Index

aberrations 161
activities, similarity and complementarity 41
activity-specific knowledge 109
actors, evolution of energy system 203–4
adaptation 63, 168
adoption
  meso trajectory 18–19
  see also technology adoption
agent-based evolutionary models xv, 24–36
advantages 200
analysis of long-term qualitative developments 193
behavioural rules 25–30
energy system
  actions 204–5
  actors 203–4, 206
    energy-consuming 205
    energy-producing 205
  endowments 207–8
  evaluation and decision processes 209–10
  interactions 208–9
  outlook 210–11
  regulatory authorities 206
  routines 206–7
  technology 210
  facts to be explained 30–33
  predictive power xi–xii, 33–6
  see also co-evolutionary model
agents
  economic systems xi, 5
  evolutionary economics 15
  altruistic behaviour, group-level selection 127
anchors of sense, learning process 56
antagonism, agent behaviour 87, 88–9, 91, 96, 104
argumentative strategy 165
Arrow, K. 193
associations, existences as 8–9
assumptions, analysis of 160
astronomy
  error in 156, 168
  probability in 157
autarkic production 136, 137, 144
automata, markets as 10–11
automobile industry, Germany
  economic mobility
    mobility indices 184
    Salter curves 180
    technological mobility
    mobility indices 183
    Salter curves 178
autonomous factors, errors 162
autonomy, of agents 204
bargaining power, division of labour 38, 45, 47
Bartholomew’s index 182
behaviour
  evolutionary economics 15–16
  law of 155
  behavioural assumptions, firm competitiveness 62–3
  behavioural rules, agents 25–30
  belief systems, knowledge as 48
  benefits, ontological flatness 7
beverages industry, Germany
  economic mobility
    mobility indices 184
    Salter curves 181
    technological mobility
    mobility indices 183
    Salter curves 179
bidmodality, of existences 9–10
biology, probability in 157
Boltzman, L. 166
bottom strategy 136, 137
boundaries, capabilities as determinants of 41–3
boundary problem 33
boundary-spanners 78
bounded rationality 40, 43, 55–6, 113
Brisbane Club conference xviii
bundle of capabilities 41–2
business cycle model 26–7
behavioural rules 27–8
facts to be explained 31–2
predictive power 34–5
business cycles, study of theories 161
C–D gap 197
capabilities
  coordination issue 41–3
division of labour 39–41, 43–4
effect on specialization 39
knowledge creation 47–50
problems with defining 38, 40–41
product development 105
  see also dynamic capabilities
capability selection 49
capability shaping 49
capital, teaching concept of 151
causal explanations 166
chance 154, 155, 157, 167
chaos 154
chemicals industry, Germany
economic mobility
  mobility indices 184
  Salter curves 180
technological mobility
  mobility indices 183
  Salter curves 178
Clark, J.B. 191
classical method, explanation of errors 161–2, 163
coevolutionary model, agent
  behaviour 87–93
  structural attractors 93–5
coevolutionary process 20
codifiability, tacit knowledge
difficulty 64, 65
knowledge transfer 69–72
cognitive framework, learning process 46–7, 50
collaborations, R&D 75–6
collective phenomena, agent-based
  modelling 200
combination, knowledge conversion 68, 73
commercial actors, routines 207
communities, knowledge within 48
competence, as a cluster of rules 8
competences and difficulties gap (C–D gap) 197
competitiveness
  agent behaviour 88
  behavioural assumptions 62–3
  energy system 209
evolutionary account of 63–4
  hierarchy of capabilities 43
  knowledge deepening 109
  managerial strategy 46, 53–6
  qualitative 39
tacit knowledge
  distinguishing between explicit and 64–6
  importing and absorbing 73–8
  in-house knowledge-building 68–73
  see also market structure and competition model
complementarities, division of labour 41
completeness 158
complex systems ix
  co-evolutionary model, agent
    interactions 85, 87–93
    economic theory 193
  evolution
    as dialoguing 86
    invadability 86–7
  evolutionary thought x
complexity, of economic systems 3–6
conflict, differing cognitive frameworks xii
conflicting goals 48
confluence analysis 158, 160
connections
  complex systems ix
  growth of knowledge 9
consistency, of knowledge 48
construction industry, Germany
economic mobility
  mobility indices 184
  Salter curves 181
technological mobility
mobility indices 183
Salter curves 179
consumers
    energy sector 205
    heterogeneous behaviour 29
contractual agreements, knowledge acquisition 76
cooperative relationships, energy system 209
coordinated action, non-optimal rules 69
coordination
    and division of labour 41–4
    evolutionary economics 12
    transfer of innovations 72
see also de-coordination; re-coordination
coordinative management process 66–7
core capabilities 42
correspondence order 17, 19, 20
cost–benefit calculations 197
cost-effectiveness, division of labour 38, 45, 46
costs
    knowledge conversion 71
    ontological flatness 7
Cournot oligopoly 28
Cowles method 165
creative destruction, knowledge growth as 13, 17
critical behaviour, agent-based modelling 200
culture, learning organizations 77
cyborg ontology 10, 11
cycles
    error term in 158–9
    pendulum models 159
see also business cycles; economic cycles
Darwin, Charles 167, 168
de-coordination 17, 19; see also coordination; re-coordination
decision processes, energy system 209–10
decomposition, evolutionary change 115–18, 127
decoupling
    knowledge evolution 109

doctrine of professional careers 165
driver business model 68
distribution
    and learning 53–6
    and production 52–3
distribution of errors 155–6
distribution of probabilities 164–5
disturbances 152, 153, 161, 163
diversity, economic evolution xiv, 129
division of human time, modelling 108–44
division of labour
    capabilities 39–41
    coordination 41–4
    effect on firm specialization 39
    elements in choice of appropriate 45–7
    evolution of knowledges 109
    function of 38–9
    knowledge creation 50–51
dynamic capabilities 62–3
    inter-firm competition 63–4
    production-related activities 66–7
tacit knowledge
    hierarchy of capabilities 67–8
    importing and absorbing 73–8
    in-house knowledge building 68–73
dynamics, see evolutionary dynamics
world energy demand from development of GDP 203
deep order 17
deepening, of knowledge 109
depth, of economic systems 3
descriptive statistics, German manufacturing firms 175–6
determinate system, economy as 158–9
determinism 156, 157, 165–9
developing countries, specializing top strategy 138
dialoguing, evolution of complex systems 86
difference-of-means tests 185–7
differentiated knowledge 63–4
diffusion
    meso trajectory 18–19
    see also knowledge transfer
discrepancies
    between expected values 152
    models for explaining 158
distribution
    and learning 53–6
    and production 52–3
distribution of errors 155–6
distribution of probabilities 164–5
disturbances 152, 153, 161, 163
diversity, economic evolution xiv, 129
division of human time, modelling 108–44
division of labour
    capabilities 39–41
    coordination 41–4
    effect on firm specialization 39
    elements in choice of appropriate 45–7
    evolution of knowledges 109
    function of 38–9
    knowledge creation 50–51
dynamic capabilities 62–3
    inter-firm competition 63–4
    production-related activities 66–7
tacit knowledge
    hierarchy of capabilities 67–8
    importing and absorbing 73–8
    in-house knowledge building 68–73
dynamics, see evolutionary dynamics
world energy demand from development of GDP 203
deep order 17
deepening, of knowledge 109
depth, of economic systems 3
descriptive statistics, German manufacturing firms 175–6
determinate system, economy as 158–9
determinism 156, 157, 165–9
developing countries, specializing top strategy 138
dialoguing, evolution of complex systems 86
difference-of-means tests 185–7
differentiated knowledge 63–4
diffusion
    meso trajectory 18–19
    see also knowledge transfer
discrepancies
    between expected values 152
    models for explaining 158
distribution
    and learning 53–6
    and production 52–3
distribution of errors 155–6
distribution of probabilities 164–5
disturbances 152, 153, 161, 163
diversity, economic evolution xiv, 129
division of human time, modelling 108–44
division of labour
    capabilities 39–41
    coordination 41–4
    effect on firm specialization 39
    elements in choice of appropriate 45–7
    evolution of knowledges 109
    function of 38–9
    knowledge creation 50–51
dynamic capabilities 62–3
    inter-firm competition 63–4
    production-related activities 66–7
tacit knowledge
    hierarchy of capabilities 67–8
    importing and absorbing 73–8
    in-house knowledge building 68–73
dynamics, see evolutionary dynamics
econometric testing 24
economic cycles 160–61
economic development
  qualitative change 195–6
  quantitative change 194–5
economic evolution xi
  evolution of knowledges 108–12
  integrated view 102–4
multi-activity models
  evolving multi-sectoral economy 138–41
  exchange 133–6
  motivation and structure 128–33
  R&D specialization 136–8
oligo-activity models
  basic specification 122–4
  innovation-based dynamics 124–7
  two-level evolution 127–8
uni-activity models
  background and specification 112–15
  developing 118–22
  Price’s general formula 115–18
see also evolutionary economics
economic mobility, German
  manufacturing firms 172–88
economic systems
  change in knowledge as meso trajectory 12–20
  as complex system of rules 10–11
  complexity of 3–6
  meso rules 8–10
economics
  economic development 194–6
  probabilistic revolution 157–65
  scientific enquiry ix–x
  transformation of industries 191–2
see also evolutionary economics
efficacy 12, 15
eigenvalue index 182–3
Einstein, A. 24–5
electronics industry, Germany
  economic mobility
    mobility indices 184
    Salter curves 180
  technological mobility
    mobility indices 183
    Salter curves 178
emergence
  flat ontology 7
  as a generative process 14–18
  emergent form, organization as an 5
emergent learning 56
empirical testing, social sciences 24
employees
  oligo-activity models 123–4
  uni-activity model 120–22
employment contracts, knowledge acquisition 76
employment shares
  qualitative change, Germany 195–6
  uni-activity model 114–15
endowments, energy system 207–8
energy sector 191
energy system, qualitative change xvii–xviii
agent-based model 203
actions 204–5
actors 203–4
  energy-consuming 205
  energy-producing 205
  regulatory authorities 206
endowments 207–8
evaluation and decision processes 209–10
interactions 208–9
outlook 210–11
regulatory authorities 206
routines 206–7
technology 210
reasons for studying 201–3
entrepreneurs
  capability 47
  macro aspect of meso adoption and diffusion 19
entry process, agent behaviour 29
environment-related behaviour 15–16
equally like cases 156
equilibrium
  among errors 155
  see also general equilibrium
equilibrium-oriented analytical techniques 192
error, see statistical error
error term 158–9
evaluative processes, energy producers 209–10
evolution
  invadability 86–7
  manufacturing 96–102
Index

theory of 5
see also economic evolution

evolutionary biology, errors xvi–xvii, 167–8, 169

evolutionary computation 200

evolutionary dynamics 11
as meso trajectory 13–14
need for structured ontology 7–8

evolutionary economics 12
agent-based models, see agent-based models

analysis ix, x
distinction between order and organization 3–4
knowledge-based approach 196–7
meso trajectory 12–14
adoption and diffusion 18–19
emergence as a generative process 14–18
stabilization and retention 19–20
qualitative change, see qualitative change
transformation of industry 192
see also economic evolution
evolutionary ontology, need for x, 6–8

evolutionary realism
meso rules 8–10
economy as complex system of 10–11

evolutionary economic problem 12
foundations of micro and macro 11–12
need for new ontology 6–8

evolutionary statics 11

evolutionary thought x

exchange, multi-activity models 133–6
existences
as associations 8–9
bimodality of 9–10
as processes 9

exogenous variables, as shocks 161
experimentation xiv–xvi, 18
expertise, localization of xiv
explicit knowledge 64–6
exploratory learning 88–93, 95, 102, 103

external knowledge-sourcing 73–8
externalization, knowledge conversion 68, 71

facts, agent-based models 30–33
fidelity, agent behaviour 89
final goods market, multi-activity
models 134–5

firm performance
industrial evolution 172–88
influence of tacit knowledge 68–9
firms
behaviour, market structure and competition 29–30

competitiveness
behavioural assumptions 62–3
evolutionary account of 63–4
knowledge deepening 109
tacit knowledge
distinguished from explicit knowledge 64–6
importing and absorbing 73–8
in-house 68–73
energy sector 205
investment decisions 68
learning process 38–57
routines, energy systems model 207
uni-activity model 113
employment shares 114–15
see also business cycle; manufacturing organizations
first-order failure, RBC models 31

Fisher, R.A. xv–xvi, 144, 159, 168
fitness function metaphor 209–10
flat ontology
costs and benefits 7
problem with 6–7
fluctuations 20
formalisms, evolutionary process 115
Frisch, R. 157–60, 161, 162, 168

Galton, G. 168
Gargantua and Pantagruel 154

GDP per capita, as indicator of economic development 194–5
general equilibrium 26, 157, 167, 168, 169
general rules 26
General Theory 27
generalized probabilistic approach 165, 166
generative process, emergence as 14–18
German manufacturing firms, technological/economic mobility xvii, 172–88
data and productivity measurement 173–6
difference-of-means tests 185–7
interpretation and further research 187–8
mobility indices 177–85
Salter curves 176–7
Germany, qualitative change, sectoral employment 195–6
group-level selection 127
growth theory 111, 193
Haavelmo, T. 159, 163, 164–5, 167, 168
Hayek, F. von xiv
Herfindahl index 33
heterogeneity, as source of learning and novelty 196–7
heterogeneous behaviour, agents 27, 28, 29
hierarchic depth, of economic systems 3
hierarchy of capabilities
problem solving 43
tacit knowledge 67–8
Hoel, P. 159–60
households
energy consumption 205
energy demand 206–7
uni-activity model 113, 120–22
human resource development, capability building 72–3
imitation
knowledge transfer 69–72
learning through 63
of tacit knowledge 65
in-house tacit knowledge 68–73
incentive-based approaches 197
incomplete information
managerial strategy 43
problem solving 40
inconsistency, of knowledge 48–9
indicators, as key facts 33
individual capabilities 40–41
industrial dynamics 172
industrial economics 191–2
industry evolution, firm performance 172–88
industry models 33
informal networking, knowledge acquisition 76
information
associations as 9
as a process 9
information processing, capability building 72
innovation effect, economic evolution xvi, 116–18, 120
‘Innovation and Learning: the two faces of R&D’ 73
innovation-based dynamics, oligo-activity models 124–7
innovations
heterogeneity and variety 197
imitation and adaptation 63
knowledge transfer 69–72
manufacturing evolution 96–102
neo-Schumpeterian theory 196
R&D specialization 136–8
see also novelty
innovative activity, and organizational structures 74–5
institutional arrangements, external knowledge acquisition 73
institutions
evolutionary realism 8, 10
use of chance 154
intended learning 56
inter-firm competition 63–4
inter-firm division of labour 41, 55
inter-population thinking 110, 129, 144
interactions
complex systems 87–93
economic systems 4
energy system 208–9
flat ontology 7
statistical physics 34–5
intermediate goods market
mean productivity 139
multi-activity models 135
internal knowledge selection 49
internalization, knowledge conversion 68, 73
International Conference on Complex Systems 193
Index

interorganizational relationships, knowledge acquisition 76
intra-population thinking 110, 129, 144
invaNability 86–7, 103
inverse square law 156
investment, in R&D 63, 73
investment decisions, analysis of 68
iron and steel industry, Germany economic mobility
mobility indices 184
Salter curves 181
technological mobility
mobility indices 183
Salter curves 179

Jenkins 167

Keynes, J.M. 27, 158
knowledge
in economic systems
as form of meso rules 8–10
meso trajectory as process of change 12–20
a source of value ix
evolutionary economic problem as growth of 12
interactions, and use of complex systems 85
machine ontology of 10
see also capabilities; explicit knowledge; tacit knowledge
knowledge acquisition xiii–xiv, 73–8
knowledge conversion 68
knowledge creation
and capabilities 47–50
for competitiveness and survival 66
division of labour 50–51
inter-firm specialization 129
knowledge evolution
economic evolution 108–12
modelling 111–44
knowledge inconsistency 49
knowledge transfer
codifiability 69–72
survival and competitiveness 66
tacitness 65
knowledge-based approach, evolutionary economics 196–7
knowledge-building activities 78
knowledge-improving labour 109

Koopmans, T. 158, 159, 163, 165, 167, 168
Kuznets, S. 191
Kyoto Protocol 202
labour economy model, knowledge evolution 110
labour markets, uni-activity model 113–14
Laplace, P.S. 155
lattices, uni-activity model 120–22
Law and Design 157
law of error 155
learning organizations 77
learning process
circumstances preventing 50–51
and distribution 53–6
division of labour 38, 40–41, 45, 46
management’s shaping of 49
manufacturing evolution 105
problem solving 40
see also exploratory learning
learning spirals 66, 67
Legendre, A.M. 155
legitimate order 167
Leontief technology 136, 140
linear programming 174
London Mint 154
long-run qualitative change, see qualitative change
lots, drawing of 154
loyalty, and learning process 51, 54
machine industry, Germany economic mobility
mobility indices 184
Salter curves 180
technological mobility
mobility indices 183
Salter curves 178
macro processes
adoption and diffusion 19
meso emergence 15, 17–18
stabilization and retention 20
macroeconomics 10
evolutionary 11–12, 16–17
growth theory 193
management
knowledge absorption 77
shaping of learning process 49
managerial strategy
capabilities and knowledge 47–50
distribution
and learning 53–6
production and 52–3
division of labour 43
function of 38
profits and 44–7
opportunities for enhancing
capabilities xii–xiii
workers’ misperceptions of and
problem solving 39
manufacturing organizations
characteristics 96–8
see also German manufacturing
firms
market structure and competition
model 28
behavioural rules 28–30
facts to be explained 32–3
predictive power 35–6
markets
multi-activity models 133–6
as rule systems 8, 10–11
uni-activity model 113–14
Markov transition matrices 172, 173, 177, 183
Marshall, A. 11, 20, 141
Marx, K. 45
maximum likelihood 155
Maxwell, J.C. 166, 167
measurement
evolution of knowledges 109–10
knowledge absorption 76–7
measurement errors 155–6, 158, 161–3
mechanical determinism, see
determinism
mechanism design 5
mental modelling, energy producers 209–10
meso objects 12
meso perspective, qualitative change 198–9
meso rules
economic systems xi, 8–10
evolutionary economic problem 12
foundations of micro and macro 11–12
meso trajectory 10, 12–14
adoption and diffusion 18–19
emergence as a generative process 14–18
stabilization and retention 19–20
mesoeconomic analysis 10
metabolic process, organization as 5
method of moments 31
methodological cyborgism xi, 10
methodological individualism xi, 10
micro agents 15
micro perspective, qualitative change 198–9
micro processes
adoption and diffusion 18–19
meso emergence 14–15, 16
stabilization and retention 20
microeconomics 10
evolutionary 11, 15–16
misperceptions
conflicting goals 48
prevention of learning 50–51
Mitchell, W. 158
mobility indices 173, 177–85
modularity, of economic systems 3
monetary policies, restrictive 57
monopolistic competition, knowledge
differences 64
monopoly paradox 127, 129
Morgenstern 158
multi-activity models 111
evolving multi-sectoral economy 138–41
exchange 133–6
motivation and structure 128–33
R&D specialization 136–8
multi-firm knowledge acquisition 73–5
multi-sectoral growth models 138–41
mutations, errors as xvi–xvii, 167, 168, 169
natural selection 167, 168
Nelson–Winter models 142, 143
neo-Schumpeterian theory 196, 197
neoclassical economics
behaviour rules 26
industrial dynamics 191–2
inter-firm competition 64
order 157
networks, knowledge acquisition 76
Index

new institutionalism, use of capabilities 46
Newtonian world, error in 156
Neyman, J. 159
non-imitable capabilities 71
non-optimal rules, coordinated action 69
Nonaka–Takeuchi framework, knowledge conversion 73
normal distribution 155
normative criticism 36
Nouvelles Méthodes pour la détermination des orbites des comètes 155
novelty
as generative process 13
heterogeneity as source of 197
ontological flatness 7
time dimension 197
see also innovations
numerical techniques 199–200
oligo-activity models 111
basic specification 122–4
innovation-based dynamics 124–7
two-level evolution 127–8
oligopoly, knowledge differences 64
omitted variables approach 158, 161–3
ontology, see evolutionary ontology
open system dynamics, ontological flatness 7
openness, of economic systems 3
operational order 17
optics firms, Germany
economic mobility
mobility indices 184
Salter curves 180
technological mobility
mobility indices 183
Salter curves 178
optimizing explanations, R&D collaboration 75
optimizing models, knowledge absorption xiv, 76–7
order
biblical origin 154
chance as an expression of 154
in economics 4, 157
evolutionary macroeconomics 17, 19
meso rules 12
neoclassical economists 167
primacy over chance 155
ordinary least squares (OLS) method 155
organization
in economic systems 4–5
meso rules 12
ontological flatness 7
organizational capabilities 40, 41
and coordination 42–3
organizational firms, characteristics 96–8
organizational structures, knowledge acquisition and innovations 74–5
orientation, of knowledge 48
The Origin of the Species 167
output growth, business cycle model
agent behaviour 27
key facts 31–2
output measure, economic performance 174–5
paper and board industry, Germany
economic mobility
mobility indices 184
Salter curves 181
technological mobility
mobility indices 183
Salter curves 179
Pareto, V. 158
partial association 9
path-dependencies xvi–xvii, 43, 101, 198
patterns 4
Pearson, K. 155
pendulum models, of cycles 159
perfect rationality 196, 197
performance of firms, see firm performance
Persons, W. 158
pharmaceuticals, knowledge acquisition and organizational structures 74–5
phenotypic gambit 110
physics
behaviour rules 26
see also quantum physics; statistical physics
Plastics industry, Germany
Economic mobility
Mobility indices 184
Salter curves 180
Technological mobility
Mobility indices 183
Salter curves 178
Poincaré, H. 166, 167
Policy actors, energy system 206
Political system, influence on transformation process 202
Population of a rule 10
Population thinking 110, 111, 112, 129, 144
Possible agent behaviours, co-evolutionary model of xv, 87–93
Power laws 32, 35
Precision mechanics firms, Germany
Economic mobility
Mobility indices 184
Salter curves 180
Technological mobility
Mobility indices 183
Salter curves 178
Predictive power 24
Agent-based evolutionary models xi–xii, 33–6
Price competitive strategy, learning process 55
Price equation
Evolutionary change 112, 115–18, 144
Mean productivity, intermediate goods sector 139
R&D in oligo-activity models 124–7
Primary energy resources, development 201, 202
Printing trade, disintegration of 129
Proactivity, of agents 204
Probabilistic models 36
Probabilistic revolution 157–65, 166–7
Probability theory, rejection of 158–9
‘The probability approach in econometrics’ 159
Problem solving
Defining capabilities 40
Organizational hierarchies of capability 43
Perceptions of managerial strategy 39
Process dynamics 11
Processes, existences as 9
Product development
Capabilities 105
Complementarities and conflicts of possible attributes 104
In-house tacit knowledge 72
Structural attractors 95
Product quality, profitability 46
Production, and distribution 52–3
Production functions, traditional 199
Production-related activities, and capability 66–7
Production-related knowledges 113
Productivity
Changes in, see economic evolution
German manufacturing firms xvii
data and methodology 173–6
difference-of-means tests 185–7
Mobility indices 177–85
Salter curves 176–7
Productivity differentials 136
Profits
Evolutionary dynamics 16
Strategy and division of labour 44–7
Publicness of knowledge, imitation rate 70
Pyx 154
Qualitative change
Challenges for analysing 197–8
In economic development 195–6
Energy system xvii–xviii
Agent based model 203–10
Outlook 210–11
Reasons for studying 201–3
Knowledge 199
Knowledge-based approach 196–7
Micro and meso perspectives 198–9
Theoretical and conceptual considerations 199–201
Qualitative competitiveness, managerial strategy 39, 53, 54
Quantitative change 194–5
Quantum mechanics 24–5
Quantum physics 166
Quetelet, A.J. 155
R&D, see research and development
Rabelais 154
random drawings 162, 163
random variations 155
random vectors 152, 153
random walks, productivities 118–20
randomness 165–9
rational improvement 86
re-coordination 19; see also coordination; de-coordination
reactivity, of agents 204
real business cycle (RBC) models 31
realized learning 56
recursive process, capabilities and coordination 42–3
redistributive action 53–4
regression to the mean 167, 168
regulatory authorities, energy sector 191, 206, 209
Reiersol, O. 158
relevance, of knowledge 48
replicator dynamics ix, 3, 114, 115, 121
research and development
autarkic production 144
expenditure, knowledge absorption 77
innovation 63
knowledge acquisition 73, 75–6
Nelson–Winter tradition 142
oligo-activity models, productivity 122–7
specialization and innovation 136–8
residuals, errors treated as 156–7, 158, 168
resource allocation, evolutionary economics 12
resource-based theory 65, 104
resources, energy system 207–8
restless capitalism 105
retention, meso trajectory 19–20
Robbins, L. 158
routines of production 113
routinized behaviours 69
energy system model 206–7
transfer of innovations 72
rubber industry, Germany
economic mobility
mobility indices 184
Salter curves 180
technological mobility
mobility indices 183
Salter curves 178
rule-related behaviour 15
rules
in economic systems xi, 5
see also behavioural rules; meso rules
Salter curves 173, 176–7, 178–81
sampling 154, 157–8, 159, 160
sampling error 163
Schumpeter, J. 11, 141, 142, 159, 191
Schumpeterian Renaissance 192
Science et méthode 166
selection effect, economic evolution xvi, 116–18, 120, 125
selection mechanisms, replicator dynamics ix
selection principle, evolutionary economics 12, 18
selection process
economic evolution 115
energy system 209, 210
evolutionary biology 167, 168
self-reinforcement, learning processes 55–6
Sen, A. xv
sentiment, agent behaviour 27
shocks 159, 161, 162–4
simplifications, in modelling 36
simulation models 193
Smith, A. x, 40, 45, 109, 141
social ability, of agents 204
social sciences, agent-based models 24–36
socialization, knowledge conversion 68, 71
socioeconomic model, qualitative change, energy sector 203–10
special purpose knowledges 108–9
specialization
capabilities effect on 39
learning processes 40
see also economic evolution
spirals of learning 66, 67
stabilization, evolutionary 19–20
statics, evolutionary 11
statistical error
determinism and randomness 165–9
epistemic ambiguity 151–3
probabilistic revolution 157–65
statistical mechanics 166
statistical physics 34–5
steel industry, see iron and steel industry
Stigler, S. 154
stimuli, disturbances as 161
stochasticity 164–5, 168
strategic outlook, see managerial strategy
string theory 24–5
structural attractors xv, 90–92, 93–5
structural change, economics 192–3
structural estimation 161
structural evolution, complex systems
co-evolutionary model 87–93
invadability 86–7
structural attractors 93–5
structural factors, industrial dynamics 172
structural order 17
stylized facts 31, 32
subgoals, managerial strategy 45, 52
supply networks, product development 105
synergy
agent behaviour 87, 88–9, 91
manufacturing evolution 96, 104, 105
systems thinking 86
tacit knowledge
distinguished from explicit knowledge 64–6
hierarchy of capabilities 67–8
importing and absorbing 73–8
in-house and dynamic capabilities 68–73
tacitness, as economic attribute 65
taxonomy, of emergence 14
teachability, tacit knowledge, knowledge transfer 69–72
technological gatekeepers 78
technological mobility, German manufacturing firms 172–88
technology, agent-based model, energy system 210
technology adoption
micro processes of meso emergence 13–14
ontological flatness 7
testimonium paupertatis 163, 164
textile industry, Germany
economic mobility
mobility indices 184
Salter curves 181
technological mobility
mobility indices 183
Salter curves 179
theoretical framework, qualitative change 198
3-bodies problem 166
time, see division of human time
time dimension, learning and novelty 197
Tinbergen 158, 160–63, 165, 168
top strategy 136–7
total factor productivity, see productivity
trace index 182
trade cycle 27
trajectories, see meso trajectories
transaction cost economics 5
transfer of knowledge, see knowledge transfer
transition matrices, Markov chains 172, 173, 177, 183
Trial of the Pyx 154
uncertainty
agent behaviour 26, 27, 28
innovation processes 196
uni-activity models 111
background and specification 112–15
developing 118–22
Price’s general formula 115–18
user–producer relationships, energy system 209
utilitarian argument, probabilistic approach 165
validation
economic models 24
market structure and competition model 35–6
RBC theorists 31
Index

value added, managerial strategy 39, 52–3
value chain, knowledge within 49
value inconsistency 39, 48–9, 50–51
variance, analysis of 168
variety, evolutionary macroeconomics 17
variety creation 123
whole-economy approach, modelling 113
widening, of knowledge 109

workers
  involvement, profitability 47
  managerial strategy
  misperceptions and problem solving 39
  need for relevant capabilities 47
  provision of a cognitive context 46–7, 50
  value inconsistency 50–51
world energy demand, decoupling from development of GDP 203

Yule, U. 168