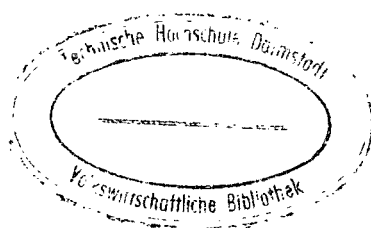

THE STRUCTURE OF APPLIED GENERAL EQUILIBRIUM MODELS

Victor Ginsburgh
and
Michiel Keyzer



The MIT Press
Cambridge, Massachusetts
London, England

Contents

Introduction	xiii
Acknowledgments	xvii
Notation	xix
1 Competitive Equilibrium	1
1.1 Basic Concepts	1
1.1.1 Commodities and Agents; Demands and Supplies	2
1.1.2 The Behavior of Producers and Consumers	3
1.1.3 General Competitive Equilibrium	4
1.1.4 Characteristics of a General Competitive Equilibrium	4
1.2 Excess Demand Equilibrium	4
1.2.1 Assumptions on Excess Demand	4
1.2.2 An Existence Proof	5
1.2.3 Multiplicity of Equilibrium	10
1.2.4 Lack of General Properties of Excess Demand	13
1.2.5 Computation of Equilibria	14
1.3 Competitive Equilibrium	15
1.4 Efficiency and Equity	18
1.4.1 Pareto-Efficiency	18
1.4.2 The First Welfare Theorem	19
1.4.3 The Welfare Optimum	20
1.4.4 The Second Welfare Theorem	24
1.4.5 The Single-Consumer Case	25
1.4.6 Welfare Consequences of Reforms	26
1.5 Possible Extensions of the Competitive Model	29
2 Optimal Production and Consumption Allocations	35
2.1 Producer Behavior	35
2.1.1 The Producer	35
2.1.2 Technology of the Firm	36
2.1.3 Profit Maximization	41
2.1.4 Producer Behavior in Applied Models	55
2.2 Consumer Behavior	59
2.2.1 The Consumer	60
2.2.2 Assumptions on Consumer Behavior	61
2.2.3 Utility Maximization	65
2.2.4 Recovering Consumer Behavior via Integrability or via Revealed Preference	71
2.2.5 Consumer Behavior in Applied Models	74
2.3 Supply and Demand under the Standard Assumptions	81

2.4	Welfare	84
2.4.1	The Welfare Optimum	84
2.4.2	Welfare Measures	87
3	Applied General Equilibrium	91
3.1	The Negishi Format	92
3.1.1	Existence of Equilibrium: Negishi's Theorem	92
3.1.2	Multiplicity of Equilibrium	96
3.2	The Full-Format	97
3.3	The Open Economy Format	101
3.3.1	Existence of Equilibrium	101
3.3.2	Extensions of the Open Economy Model	106
3.4	The CGE Format	107
3.4.1	The Basic CGE Model and the CGE Format	108
3.4.2	Extensions of the Basic CGE Model	110
3.5	Comparing the Formats	112
3.6	Model Implementation	115
3.6.1	Empirical Elaboration	116
3.6.2	The Treatment of Missing Commodities and Markets	122
3.6.3	Simulations	127
3.6.4	A GAMS Application of the Basic CGE Model	129
4	International Trade	137
4.1	Reinterpreting the Competitive Equilibrium Model as a World Model	137
4.2	International Trade in the General Equilibrium Model	138
4.2.1	The Multi-country Case	138
4.2.2	The Two-Country Case and the Small-Country Assumption	142
4.3	Welfare Implications	143
4.3.1	The International Competitive Equilibrium	143
4.3.2	The Competitive Equilibrium under the Small-Country Assumption	143
4.4	Practices in Applied Modeling	144
4.4.1	International Trade in the CGE Model	145
4.4.2	Issues in Model Specification	147
4.4.3	Empirical Elaboration: The SAM for a Country Model with International Trade	153
4.4.4	Simulations	155
5	Taxes, Tariffs, and Quotas	157
5.1	Government and Taxation	157
5.1.1	Government	157

5.1.2	A Short Typology of Taxes	157
5.1.3	Taxes May Affect Allocations	161
5.2	Taxes and Quotas in General Equilibrium	162
5.2.1	Indirect Taxes on Consumption	163
5.2.2	Indirect Taxes on Production and Intermediate Demand	168
5.2.3	Tariffs and Quotas in International Trade	170
5.2.4	Government Activity: A Summary	173
5.3	Welfare Implications	173
5.3.1	Indirect Taxes on Consumption in the Closed Economy	174
5.3.2	Indirect Taxes on Production and Intermediate Demand in the Closed Economy	178
5.3.3	Tariffs and Quotas in the International Trade Model	178
5.3.4	Indirect Taxes and Tariffs in the Small Open Economy	179
5.3.5	Welfare Analysis in the Absence of Compensation	181
5.3.6	Consequences of the Propositions for Policy Design	182
5.4	Practices in Applied Modeling	183
5.4.1	Taxes and Tariffs in the CGE Model	183
5.4.2	Issues in Model Implementation	185
5.4.3	Empirical Elaboration: The SAM with Taxes and Tariffs	187
5.4.4	Simulations	188
6	Price Rigidities	193
6.1	Price Rigidities and Supporting Mechanisms	193
6.2	Price Rigidities in General Equilibrium	194
6.2.1	Centrally Held Stocks	195
6.2.2	Shifting the Adjustment to Consumers	198
6.2.3	Drèze Rationing	202
6.2.4	Benassy Rationing: Fix-Price Exchange Equilibria	208
6.2.5	Virtual Tax Rationing	211
6.2.6	Soft Rationing	212
6.2.7	Shifting the Adjustments Also to Producers	213
6.3	Welfare Implications	215
6.3.1	Centrally Held Stocks	215
6.3.2	Consumer (and Producer) Rationing	216
6.4	Practices in Applied Modeling	218
6.4.1	Fixed Prices in the CGE Model	218
6.4.2	Issues in Model Implementation	223
6.4.3	Empirical Elaboration	225
6.4.4	Simulations	226

7	Finite-Horizon Dynamics	229
7.1	Elements of Dynamics	229
7.2	Finite-Horizon Dynamics	230
7.2.1	T -Period Competitive Equilibrium	230
7.2.2	Temporary Equilibrium	240
7.2.3	Single-Period Equilibrium	247
7.2.4	Dynamics in the Presence of International Trade, Taxes, and Price Rigidities	249
7.3	Welfare Implications	252
7.3.1	Intertemporal Pareto-Efficiency	252
7.3.2	Static Pareto-Efficiency	253
7.4	Practices in Applied Modeling	253
7.4.1	Dynamics in the CGE Model	255
7.4.2	Issues in Model Implementation	257
7.4.3	Empirical Implementation	263
7.4.4	Simulations	266
8	Infinite-Horizon Dynamics	267
8.1	Dynastic Models	267
8.1.1	Specification of the Dynastic Negishi Program	267
8.1.2	Negishi Equilibrium: Fixed Discount Factor β	270
8.1.3	Existence and Efficiency of Equilibrium with Recursive Utility Functions	272
8.1.4	Multiplicity and Indeterminacy of Equilibrium	278
8.1.5	Dynamics and Steady States	279
8.1.6	Finite-Horizon Approximations	283
8.1.7	Real Business Cycles	285
8.2	Overlapping Generations Models of Pure Exchange	291
8.2.1	Alternative OLG Models	291
8.2.2	Specification of the Model with Financial Claims and Existence of Equilibrium	294
8.2.3	Inefficiency of Equilibrium	304
8.2.4	Indeterminacy of Equilibrium	307
8.2.5	Dynamics and Steady States	307
8.2.6	Finite-Horizon Approximations	309
8.3	Overlapping Generations Models with Production	310
8.3.1	Specification of the Model	310
8.3.2	Existence of Equilibrium	312
8.3.3	Inefficiency of Equilibrium	316
8.3.4	Indeterminacy of Equilibrium	317
8.3.5	Dynamics and Steady States	317
8.3.6	Finite-Horizon Approximations	318

8.4	Practices in Applied Modeling	319
8.4.1	Issues in Model Implementation	319
8.4.2	Simulations	322
9	Externalities	325
9.1	Positive Externalities	325
9.1.1	Nonrival Commodities in Consumption	325
9.1.2	Interdependent Utilities: Empathy	332
9.1.3	Interdependent Consumption's	336
9.1.4	Interdependence in Production	339
9.1.5	Endowments Dependent on Consumption: Efficiency Wages	341
9.2	Pollution and Negative Externalities	345
9.2.1	Pollution in the Competitive Model	345
9.2.2	The Treatment of Externalities	347
9.3	Perspectives for Implementation in Applied Models	347
10	Nonconvexities	351
10.1	Within-Firm Nonconvexities	352
10.2	Indivisibilities at Firm Level	355
10.2.1	Decentralization of a Welfare Optimum: The General Case	357
10.2.2	Setup Costs: Decentralization of a Welfare Optimum	359
10.2.3	Setup Costs: Equilibrium with Given δ_j Zero Transfers among Consumers	361
10.2.4	Increasing Returns to Scale: Decentralization of a Welfare Optimum	363
10.2.5	Increasing Returns: Equilibrium with Rules to Determine q_j and Zero Transfers among Consumers	365
10.2.6	Increasing Returns: Equilibrium for Concave-Convex Cost Functions	370
10.2.7	Solving Model with Indivisibilities	371
10.3	Nonconvexities at Above-Firm Level	372
10.3.1	Nonrival Goods Produced Intentionally: Research and Development	372
10.3.2	Nonrival Goods Produced as By-products: Economies of Scope and Learning by Doing	374
10.4	Nonconvexities in Consumption	376
10.4.1	Nonconvexities in the Utility Function and Indivisible Commodities	376
10.4.2	Nonconvexity and Efficiency Wages	379
10.5	CGE Applications	384

11	Imperfect Competition	387
11.1	The Main Issues in Partial Equilibrium	388
11.1.1	An Example: Cournot Duopoly	388
11.1.2	Main Issues	390
11.1.3	The Stages of Anticipation and Market Clearing	391
11.2	The Main Issues in General Equilibrium	393
11.2.1	An Example with Two Strategic Consumers	393
11.2.2	A Representation That Avoids Inverse Demand Functions	396
11.2.3	A First Sketch of Alternative Specifications for the Anticipation Stage	397
11.2.4	Introducing Producers	398
11.2.5	Producers as Noncompetitive Agents	400
11.2.6	The Normalization Issue	402
11.2.7	Free Entry	403
11.2.8	Pareto-Efficiency	403
11.3	Alternative Specifications for the Anticipation and the Market-Clearing Stages	404
11.3.1	The Anticipation Stage	404
11.3.2	The Market-Clearing Stage	406
11.4	Simplified Representations of the Anticipation Stage	408
11.4.1	Negishi's Subjective Demand Approach	408
11.4.2	Generalizing Negishi's Approximation	409
11.4.3	A Markup Representation	411
11.4.4	Objective Markups	414
11.5	Practices in Applied Modeling	416
11.5.1	Issues	417
11.5.2	Applications	420
11.5.3	Possible Extensions and Directions for Future Research	422
12	Money and Incomplete Asset Markets	427
12.1	Cash-in-Advance	427
12.1.1	Flexible Supply of Money	428
12.1.2	Scarcity of the Medium of Exchange: General Equilibrium with Cash-in-Advance	430
12.1.3	Welfare Properties of the Equilibrium	435
12.2	Incomplete Asset Markets	436
12.2.1	An Example of Restricted Access: The Case of Commodity Markets	437

12.2.2	Concepts and Assumptions	438
12.2.3	Issues and Approaches Related to the Existence Proof	441
12.2.4	Approximate Equilibrium with Financial Assets: An Existence Proof	444
12.2.5	Properties of the Equilibrium: Pricing of Assets, Nonarbitrage and Efficiency	452
12.2.6	Introducing Firms	455
12.2.7	Returns in State s Depend on Prices in State s Only	457
12.3	Practices in Applied Modeling	458
12.3.1	Determination of the Absolute Price Level: Nonhomogeneities	459
12.3.2	Exchange Rates	460
12.3.3	Transactions Demand for Money	460
12.3.4	Financial Assets	461
12.3.5	Models with Nonhomogeneities, Transactions Demand for Money, and Financial Assets	462
A	Mathematical Background	465
A.1	Sets and Functions	465
A.2	The Convex Program	470
A.3	The Parametric Convex Program	472
A.4	The Fixed-Point Mapping	476
A.5	The Nonconvex Program	478
A.6	Infinite Dimensions	479
A.7	Multiplicity of Solutions of $F(x) = 0$	479
A.8	Solving a System of Equations $F(x) = 0$	483
A.9	Solving a Nonlinear Complementarity Problem	488
B	A GAMS Application	493
B.1	Defining the Model in GAMS	493
B.2	Computation of Equilibrium	509
B.3	Accounting	510
B.4	Report Writing	514
B.5	Running the GAMS Job	519
B.6	Listing of Results	521
C	Assumptions	529
	References	535
	Index	551