

图书分类号: _____

密 级: _____

中国能源安全测度理论与方法研究
MEASURE THEORIES AND METHODS
ANALYSIS OF CHINESE ENERGY
SECURITY

作者姓名 邹艳芬

学位类别 博士

学科专业 管理科学与工程

研究方向 能源经济

导师姓名 魏晓平

职 称 教授

入学时间 2003. 9. 3

论文完成日期 2006. 5. 28

论文答辩日期 _____

授予学位日期 _____

中国矿业大学

摘 要

能源作为人类赖以生存和发展的基础,在人类社会的进步中发挥了难以估量的作用。将经济、社会、环境与能源科学整合到能源安全的研究框架中,探讨国家能源安全的机理,进行能源安全测度理论与方法研究,提出能源安全调控政策与措施,促使各国能源保持安全状态,实现可持续发展。

本文从能源对社会、经济、国家安全和人类发展的重要性说明能源安全研究的意义;系统总结了能源安全研究的全球化背景,这一课题的国内外研究现状;明确了进一步研究的基本思路;界定论文研究的主要内容及研究方法和技术路线等;通过对国家能源安全概念、内涵的界定,论证了能源供应安全的相对柔性和能源使用安全的相对刚性;简要分析了经济、社会发展与能源安全的正负反馈关系和国家能源安全前向作用机制及后向作用机制,提出国家能源安全的作用因素;对国家能源安全的相关理论,尤其是地缘政治理论和可持续发展理论等进行了回顾,分析了他们与能源安全测度研究的关系;从经济因素,安全控制力因素、能源本身因素和生态环境因素四个方面,通过时变消费函数、状态空间模型、单位根检验和协整检验、波特与劳拉的激励模型等,进一步系统确定了国家能源安全的影响因素;依据能源供应安全指标体系建立的原则,构建能源供应安全的测度指标体系,并利用主成分投影法对中国与其它 37 个国家的能源供应安全进行测度及横向对比分析;确定各国能源供应安全状况,证明了我国的能源供应安全总体处于基本安全状态,经济因素和能源因素水平偏低,安全控制力因素较好;利用 CGE 模型和生态足迹分析法,建立我国能源使用安全的 CGE 模型,对我国 1962—2002 年能源使用安全状况进行测度,描述了我国 40 多年来能源使用安全从安全到不安全的的演进历程,发现我国能源使用安全变化的规律,评估我国能源使用安全的总体状况;对我国能源供应安全和能源使用安全的总体状况进行详细评估,探寻了对我国能源安全保障有利的优势因素和可能对国家能源安全造成重大影响的劣势因素;最后根据我国能源安全的评估结论,结合我国的实际情况,确定中国能源安全具体战略、战略实施顺序、社会支付意愿和能源安全的保健性特征等,以便采取有效的措施,保障能源、经济及社会等的可持续发展。

关键词: 能源供应安全 能源使用安全 测度 评估

260

ψ

Abstract

The energy has been playing an important role in the development history of the society as the basis for the human being. The energy security measurement is studied including the economy, the society, the environment and the energy sciences, the national energy security mechanism is probed into and the security controlling policies is given for the energy security and sustainable development of every country even to the global.

In this paper, from the viewpoints of the fatal valuable of energy to the society, the economy, national security and the human progress, the necessity of energy security measurement is put forward, the study condition is systematical reviewed and summarized, the theories basis and the train of thought are cleared, the content, method, and the technical line are defined, the background, the promise, the distinguish, the style, the subject, and the conduction mechanism are expounded. According to the import dependence and the energy self-sufficiency, from the three factors of economy, security control and energy, through the estimation and hypothesis testing of cointegration analysis, granger causality tests, the system dynamics and the encourage model of Peter and Lawler, the affections of energy supply security are further tested, then the measurement indexes system is built, the 38 countries as the cases, whose energy supply security evaluations are given by the method of main factor projection, so the calculation shows that our national energy supply security is in an general condition, and of which, the level of the economy factor, security control factor, and the energy factor are fairly low. The Chinese energy security model is built to estimate the energy consume security to show that it is unsafe, based on the energy security measurement, the total condition is discussed detailed with the practice, and the strategies, operational order and the other policies are advanced, which are essential to the sustainable development of Chinese energy, society and economy.

Keywords: energy supply security; energy use security; measurement; evaluation

Abstract (detailed)

The energy has been playing an important role in the development history of the society as the basis for the human being. Energy is the key factor to guarantee the economic security and national defense security, or they will face with the serious menace without it. The energy security measurement is studied including the economy, the society, the environment and the energy sciences, the national energy security mechanism is probed into and the security controlling policies is given for the energy security and sustainable development of every country even to the global.

In this paper, from the viewpoints of the fatal valuable of energy to the society, the economy, national security and the human progress, the necessity of energy security measurement is put forward, the study condition is systematical reviewed and summarized, the theories basis and the train of thought are cleared, the content, method, and the technical line are defined, the background, the promise, the distinguish, the style, the subject, and the conduction mechanism are expounded.

According to the import dependence and the energy self-sufficiency, from the three factors of economy, security control and energy, through the estimation and hypothesis testing of cointegration analysis, granger causality tests, the system dynamics and the encourage model of Peter and Lawler, the affections of energy supply security such as economic development and its construction of three industries, polices, science and technological advance, and so on are further tested.

Then the measurement indexes system is built composed of three levels, the first one includes three indexes-economy, security control and energy, the second one contains fifteen indexes and the last one includes 126 indexes, the 38 countries as the cases such as America, China, Japan etc. , whose energy supply security evaluations are given by the method of main factor projection, so the calculation shows that 5 countries' are good(Russian Federation、Canada、Australia、United States and Iran), 9 ones' (United Kingdom、Kazakhstan、Netherlands、Germany、Japan、Venezuela、China、France、Brazil) are fairly good, 15 ones' (Singapore、Italy、India、Poland、Nigeria、Pakistan、Korea, Rep.、Czech Republic、Mexico、Ukraine、

Spain、Turkey、Egypt、Argentina、South Africa) is ordinary, 9 ones' (Romania、Malaysia、Thailand、Viet Nam、Sri Lanka、Belarus、Philippines、Bulgaria、Indonesia) are poor, so, our national energy supply security is in an general condition, and of which, the level of the economy factor, security control factor, and the energy factor are on the low side.

The Chinese energy consume security measurement model is built by the CGE and the energy ecological deficit(surplus) is calculated as the simple index to evaluate the national energy consume security whose concept is from the ecological footprint theory, to estimate Chinese energy consume security, sampling its input-output figure data of the statistical yearbook, according to the conclusion, it is unsafe and the energy ecological footprint is more than half of the total ecological footprint, which is caused by our most portion of fossil energy, especially the coal, the less and less forest, the worse and worse environment, meanwhile stronger and stronger pollution, and so on.

Based on the measurement, the total energy security condition is discussed detailed with the Chinese practice, economic factor is 0.555126, just in the middle level, security control is 0.852791, in a relative high level, but the energy factor is 0.277831, too low. The superior factor useful for the energy supply security such as economic operation, trade performance, national protection, foreign direct investment, social stability, governmental capacity for finance, energy reserve, etc. and the shortcoming aspects threaten to it such as industrial construction, product competitive, financial environment, management effective, science and technology, national quality, the other energy indexes, etc. are suggested.

At last, according to the calculation, the strategies and operational order are building the strategy oil storage system, restart the petroleum futures market, establishing energy warning system, international market resoucization, enhancing energy exploitation and save; developing clear and renewable energy, and the permanent strategies in all the process are regulating the national consume, deepening the international cooperation, especially the organizations of the same interest, heightening the influence to affect the international energy decision and market, further investing in the education on environment protection and energy,

1) taking positive and cautious actions to fulfill the international convention for the energy security and development.

The social pay-willing and the cost economy are advanced, and in the light of the former, the useful arrangements are lengthening the energy exhaustible term, raising the consume elasticity of effectiveness, and lower the present consume preference, and on the basis of the latter, the benefit proposals are that energy security should integrate the benefit and cost, should unify the economic development and social effectiveness, should be an unitary multi-angles balance to throw suitable fund into it and inverse the unfavorable situation of high cost, which are essential to the sustainable development of Chinese energy, society and economy.

Keywords: energy supply security; energy use security; measurement; evaluation

6

目 录

1 绪论.....	1
1.1 研究背景.....	1
1.1.1 全球化对国家主权的影响.....	2
1.1.2 全球化对能源安全的影响.....	3
1.2 论文选题的意义.....	5
1.2.1 揭示能源安全内涵.....	6
1.2.2 丰富能源安全理论.....	6
1.2.3 缩小国内外差距.....	6
1.3 研究现状.....	7
1.3.1 国外研究现状.....	7
1.3.2 国内研究现状.....	9
1.4 现有研究的不足.....	15
1.5 研究思路及内容.....	15
1.5.1 研究思路.....	15
1.5.2 研究内容及结构.....	16
1.6 研究方法及技术路线.....	18
1.6.1 研究方法.....	18
1.6.2 研究的技术路线.....	18
2 国家能源安全作用机制分析.....	20
2.1 国家能源安全的内涵界定.....	20
2.1.1 国家能源安全的界定.....	20
2.1.2 国家能源安全内涵的界定.....	21
2.1.3 国家能源安全刚性分析.....	23
2.2 国家能源安全的作用机制.....	27
2.2.1 经济社会对国家能源安全的影响.....	27
2.2.2 国家能源安全的目标.....	30
2.2.3 国家能源安全作用机制.....	32
2.3 国家能源安全前向作用机制分析.....	35
2.3.1 基于能力的前向作用机制分析.....	36
2.3.2 基于环境的前向作用机制分析.....	39
2.3.3 其他因素分析.....	39

2.4 国家能源安全后向作用机制分析	40
2.4.1 后向作用机制模型的建立	41
2.4.2 后向作用机制分析	42
2.4.3 作用的定量衡量	44
2.5 本章小结	48
3 国家能源安全理论与测度方法的选择	49
3.1 国家能源安全的相关理论	49
3.1.1 国家能源安全相关的前期理论	49
3.1.2 地缘政治理论	51
3.1.3 可持续发展理论	56
3.2 国家能源安全测度方法选择	62
3.2.1 可计量一般均衡模型	62
3.2.2 生态足迹分析法	66
3.2.3 能源 CGE 模型构造	72
3.2.4 基于 CGE 模型能源使用安全测度的框架	77
3.3 本章小结	78
4 国家能源安全影响因素分析	79
4.1 国内经济因素分析	79
4.1.1 经济发展因素	81
4.1.2 产业结构因素	85
4.1.3 科技进步因素	90
4.1.4 其它国内经济因素	93
4.2 安全控制力因素分析	94
4.2.1 政府控制力因素	94
4.2.2 军事因素	99
4.2.3 国民素质因素	99
4.3 能源本身因素分析	100
4.3.1 能源禀赋与能源自给因素	100
4.3.2 能源消费因素	100
4.3.3 能源运输因素	100
4.3.4 能源进口因素	101
4.3.5 能源价格因素	102
4.3.6 其它资源因素	102
4.4 生态环境因素分析	102

4.4.1 生态环境的日益恶化.....	103
4.4.2 全球对生态环境的日益重视.....	107
4.5 本章小结.....	109
5 中国能源供应安全测度.....	110
5.1 能源供应安全测度指标体系构建.....	110
5.1.1 指标选取的原则.....	110
5.1.2 指标体系的构建.....	110
5.2 指标数据来源及计算.....	116
5.2.1 指标数据来源.....	116
5.2.2 指标计算说明.....	116
5.3 能源供应安全指标权重确定.....	119
5.3.1 指标权重确定方法.....	119
5.3.2 指标权重计算结果.....	120
5.4 能源供应安全测度.....	124
5.4.1 能源供应安全测度方法.....	124
5.4.2 能源供应安全测度结果.....	125
5.5 能源供应安全测度结果分析.....	127
5.5.1 测度结果的统计描述.....	127
5.5.2 各国能源供应安全状况.....	128
5.5.3 能源供应安全的统计特征.....	129
5.5.4 能源供应安全的统计比较.....	138
5.6 本章小结.....	141
6 中国能源使用安全测度.....	142
6.1 中国能源使用安全的提出.....	143
6.1.1 中国生态环境的日益恶化.....	143
6.1.2 能源使用的环境影响.....	146
6.2 基于 CGE 模型的中国能源使用安全测度.....	150
6.2.1 各部门投入—产出分析.....	150
6.2.2 各部门产量分析.....	157
6.2.3 各部门初始能源需求分析.....	158
6.2.4 初始能源消耗分析.....	160
6.2.5 能源生态足迹分析.....	161
6.2.6 中国能源使用安全测度结果.....	164
6.3 进一步讨论.....	165

6.4 本章小结	168
7 中国能源安全评估	169
7.1 中国能源供应安全评估	169
7.1.1 经济因素评估	169
7.1.2 安全控制力因素评估	174
7.1.3 能源因素评估	177
7.2 中国能源使用安全评估	181
7.2.1 中国历年能源使用安全测度	181
7.2.2 测度结果分析	182
7.2.3 部分国家能源使用的对比	187
7.3 本章小结	190
8 中国能源安全战略选择及政策建议	191
8.1 中国能源安全战略	191
8.1.1 经济方面	191
8.1.2 安全控制力方面	192
8.1.3 能源方面	193
8.2 能源安全战略实施顺序	196
8.2.1 能源安全战略实施顺序选择的依据	197
8.2.2 中国能源安全战略实施顺序	201
8.3 基于国家能源安全社会支付意愿的政策建议	203
8.3.1 能源安全的社会支付意愿定量分析	203
8.3.2 提高能源安全社会支付意愿的途径	209
8.4 基于国家能源安全成本收益经济学分析的政策建议	209
8.4.1 能源安全收益	210
8.4.2 能源安全收益的保健特性	211
8.4.3 基于成本收益分析的能源安全政策建议	214
8.5 本章小结	216
9 结论与展望	217
9.1 研究的主要结论	217
9.2 论文的主要创新点	219
9.3 研究不足及进一步展望	220
致谢	221
参考文献	222

目 录

学术成果.....	231
附录.....	232

Table of Contents

1 Preface.....	1
1.1 Research background.....	1
1.1.1 Impact of globalization to national sovereignty.....	2
1.1.2 Impact of globalization to energy security.....	3
1.2 Research significance	5
1.2.1 Revealing the intention of energy security	6
1.2.2 Enriching the theory of energy security.....	6
1.2.3 Narrowing the difference between foreign and domestic	6
1.3 Literature review.....	7
1.3.1 Foreign literature review.....	7
1.3.2 Domestic literature review.....	9
1.4 Research justification.....	15
1.5 Research train of thought and content	15
1.5.1 Research train of thought.....	15
1.5.2 Research content and structure	16
1.6 Research approaches and procedure	18
1.6.1 Research approaches.....	18
1.6.2 Research procedure.....	18
2 Analysis on national energy security mechanism	20
2.1 Definition of national energy security intension	20
2.1.1 Definition of national energy security	20
2.1.2 Definition of national energy security intension.....	21
2.1.3 Analysis on flexibility of national energy security	23
2.2 Analysis on mechanism of action of national energy security	27
2.2.1 Impact of economy and society to national energy security	27
2.2.2 Objectives of national energy security.....	30
2.2.3 Analysis on mechanism of action of national energy security	32
2.3 Analysis on former mechanism of action	35
2.3.1 Analysis based on ability	36
2.3.2 Analysis based on environment	39
2.3.3 Other factors analysis	39

2.4 Analysis on back mechanism of action	40
2.4.1 Building model.....	41
2.4.2 Analysis on back mechanism of action	42
2.4.3 Quantitative estimation	44
2.5 Summary and conclusions.....	48
3 Theories and measurement approaches for national energy supply security	49
3.1 Related theories of national energy security	49
3.1.1 Related classical theories of energy security.....	49
3.1.2 Geopolitics	51
3.1.3 Sustainable development.....	56
3.2 Methodology for measuring national energy security.....	62
3.2.1 Introduction of CGE.....	62
3.2.2 Introduction of ecological footprint analysis	66
3.2.3 Building energy CGE model	72
3.2.4 Measurement fram	77
3.3 Summary and conclusions.....	78
4 Analysis on the elements influencing the national energy supply security	79
4.1 Analysis on elements of national economy	79
4.1.1 Analysis on elements of national economy development.....	81
4.1.2 Analysis on elements of industrial structure	85
4.1.3 Analysis on elements of science and technology advance	90
4.1.4 Analysis on other elements of national economy	93
4.2 Analysis on elements of Security control.....	94
4.2.1 Analysis on elements of government control	94
4.2.2 Analysis on elements of military	99
4.2.3 Analysis on elements of national quality.....	99
4.3 Analysis on elements of energy.....	100
4.3.1 Analysis on elements of energy resources and self-satisfication.....	100
4.3.2 Analysis on elements of energy consumption	100
4.3.3 Analysis on elements of energy transportation	100
4.3.4 Analysis on elements of energy import	101
4.3.5 Analysis on elements of energy price.....	102
4.3.6 Analysis on elements of other resouces.....	102
4.4 Analysis on elements of environment	102

4.4.1 Worse and worse ecological environment	103
4.4.2 Growth of importance of environment	107
4.5 Summary and conclusions	109
5 Measuring Chinese energy supply security	110
5.1 Foundation of index system to measure national energy supply security	110
5.1.1 Chioce laws.....	110
5.1.2 Foundation of index system	110
5.2 Data source and computation of indexes	116
5.2.1 Data source of indexes.....	116
5.2.2 Computation of indexes	116
5.3 Computation of weight of indexes.....	119
5.3.1 Approach to compute weight	119
5.3.2 Result of computing weight.....	120
5.4 Energy supply security measurement	124
5.4.1 Methodology for assessing energy supply security	124
5.4.2 Results of measuerment.....	125
5.5 Analysis on measurement of energy supply security.....	127
5.5.1 Statistical description of measurement	127
5.5.2 National energy supply security condition	128
5.5.3 Statistical characteristics of energy supply security.....	129
5.5.4 Statistical comparison of energy supply security	138
5.6 Summary and conclusions	141
6 Measuring Chinese energy use security.....	142
6.1 Chinese background.....	143
6.1.1 Worse and worse environment.....	143
6.1.2 Environmental impact of energy consume	146
6.2 Measurement of Chinese energy use security based on CGE model	150
6.2.1 Analysis on the input-output of every industry.....	150
6.2.2 Analysis on production of every industry	157
6.2.3 Analysis on energy demand of every industry	158
6.2.4 Analysis on energy consume.....	160
6.2.5 Analysis on energy ecological footprint	161
6.2.6 Measurement of Chinese energy use security.....	164
6.3 Further discuss	165

6.4 Summary and conclusions.....	168
7 Evaluation of Chinese energy security	169
7.1 Evaluation of Chinese energy supply security	169
7.1.1 Evaluation of Chinese economic factor	169
7.1.2 Evaluation of Chinese security control factor	174
7.1.3 Evaluation of Chinese energy factor	177
7.2 Evaluation of Chinese energy use security	181
7.2.1 Measurement of Chinese annual energy use security	181
7.2.2 Analysis on measurement.....	182
7.2.3 Comparison of national energy use security of some countries	187
7.3 Summary and conclusions.....	190
8 Towards Chinese strategies and policies suggestions for energy security	191
8.1 Chinese strategies for energy security.....	191
8.1.1 Strategies of economy	191
8.1.2 Strategies of security control.....	192
8.1.3 Strategies of energy	193
8.2 Operational order of strategies	196
8.2.1 Choice laws	197
8.2.2 Operational order of strategies	201
8.3 Policy suggestions based on the social willing-to-pay for national energy security)	
.....	203
8.3.1 Quantitative analysis	203
8.3.2 Ways to highen the social willing to pay for national energy security	209
8.4 Policy suggestions based on economic analysis on cost-benefit of national energy security	209
8.4.1 Energy security benefit	210
8.4.2 Hygiene characteristics of energy security benefit.....	211
8.4.3 Policy suggestions based on cost-benefit analysis	214
8.5 Summary and conclusions.....	216
9 Conclusions and future work	217
9.1 Conclusions	217
9.2 New ideas	219
9.3 Future work	220
Acknowledgments	221

References.....	222
Academic Achievements	231
Appendix.....	232

第1章 绪论

Chapter 1 Preface

能源是人类赖以生存繁衍、社会得以繁荣进步的重要物质基础。人类进化、发展都离不开能源消费，人类的现代文明更是以消耗大量能源而换取的。现代社会经济发展的历程表明，能源消费的多少直接与社会经济的发展水平密切相关，人均能源消费量也成为衡量国家现代化程度的指标之一^[1]。因而，对能源安全的研究具有十分重要的意义^[2]。

能源作为人类赖以生存和发展的基础，在人类社会的发展中发挥了难以估量的作用^[3]。它是经济运行的动力，是现代社会的血液，能源安全是经济安全和国防安全等的重要保障^[4]；一旦出现供给中断，国家的经济安全、政治安全等将会遭到严重威胁。正因为如此，能源供应与能源保障始终是世界各国关注的大问题，围绕能源的争夺和控制也从来没有停止过。冷战结束后，能源安全问题越来越突出。20世纪70年代世界范围内的两次石油危机，使得发达国家的经济遭受重创，为了防止和减轻可能再次发生的类似冲击，西方发达国家纷纷重新制定能源战略，积极开展维护能源安全的多边合作，同时采取节能、改善能源结构，实现供应多元化等一系列保障石油供应安全的战略措施；并于1974年成立了IEA（International Energy Association），正式提出了以稳定原油价格为中心的国家能源安全概念。80年代中后期，由于化石能源（煤炭、石油等）的大量使用，导致全球气候变暖、生态环境恶化，于是发达国家开始重新审视本国的能源安全问题，并在新一轮国家能源发展战略中增加了能源使用安全概念，从而使得能源安全包括了两个层面的含义^[5]：第一个层面含义——能源供应安全，是指有足够数量的能源战略储备、持续稳定的生产能力、安全可靠的境外供货渠道以满足国家在经济发展、国防建设过程中对能源的需求；同时，获取能源的成本不至于使其在竞争中处于劣势，从而危及国民的社会福利。从这个层面上讲，能源供应安全是国家能源安全追求的基本目标，若消费者或政府在追求其发展目标的过程中，由于突发事件导致能源供应中断而发生大幅度价格波动，致使发展目标的实现受到威胁时，就出现了能源危机。能源安全的第二个层面含义——能源使用安全，是指在能源开发利用过程中，对人类自身生存与发展的生态环境造成的影响被控制在一个合理水平之内，能够满足可持续发展的战略目标。显然能源使用安全是对能源安全更高层次目标的追求。

1.1 研究背景（Research background）

各国的能源安全活动都是在全球化的条件下进行的，因此，要使其研究具有实际指导意义，就必须以此为背景进行研究。

在全球化条件下，随着经济社会的发展，现代文明的进步，国家安全重点已由传统意义上的政治和军事等方面的安全转变为没有硝烟的经济、文化等非传统方面的安