Chapter 1
Introduction

1.1 The Motivations for This Study

The motivations for this study come from two aspects. Firstly, the importance of China's energy economy, which is rooted in China's aggregate national economy, which is still in transition The second is the fact that China's energy economy is still in its infancy and therefore there are a number of important topics to be considered, revised and revisited.

1.1.1 The Importance of China's Energy Economy

It is well known that China is one of the largest and fastest growing emerging economies in the world since the reforms initiated in the late 1980s. According to China's Statistical Yearbook (CSY), its GDP growth rate has approximated 10% annually and its aggregate GDP has reached 3.1 trillion US dollars by 2006.[1] As a consequence, China's aggregate energy consumption also expanded both in volume and growth rate terms during the same period, especially post 2002. Figure 1.1 shows the historical change of both China's GDP and aggregate energy consumption from 1978 to 2006. It can be clearly seen that GDP grows strongly and consistently, although it does trend downwards between 1996 and 2002 and aggregate energy consumption generally increases consistently with GDP. Apart from the short downward trend, aggregate energy consumption typically tracks GDP after 2002, in fact, the annual growth rate (12.9%) of aggregate energy consumption is slightly higher than that (10.4%) of GDP for the period 2002–2006 (CSY 2007).

With strong growth of GDP and aggregate energy consumption, China has become the second largest consumer of energy products and the third largest oil

[1] Exchange rate of Chinese¥ to US$ is 6.9:1 in the 2006 price base.

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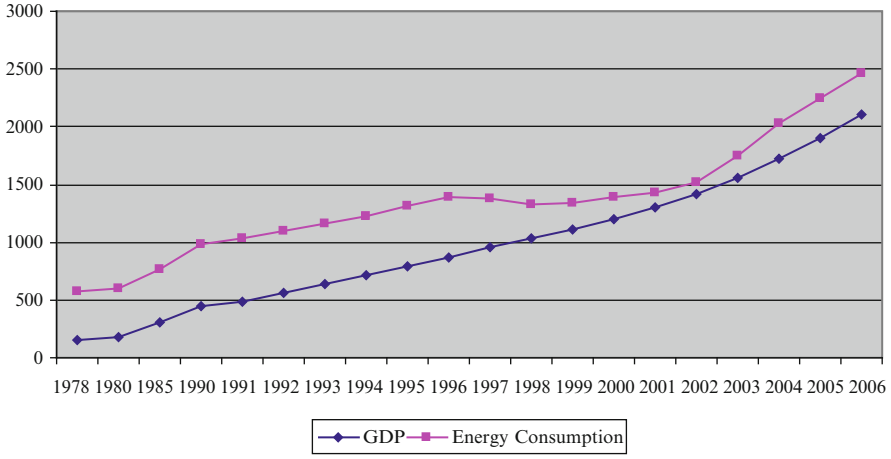

Fig. 1.1 China's GDP and aggregate energy consumption. Note: GDP is measured in 10 billion Chinese yuan based on the 2006 price. Aggregate energy consumption is measured in million ton standard coal (Data source: China statistical yearbooks)

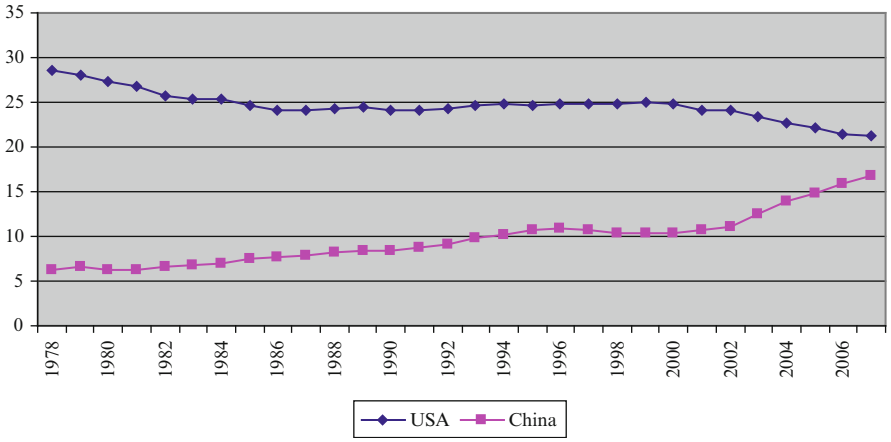

Fig. 1.2 Global share of primary energy consumption of China and USA (Data source: BP statistical review of world energy June 2008)

importer in the world. China's primary energy consumption reached 1,863.4 million tons oil equivalent in 2007, the second largest consumer after the USA (BP 2008). More importantly, China's global shares of primary energy consumption have increased dramatically since 1978, especially after 2002 (Fig. 1.2). The global shares of primary energy consumption were only 6.3% for China and as high as 28.6% for USA in 1978. However, China's global share of primary energy consumption soared to 16.8%, in 2007. In contrast, the USA's global share of primary energy consumption decreased dramatically to 21.3% in 2007.

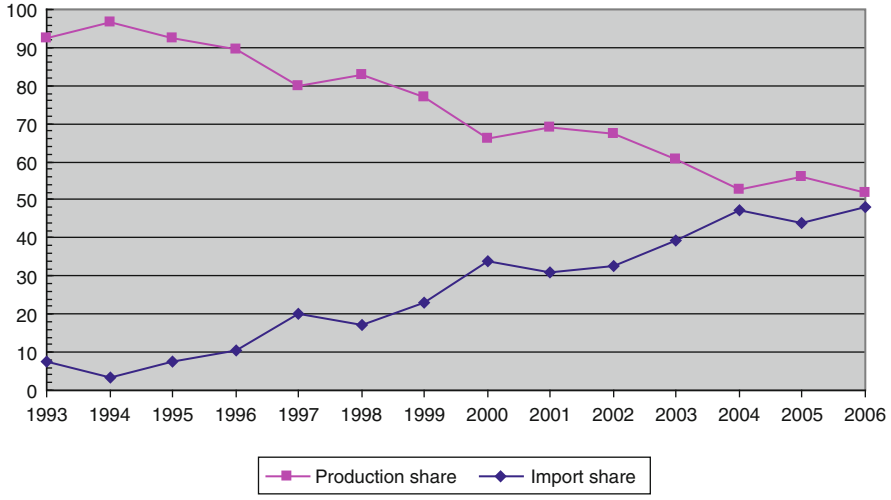

Fig. 1.3 Shares of supply and import of petroleum products (Data source: China statistical yearbooks 1994–2007)

Due to its rising energy demand, China has had to import large quantities of oil to meet its domestic demand. Despite being a net exporter of petroleum in 1990, China's import share of petroleum dramatically increased from less than 8% in 1995 to approximately 50% in 2006 (Fig. 1.3). By 2007, China's imports of crude oil and products reached 184 million tons, becoming the third largest importer after USA and Japan (BP 2008).

There are many factors that require China to import more petroleum products. Of them, household car ownership is one of the most important. Private car purchases have increased rapidly. In 2000 there were only 0.5 cars per hundred urban households. By 2006 it had risen to 4.32 cars per hundred urban households (CSY 2007). The rise in electricity consumption has been driven not only by rapidly growing industrial demand, but also an even more rapidly spreading ownership of household appliances (Smil 1998). For example, household air conditioners and microwave ovens trebled over 2003–2009, from 30 and 17 to 88 and 51 per hundred urban households, respectively. As a result, household electricity consumption has expanded rapidly. Household electricity consumption was 48 billion kWh in 1990, doubling to 101 billion kWh in 1995 and doubling again to 201 billion kWh by 2002. In 2006 this figure had risen to nearly 325 billion kWh. As a consequence, there has been a growing shortage of electricity in China which has attracted growing interest and concern (Lin 2004).

Raw coal production accounts for most of China's primary energy supply and electricity production is mainly generated from coal. This raises considerable environmental issues. During the past three decades, China's share of raw coal consumption remained steady at 70% of aggregate primary energy consumption (Table 1.1). By 2006 this had risen to approximately 77%. Raw coal is the most

Table 1.1 The role of coal in China's energy demand and supply

Year	Share of raw coal in primary energy consumption	Share of raw coal in primary energy production	Share of electricity generated from coal
1978	70.7	70.3	–
1980	72.2	69.4	80.6
1985	75.8	72.8	77.5
1990	76.2	74.2	79.6
1991	76.1	74.1	80.1
1992	75.7	74.3	81.2
1993	74.7	74.0	81.6
1994	75.0	74.6	80.4
1995	74.6	75.3	79.8
1996	74.7	75.2	81.3
1997	71.7	74.1	81.5
1998	69.6	71.9	81.0
1999	69.1	72.6	82.3
2000	67.8	72.0	82.2
2001	66.7	71.8	80.0
2002	66.3	72.3	80.9
2003	68.4	75.1	82.7
2004	68.0	76.0	81.5
2005	69.1	76.5	81.9
2006	69.4	76.7	82.7

Data source: Calculated based on China statistical yearbooks 1996–2007

important source of electricity where, in the last three decades, over 80% of electricity consumed was generated from burning raw coal. Electricity from hydro, nuclear and wind accounted for only 8%.

Following three decades of rapid economic growth and rising demand for energy products, Chinese residents are now becoming more environmentally aware. Consequently, policy makers have begun to acknowledge the need for cleaner sources of energy, such as natural gas, electricity and hydropower. Continued movements in this direction will see the share of coal in total energy consumption decline further, with the share of oil, gas, electricity and hydro increasing rapidly. This will push China to import more oil with significant effects on global energy markets (Crompton and Wu 2005), and meanwhile more power plants are being encouraged to be built.

However, raw coal remains the most important energy source in China. Therefore, China may face more severe challenges in dealing with future environmental issues than most rapidly developing countries. Given the size of the economy and its current growth rates and its special features of energy economy, any changes in industrial structure, energy price deregulation, technological progress and improvements in energy efficiency in China will produce a significant effect on the global energy market. Therefore, the emergence of China's energy market does matter nationally and globally, especially in the world oil market (Li and Lin 2011; Mu and Ye 2011).

1.1.2 China's Energy Economics Is Still in Its Transition

Compared with its global importance, China's energy economy is less developed and less understood. Despite some areas having been extensively investigated for example, the relationship between energy consumption and economic growth, and changes in energy intensity, many other important issues, including energy price convergence; energy demand; energy-other-factor substitution, and energy economic studies at the disaggregate level, have not been extensively studied or in some cases, considered at all.

Energy policy reforms play an important role in the development of China's energy economy. Therefore, China has introduced numerous measures to rationalize oil, coal, gas and electricity prices since the early 1980s. At the same time, China's energy reforms have attracted increased attention from researchers, both domestic and international. It has also seen many studies on China's energy reforms, including regulatory and pricing system. For example, Andrews-Speed et al. (2000), Xu and Chen (2006), Cherni and Kentish (2007), and Ma and He (2008) discuss the ongoing regulatory reform to China's government and state sector of energy industry. On the other hand, Wu (2003), Wang (2007) and Hang and Tu (2007) address the reforms of price deregulation over time. Unfortunately, all these studies only introduce institutional reform programs in China's energy industry to the world. They did not assess econometrically, any potential effects of those reform programs on the development of China's energy economy or on national economic growth. No strongly supported econometric policy suggestions have yet been provided to policymakers. Therefore, it is not surprising that the gradualism strategy was adopted in the reforms of China's energy industry.

1.1.3 The Importance of Understanding China's Energy Economy

Understanding China's energy economy in the new millennium is crucial for politicians, business people and energy economists. In particular, China's energy policy choices will present both challenges and opportunities to the World in terms of an increasing share of primary energy consumption and investment opportunities (Wang 1995; CIAB 1999). China's industrialization, modernization and urbanization affect the way in which energy resources will be developed as the basis of economic growth (Dean 1974). In particular, China's petroleum industry is playing a more important and growing role in determining the economic impacts of change (Xu et al. 2011). China's economy is of becoming more vulnerable to potential interruptions of energy supply (Gnansounou and Dong 2010). As a result, Yu et al. (2010) wonder whether it is time for China to consider a zero growth of energy consumption strategy?

1.2 The Foci of This Study

This study commences with a survey of the literature on China's energy economy. This is followed by a review of China's energy situation in the new millennium. By doing this, we want to focus our study to provide readers with the most important information on China's energy economic research. This is followed by focusing on research that we feel is worthy of further study and also important to those who are concerned with China's energy economy, environmental issues, as well as global energy markets. Specifically and logically, these topics are:

- A survey of literature on the study of China's energy economy.
- China's energy situation in the new millennium.
- The regulation and pricing system of China's energy industry.
- Energy reforms and market development.
- Energy price convergence and cointegration.
- Substitution of and the demand for energy
- The driving forces of the changes in energy intensity

These topics comprise our study based upon the following specific motivation for inclusion.

1.3 The Motivation for Each Topic

1.3.1 A Survey of the Literature

Given the importance and rapid pace of economic growth and the special features of energy consumption and trade, there is need for up to date and critically assessed information on China's energy economy. Such information will inform both academic and political decision making including environmental policies. Because of the political importance of energy, leaders in all countries have typically demanded that predictions be made on energy efficiency, energy consumption and energy trade. Those charged with negotiating and managing China's energy trade agreements, including the nation's top leaders, also need to have accurate predictions about future energy demand, imports and crucially impacts on economic growth and employment. In addition, researchers interested in the energy economy need to know what has been done well and what has not; what resources they can access to conduct studies of China's energy economy. To date, there has been no such review that provides such information until now. Our survey of the literature will review existing research and help facilitate future research to better understand and study China's energy economy.

1.3.2 China's Energy Situation in the New Millennium

Many authors have focused on the energy situation in China (Dean 1974; Dorian and Clark 1987; Kambara 1992; Wu and Li 1995; Intarapravich et al. 1996; Smil 1998; CIAB 1999; Liang et al. 2000; Downs 2004; Zweig and Bi 2005; Cai and Zhang 2006; Asif and Muneer 2007; Skeer and Wang 2007; Konan and Zhang 2008; Andrews-Speed 2009; Zhang et al. 2011d), however, many energy related issues in China still remain unanswered for example, what are the potential forces driving energy demand; what are the potential forces driving energy supply? Previous reviews focused only on fossil fuel based energy and ignored other important elements including renewable and 'clean' energy sources. Therefore, a comprehensive and complete review of the energy situation in China is timely and necessary. The work presented here is intended to fill this gap by bringing the research on fossil-based and renewable energy economic studies together and identifying the potential drivers behind both energy demand and supply to provide a complete picture of China's energy situation in the new millennium. This will be of interest to anyone concerned with the development of China's economy in general and the energy economy, in particular.

1.3.3 Energy Reforms and Market Development

To conduct an academic study of China's energy economy, we not only have to understand the situation of China's energy economy and to survey the literature on China's energy economy, but we also require a comprehensive understanding of the regulatory system and price reforms in China's energy industry. Although many studies have mentioned changes to the regulatory system and price reforms, their presentation of these issues is often incomplete and sometimes outdated. Therefore, for this present study, we need to have a thorough understanding of changes to the regulatory system and price reforms in China's energy economy over time so as to better approach our issues and derive accurate policy implications. This particular chapter will review the changes made to and by regulatory bodies and the evolution of price reforms as well as their effects on the changes to energy prices and on the emergence of an energy market economy in China.

1.3.4 Tests for the Emergence of an Energy Market

The ongoing transition of former communist countries from planned to market economies has been one of the most important economic phenomena in the last few decades. It is interesting, therefore, to consider whether liberalization of domestic trade prompts major shifts in the price structures that were highly distorted under central planning (Fan and Wei 2006). Moreover, in the context of China, there

is continued debate about whether gradualist reform has been successful (see Lau et al. 2000; Young 2000; Poncet 2003, 2005). Since China embarked on its economic reforms and adopted an open door policy in the late 1970s, its economic development has been greatly enhanced by active participation in international trade. However, recently there has been more debate about domestic trade with China's major trading partners urging further opening of the domestic market, especially post-accession to the World Trade Organization (WTO). Moreover, even if the Chinese government removes remaining barriers to international trade, the effectiveness of this policy might be compromised by regional trade barriers within China itself (Fan and Wei 2006; Poncet 2003, 2005). It is thus useful to investigate whether domestic markets in China are in fact integrated.

Prices play an important role in determining the allocation of resource inputs. Therefore, energy prices, worldwide, have been extensively analyzed in the literature over the past three decades (Lanza et al. 2005). Much of the applied research and policy studies have also examined the role played by the price of energy in determining economic growth and inflation rates both in developed and developing countries (Adrangi et al. 2001; Asche et al. 2003; Stern 2000; Girma and Paulson 1999; Gjolberg and Johnsen 1999; Serletis 1994; Shaked and Sutton 1982). Given its high energy intensity and huge economic volume, it is surprising to find that little work has been done on the role that energy prices play in determining economic growth and energy consumption in China. The reasons for this are unclear, however, it is most likely that there remains concern whether there has been sufficient movement towards a market-oriented energy economy in China.

The emergence of a market economy has been successfully tested for China's agricultural commodity sector (Huang and Rozelle 2006). However, as the second special industry, the convergence of prices has not been well investigated for China's energy economy. Energy market integration has been extensively investigated for other countries (Asche et al. 2002, 2003, 2006; Bachmeier and Griffin 2006; De Vany and Walls 1999; Narayan and Smyth 2005; Adrangi et al. 2001; Gjolberg and Johnsen 1999; Serletis 1994; Weiner 1991). Recent work, however, reveals only one study, Fan and Wei (2006), tests the price convergence of gasoline and diesel, which one might expect, *a priori* to be the most likely, to show market integration among the key energy inputs for China. More importantly, the study of Fan and Wei (2006) did not take into consideration of the effect of the gradual reforms on the course of energy economic development in China. To the best of our knowledge, there has been no specific study on energy market integration using data from China that includes two other key fuels, coal and electricity.

1.3.5 Factor Substitution and the Demand for Energy

Given the present energy situation, many studies have made great efforts to predict China's energy demand (Shiu and Lam 2004; Zou and Chau 2006; Han et al. 2007; Wang et al. 2005; Garbaccio et al. 1999; Fisher-Vanden et al. 2004; Price et al.

2001; Sinton and Levine 1998; Sinton and Fridley 2000; Hu and Wang 2006). It is clear, however, that predictions of China's energy demand should be based on empirically estimated parameters, such as elasticities of factor and energy substitution, and price elasticities of energy demand (Ozatalay et al. 1979). Thus, it is crucial to know the substitution possibilities between energy and non-energy inputs if one is interested in deriving the implications of increasingly scarce and higher priced energy inputs (Berndt and Wood 1975), including the implications for economic growth (Hogan and Manne 1977). Yet when one looks for estimates of inter-factor and inter-fuel substitution possibilities and price elasticities of energy demand for China, they are almost non-existent. The few papers that do exist (e.g., Han et al. 2007; Hang and Tu 2007; Fan et al. 2007) say little about substitution between energy and non-energy factors and they do not consider technological effects on the change in energy intensity. Moreover, the empirical methods used are only simple cost function approaches (Hang and Tu 2007) and some important independent variables or interaction terms are excluded due to price data limitations and small sample size (Fan et al. 2007).

1.3.6 The Changes and Determinants of Energy Intensity

Ever since the 1973 world petroleum crisis encouraged the development of energy efficiency strategies, energy-related departments and agencies have studied energy efficiency.[2] The Office of Energy Efficiency and Renewable Energy of the United States Department of Energy (OEERE 2005) for example, created a new system of indexes of energy intensity which were designed to measure the change in national energy efficiency of strategic industries. A series of Energy Efficiency Trends in Canada published by the Canada Natural Sources Committee systematically analyzes and assess changes in Canadian energy efficiency trends (NRC 2005). Moreover, the International Energy Agency began to explore energy efficiency assessment indicators in 1995 and currently publishes a series of reports of energy efficiency for OECD countries (IEA 2004).

Energy efficiency has recently become an important topic in China and has as a consequence has been extensively investigated. China's energy intensity is relatively high by world standards for example, it's energy intensity was 0.91 t oil equivalent per thousand US$ GDP at 2000 prices in 2005 compared with 0.32 for the world as a whole and 0.195 in OECD countries (CESY 2007). Given its size and high energy intensity, any improvements in energy efficiency in China will affect world energy demand and in turn the world energy price. China's energy intensity has dramatically declined since 1978 (Ma et al. 2008). There is considerable debate about the major factors responsible (Garbaccio et al. 1999; Fisher-Vanden et al.

[2] The energy intensity is simply defined as the ratio of energy consumption to output (gross domestic products-GDP), which reflects the energy efficiency.

2004); about the timing of the decline (Zhang 2003); about whether the decline is secular or fluctuating (Liao et al. 2007) and even about the measures of energy intensity used (Qi et al. 2007a).

Most of the previous studies on China's energy intensity employ an index number approach to decompose the change in energy intensity into the effects of industrial structure change and the change in industrial energy intensity (Ma et al. 2008). As a consequence, these studies cannot derive an economic explanation of the change in energy intensity as they cannot separate out price change from factor substitution. Moreover, even though technological change is well known to be an important driver of the change in energy intensity, the index number approach cannot show the contribution coming from this source.

In addition, since the existing studies provide conflicting results, they are unable to explain the reasons why aggregate energy intensity declined, especially after 2000. For example, the measured contributions of industrial energy intensity and industrial structural change to the change in energy intensity vary between 42:58 (Qi and Chen 2006), 70:30 (Gao and Wang 2007), 46:54 (Ma and Stern 2008), 20:80 (Zhang and Ding 2007), 55:45 (Zhou and Li 2006) and 69:31 (Shi 2007c).

Finally, most studies ignore the fact that China is a vast territory with large variations in geography, climate and economic growth. Even if we consider the broad regions shown in Fig. 1.4, there are large apparent differences in energy intensity. The highest energy intensity can be found within the industrial and transportation sectors where it ranges from 13.5 in region 2 to 40.0 in region 7 for the industrial sector and from 15.1 in region 1 to 27.2 in region 7 for the transportation sector (Table 1.2). The differences are also evident in other sectors across regions. Thus, energy demand and factor substitution possibilities between

Fig. 1.4 Regional classification of china. Note: Region 1: Hebei, Shanxi, Anhui, Shandong and Henan; Region 2: Beijing, Tianjin, Shanghai; Region 3: Liaoning, Jilin, Heilongjiang; Region 4: Jiangsu, Zhejiang, Jiangxi, Hubei; Region 5: Fujian, Hunan, Guangdong, Guangxi, Hainan; Region 6: Chongqing, Sichuan, Shaanxi, Gansu, Guizhou, Yunnan; Region 7: Inner Mongolia, Tibet (no data), Qinghai, Ningxia, Xinjiang

Table 1.2 Regional aggregate energy intensity in 2006

Region[a]	Agriculture	Industry	Construction	Transportation	Commerce	Others
Region 1	4.3	22.0	4.4	15.1	3.6	1.8
Region 2	11.4	13.5	5.2	26.1	6.6	2.7
Region 3	4.8	22.1	2.8	19.5	5.3	2.9
Region 4	4.0	16.6	3.0	18.9	2.7	1.3
Region 5	3.7	17.1	2.9	21.4	5.2	1.7
Region 6	4.8	28.4	3.6	25.8	8.0	1.9
Region 7	6.6	40.0	3.5	27.2	10.7	3.5

Note: Calculated based on 1978 price and unit is ton coal equivalent/¥1,000
Data source: China statistical yearbook and China energy statistical yearbook 1997 and 2007. China Statistical Publisher, Beijing
[a]Region 1: Hebei, Shanxi, Anhui, Shandong and Henan; Region 2: Beijing, Tianjin, and Shanghai; Region 3: Liaoning, Jilin and Heilongjiang; Region 4: Jiangsu, Zhejiang, Jiangxi and Hubei; Region 5: Fujian, Hunan, Guangdong, Guangxi and Hainan; Region 6: Chongqing, Sichuan, Shaanxi, Gansu, Guizhou and Yunnan; Region 7: Inner Mongolia, Qinghai, Ningxia and Xinjiang

Table 1.3 The regional energy balance sheet in 2006

Region[a]	Regional energy production				Regional energy balance			
	Coal	Crude oil	Electricity	Natural gas	Coal	Crude oil	Electricity	Natural gas
Region 1	1,084.3	38.6	763.7	4.0	−1.0	−22.2	29.6	−2.4
Region 2	6.5	19.6	129.5	1.6	−113.6	−15.7	−76.0	−6.1
Region 3	206.5	62.5	210.4	3.9	−101.4	−21.1	−13.3	−0.5
Region 4	69.7	2.7	604.8	0.2	−370.3	−54.1	22.1	−4.9
Region 5	85.6	13.5	474.5	5.1	−219.1	−27.6	−57.1	0.7
Region 6	539.6	20.9	437.3	24.9	194.1	4.9	52.6	5.2
Region 7	380.4	26.9	245.5	18.9	34.6	−17.2	59.0	7.9

Note: The units for coal, electricity, crude oil and natural gas are million metric tons, billion kWh, million metric tons and million cube meters, respectively
Data source: China energy statistical yearbook 2007. China Statistical Publisher, Beijing
[a]Regional classification refers to Table 1.2

energy and non-energy and determinants of energy intensity are important issues for regional policy-makers. Table 1.3 presents data on regional energy production and balances from which it can be seen that, regional energy production is quite uneven, especially in terms of coal production. For example, total coal production in region 1 accounts for almost 50% of national total coal output, while in region 2 little coal is produced. Crude oil production comes mainly from regions 1, 3 and 7. Natural gas production is also unevenly distributed across regions, with approximately 75% coming from regions 6 and 7 which are located in the west of China. Due to the uneven distribution and rising demand for energy, shortages of particular types of energy might be expected in some regions for example, most regions run a coal shortage except for regions 6 and 7 where there is a surplus of approximately 120 million metric tons. Similar effects exist for electricity and natural gas, but in contrast most regions run a deficit of crude oil – the exception is region 6. With such uneven energy supply across regions, interregional energy transportation is inevitable which

Table 1.4 Regional energy price changes over time

Region[a]	Coal (¥/t)		Electricity (¥/100 kWh)		Gasoline (¥/t)		Diesel (¥/t)	
	2005	Δ%	2005	Δ%	2005	Δ%	2005	Δ%
Region 1	451	144	53	85	5,412	100	4,556	104
Region 2	470	145	65	51	5,458	95	4,473	103
Region 3	398	90	61	104	5,245	89	4,437	94
Region 4	484	95	64	36	5,325	96	4,351	92
Region 5	444	56	62	34	5,527	94	4,460	90
Region 6	339	108	52	29	5,571	100	4,560	94
Region 7	262	54	49	62	5,497	102	4,640	114

Data source: Calculated by taking the average of 10-day interval spot price time series of all capital city market spot prices within region published by State Development and Reform Committee of China

[a]Regional classification refers to Table 1.2

in turn leads a huge investment in pipeline and railway construction. These interregional characteristics of energy production and consumption undoubtedly have an impact on regional economic growth and regional energy intensity.

Following a series of policy adjustments during the last three decades, the price of major primary energy sources appear to be converging over time (Ma et al. 2008). They also appear to be rising and becoming more dependent upon those in international markets (Hang and Tu 2007; Wu 2003). However, regional level energy price heterogeneity appears to remain endemic for some forms of energy. Table 1.4 displays the energy spot prices and their changes over time for four energy fuels over seven regions in China. Firstly, note all energy prices have increased significantly in the past decade for example, prices almost doubled for coal, gasoline and diesel and increased by 54% for electricity during the last decade as a whole. Secondly, variations in the price are also evident across regions for example, coal prices are over ¥470/t in regions 2 and 4, while they are below ¥340/t in region 6 and even as low as ¥260/t in region 7 (in 2005, US$1 = ¥8.18). Thirdly, price changes over time are also apparent across regions, for example, coal prices increased by approximately 150% in regions 1 and 2 in the last decade, while they only increased by 50% in regions 5 and 7 over the same period. The same can be seen for the price of electricity. Finally, the prices of gasoline and diesel products seem fairly similar both in levels and changes over time across region. However, this result is to be expected due to their similar physical and functional characteristics.

1.4 Organization of the Study

The study is organized as follows. Chapter 2 conducts a survey of literature on the China's energy economy followed in Chap. 3 by an investigation of China's energy situation in the new millennium. Chapters 4 and 5 present the methodologies and

data used in the study, respectively. Energy reforms and market development are reviewed in Chap. 6. Factor substitution and the demand for energy are discussed in Chap. 7 and the changes and decomposition of energy intensity are investigated in Chap. 8, respectively. Graphical and statistical tests for the emergence of an energy market in China are conducted in Chap. 9. Chapter 10 presents our conclusions and implications.

1.5 Published Work

At the end of this chapter, we want to introduce our research work, Chapters or Sections which have been published as follows:

- Section 1 of Chap. 7 and Sect. 1 of Chap. 8, titled "China's energy economy: technical change, factor demand and interfactor/interfuel substitution", have appeared in *Energy Economics* 30 (2008):2167–2183.
- Parts of Chap. 3 and Sect. 4 of Chap. 10, titled "China's Energy Situation in the New Millennium", have appeared by *Renewable and Sustainable Energy Reviews* 13 (2009):1781–1799.
- Section 2 of Chap. 7 and Sect. 1 of Chap. 8, titled "Substitution possibilities and determinants of energy intensity for China", have appeared in *Energy Policy* 37 (2009):1793–1804.
- Section 3 of Chap. 7 and Sect. 2 of Chap. 8, titled "China's Industrial Energy Demand: An Empirical Analysis of Substitution Possibilities", have appeared in *Environmental Modelling and Software* 24(2009): 1293–1301.
- Section 9 of Chap. 3, titled "A survey of China's renewable energy economy", has appeared in *Renewable and Sustainable Energy Reviews* 14(2010): 438–445.
- Parts of Chap. 2, titled "China's energy economy: a survey of the literature", have appeared in *Economic Systems* 34(2010):105–132.
- Parts of Chap. 2, titled "China's energy economy: a survey of the literature", have appeared in *Economic Systems* 34(2010):105–132.
- Parts of Chap. 6 and Parts of Chap. 9, titled "Gradual reforms and the emergence of energy market in China: evidence from tests for convergence of energy prices", have appeared in *Energy Policy* 37(2009):4834–4850; titled "Are China's energy markets cointegrated", have appeared in *China Economic Reviews* 22(2011):398–407; titled "The integration of major fuel source markets in China: evidence from panel cointegration tests", have appeared in *Energy Economics* 32(2010):1139–1146; and titled "The emergence and evolution of regional convergence clusters in China's energy markets", have appeared in *Energy Economics* 2011, DOI:10.1016/j.eneco.2011.02.015, respectively.

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China's Energy Economy

Situation, Reforms, Behavior, and Energy Intensity

Ma, H.; Prof. Les Oxley

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