowledge as a prerequisite, 238, 240, 305, 322, 340, 343
  - knowledge as an obligation, 240–242, 250, 343–345
  - legal, 225–228, 254, 255, 288, 305, 323, 343
  - limits, 226, 230, 230, 253, 255–259, 263–265, 304, 340–344
  - moral, 223–227, 254, 288, 343
  - moral obligation, 227–228, 229, 234, 249, 259, 305, 343, 344
  - negative, 227, 229, 234
  - of the economic agent, 263–265
  - political, 256, 263, 287, 305, 323, 340, 343, 345
  - political-ethical, 256, 257, 261, 265, 340, 343, 345
  - positive, 228, 229, 234, 237
  - power and, 226
  - self-, 231
  - ubiquity of phenomenon, 223
- risk society, 260
- roundaboutness, 202
- scientific realism, 153, 160
- secondary resource, 163–170, 177, 178, 273–276, 283–288, 320, 325, 338
- markets, 289–290
- sensus communis, 249, 252
- SO<sub>2</sub> (sulphur dioxide), 79, 93–95, 100, 139, 318, 319, 320, 323, 327–337
- environmental impact, 329–333, 338
  - environmental regulation, 329, 338
- SO<sub>2</sub> emissions, 204, 220, 319, 320, 323, 327, 328, 329, 332, 336
- spatial structure, 332
  - time structure, 331–332
- soda, 172, 239, 241, 251, 294, 296, 297, 299, 304, 293–305, 306, 328
- soda and chlorine industry, 292–304
- environmental regulation, 294, 295, 300
  - historic development, 293–299
  - joint outputs, 294
- Solvay process, 296, 297, 296–299
- spent acid, 335, 336
- stationary state, 211, 216
- stock, 2, 72, 73, 339, 341, 345
- accumulation, 41, 173, 186, 188, 192, 193, 216
  - attribute of appertainment, 71, 73–78
  - basic idea, 70–71
  - concept of, 69, 71–74
  - durability of elements, 74, 75
  - duration, 72, 73, 73
  - dynamics, 74, 74–77, 96, 186, 191, 292, 303, 345
  - ecological, 88
  - economic, 88
  - effects of, 83, 84, 307, 325
  - history, 75
  - induced time lags, 96, 292, 303, 311, 327
  - interaction of, 325, 339
  - joint production and, 70, 82–83, 292
  - knowledge, 77, 96, 302, 311–318, 324, 325

- lifetime, 78, 79
- non-quantifiable, 71, 76, 76–78, 83, 302, 303
- pollutant, 78–80, 173, *182*, 184–193, 204, 210, 211, 215–217, 295, 325, 331
- population, 80–81
- reproduction of elements, 74, 75
- spatial dimension, *88*
- variable, 73, 74
- stock of capital, 81–82, 184, 201, 209–211, 295, 302, 303, *306*, 307, 311, 324, 325
  - modification of, 92, 302, 303
- stock pollution, 80, 184, 188, 190, 191, 194, 195, 199, 204, 210, 213, 215, 331
- structural change, 199–204, 207, 337
- structuralism, 152, 155, 156, 159, *160*
  - axiomatisation, 156
- substitution
  - inputs to paper production, 276
  - limits, 5, 165, 169, 177
  - principle of, 120
- sulphuric acid, 170, 176, 271, 293, 295, 297, 327, 329, *333*, *334*, 333–336, *338*
  - production, 333, 334
  - sources of sulphur, *334*
- superiority of a technique, 202–208
- sustainability, 1–2, 12–13, 69, 339–345
- system representation, 29, *31*, 27–32, 37, 38, 53, 86, 93, 96, 232, 264, 302, 303
  - accounting, 30
  - choice of, 32–37, 264, 342
  - dynamics, 69
  - environmental-economic, 31
  - thermodynamic, 30, 84, 232
- system under study, 26, 38
  - ‘purpose’, 25, 33, 39
  - boundaries, 25, *28*, 34–37
  - complete description, 30
  - elements, *28*, 26–29, 74
  - exogenous and endogenous interactions, 27, *28*, 34, 37
- technological change, 243, *306*, 324
- technology, 184
- thermodynamics, 3, 188, 339, 341
  - entropy law, 4, 46, 52, 53–55, 64–65
  - finite-time and -size, 59–60
  - law of Gouy and Stodola, 54, 55
  - law of mass conservation, 4, 46, 52, 53–54, 61, 63–64, 78
- time
  - horizon, 10, 32, 34–38, 40, *42*, 69, 71, 74, 183–185, 187, 189–196, 203, 208, 342, 344
  - interval for measuring flows, *45*
  - of observation, 26, *42*, 40–42, 72
  - scale of observation, 35, 34–36, *73*, 70–75
- uncertainty and ignorance, 2, 69, 75, 235, 246, 248, 301
  - choice of system representation, 32, 33
  - ignorance proper, 248–250
  - in valuing joint products, 99, 243, 244
  - irreducible, 246–250, 262, 265, 344
  - open and closed, 246, 250
  - reducible, 246, 247
  - risk, 248
- United Alkali Company, 298–301
- utilitarianism, 255, *259*
- utility function, 166, 169, 171, *181*
- valuation, 341
  - classical approach to joint production, 108–112
  - information needs, 219, 242
  - limits, 340
  - neoclassical approach to joint production, 118–123, 143
  - of environmental impact, 48, 89, 213, 218

- of outputs, 27, 33, 39, 162–163, 168, 175, 177, 340
- virtue, 225, 233–236, 249, 253, 254, 261–263, 345
- waste, 4, 5, 8, 41, 46, 48, 56–62, 66, 67, 88, 100, 108, 114–118, 122, 143, 148, 163–170, 174–176, 183, 188, 189, 232, 295, 310, 320, 321
  - accumulation, 172
  - disposal, 89, 163, 166, 168, 177, 264, 295
  - disposal cost, 44
  - dumping, 166
  - heat, 58, 60, 67, 162, 188, 310
  - high entropy, 10, 51, 51–56, 62
  - incineration, 32, 33, 38, 166, 242
  - inefficiency, 46, 47, 54, 58, 61
  - nuclear, 8, 80, 188, 192, 196, 342
  - output in Germany, 65
  - sulphurous, 2, 170, 176, 327, 328, 335, 336
  - tank-, 294, 295, 302
  - ubiquity of, 5, 50, 55
- waste paper, 275
  - foreign trade, 283–289
  - history of German industry, 277–278
  - legal frame, 280–283, 286, 288
  - market, 163, 273–279, 280, 288
  - price ambivalence, 274, 279–281, 288, 289
  - price index, 279, 281
  - recovered paper utilisation rate, 277, 276–289
  - recovery rate, 275–289
  - recycling and disposal industry, 274, 276, 287
  - seasonal market fluctuations, 285, 286
  - supply, 276
- welfare analysis, 11, 131, 138–141, 145, 154, 159, 189, 218, 289, 339
  - consumption vs. environmental quality, 200, 216
- welfare function, 203, 213, 217, 219
  - intertemporal, 200, 213
- wet deposition, 329–331