



SOLVAY BRUSSELS SCHOOL
OF ECONOMICS
& MANAGEMENT

UNIVERSITÉ LIBRE DE BRUXELLES

Investigating the effects of environmental and energy policies in Turkey using an energy-disaggregated CGE model

Thesis submitted by Dizem ERTAÇ-VAROĞLU
in fulfilment of the requirements of the PhD Degree in Applied Economics
("Docteur en Économie Appliquée")
Academic year 2020-2021

Co-supervisor: Professor Ali BAYAR
Co-supervisor: Professor Michele CINCERA

Contents

List of Figures	ix
List of Tables	xii
1. Introduction	1
1.1. Motivation behind choice of research topic.....	1
1.2. Analytical framework.....	2
1.3. Outline of the thesis.....	4
2. Recent developments in Turkey's energy sector and its link to the environment	7
2.1. An overview of Turkey's economy and its energy sector.....	7
2.2. Supply of energy in Turkey.....	11
2.3. Demand for energy in Turkey.....	17
2.3.1. Industrial sector energy demand.....	20
2.3.2. Residential sector energy consumption.....	25
2.3.3. Transport sector energy consumption.....	28
2.4. A brief overview of specific energy sectors in Turkey.....	30
2.4.1. The Turkish electricity sector.....	30
2.4.2. Coal.....	33
2.4.3. Natural gas.....	36
2.4.4. Oil.....	41

2.4.5. Renewable energies.....	44
2.4.6. Nuclear power.....	50
2.5. Environmental sustainability in Turkey.....	51
2.5.1. The energy-environment link.....	51
2.5.2. Greenhouse gas (GHG) emissions, UNFCCC, the Kyoto Protocol and the Paris Agreement.....	54
2.5.3. Energy and environmental policies of Turkey: alignment with the EU acquis.....	62
2.5.4. Energy efficiency and Turkey's efforts to this end.....	66
3. Literature Review	72
3.1. An introduction to the literature on CGE model applications to Turkey	72
3.2. CGE model applications on energy and environmental issues in Turkey.....	75
4. Methodology: Model specification	84
4.1. Motivation behind methodology choice.....	84
4.2. Theoretical framework of CGE models.....	87
4.2.1. Theoretical background of “general equilibrium”	88
4.2.2. Mathematical representation of general market equilibrium.....	93
4.3. Main technical features of TurkMod.....	96
4.3.1. Household behavior.....	97
4.3.2. Firms’ behavior.....	101
4.3.3. Government’s behavior.....	113
4.3.4. Investment demand.....	118
4.3.5. Foreign sector.....	119
4.3.6. Price equations.....	123

4.3.7. Labor market.....	125
4.3.8. Market-clearing conditions.....	126
5. Calibration of the CGE model	130
5.1. An energy-disaggregated SAM for Turkey.....	130
5.1.1. Defining social accounting matrices (SAMs).....	131
5.1.2. Aggregated SAM: Data and balancing issues.....	135
5.1.3. Constructing an energy-disaggregated SAM for Turkey for 2012.....	139
5.1.4. Detailed SAM Accounts.....	142
5.1.4.1. Commodities account.....	143
5.1.4.2. Activities account.....	145
5.1.4.3. Factors account.....	149
5.1.4.4. Households account.....	150
5.1.4.5. Government account.....	151
5.1.4.6. Capital account.....	153
5.1.4.7. Rest of the World account.....	154
5.2. Satellite Accounts: Adjusted Energy Balance and Greenhouse Gas Emissions	155
5.2.1. Adjusted energy balance.....	156
5.2.2. Greenhouse gas emissions accounts.....	159
5.2.3. Deriving implicit price levels and GHG emissions in TurkMod	163
5.3. Calibration, solution and validation of TurkMod.....	166
5.3.1. Calibration of the CGE model.....	166
5.3.2. Solution of the CGE model.....	168
5.3.3. Validation of the CGE model.....	170
6. Scenario analysis and results	173

6.1. Introducing scenario analysis for policy-making.....	173
6.2. The Paris Agreement scenario.....	174
6.2.1. Scenario E1: increasing energy efficiency in all production sectors by 30%.....	176
6.2.2. Scenario E2: Increasing energy efficiency in both production sectors and the residential sector by 30%.....	182
6.3. Carbon Tax scenarios.....	185
6.3.1. Introducing the carbon tax concept.....	185
6.3.2. Scenarios C1&C2: medium-level and high-level carbon tax scenarios... ..	188
6.4. Renewable energy subsidy scenarios.....	197
6.4.1. Scenario R1 for renewable subsidies.....	200
6.4.2. Scenario R2 for renewable subsidies.....	202
6.5. World prices of energy (WPE) scenario.....	206
6.6. The “ideal” policy scenario.....	210
6.7. Results.....	213
7. Conclusion	215
7.1. Conclusive remarks and policy implications.....	215
7.2. Limitations and directions for future research.....	218
References	221
A Additional Tables	233
B Additional Figures	254
C Extended literature review	257