BOOK REVIEWS

Modeling and Valuation of Energy Structures, by Daniel Mahoney. Palgrave MacMillan. 455 pages. ISBN 978-1-137-56014-8.

The goal of this book is to correctly adapt the traditional valuation methods used in bond and equity markets to energy markets, while recognizing the quantitative modeling challenges inherent to energy markets. These challenges include high volatilities, small sample sizes, structural market changes, and operational complexity. Mahoney makes clear that the book is not an introduction to the subject of energy markets and their commonly transacted products. I couldn't agree more. In the book, the advanced level of financial mathematics (i.e., stochastic calculus and option pricing) and econometrics applied to energy markets validates his premise. The book still provides a high-level overview of energy markets and products for natural gas and electricity in the US. The book also provides short descriptions of concepts used from financial mathematics and econometrics. According to Mahoney, the book is aimed at energy traders with advanced technical background, academics with interest in energy markets, and practitioners at different levels of development.

At the heart of the book is the introduction of valuation of structured products as a replication/decomposition problem in conjunction with estimation that is robust (not sensitive) to the energy market challenges of concern. Using this valuation approach, Mahoney determines the level of model detail consistent with how much value can be realistically gained given the data available and how robust the model results can be. The book is structured into two parts. Part I (Chapters 1 through 4) introduces the valuation approaches customized to energy markets and how they are applied. Part II (Chapters 5 through 8) covers the underlying theory.

In Part I, Mahoney generally covers the application of valuation to four popular structured products in energy markets: namely, tolling arrangements, gas transport, gas storage, and load serving. According to Mahoney, each of these products has underlying physical operational complexities with consequent physical options. These options present a challenge to value these products using available market instruments that do not capture physical flexibility. To simplify their financial valuation, Mahoney identifies the primary driver of product value. For tolling arrangements, gas transport, and gas storage, the identified primary drivers of value are the spark spread option, the locational spread option, and the seasonal spread option, respectively. Unlike the other three products, the central feature in load serving is volumetric risk and not an explicit spread optionality.

In Part I, Chapter 1 describes the four selected energy structures (mainly, as spread option structures) and their markets. Chapter 1 also identifies the four main challenges of modeling in energy markets, i.e., high volatilities/jumps, small samples, structural change, and physical/operational constraints. Chapter 2 reviews the econometric challenges in energy markets and the essential features the econometric analysis must address to achieve the primary goal of robust valuation. Econometric challenges include the required relaxation of standard econometric assumptions in energy markets (such as stationarity), which can lead to incorrect inferences. Essential features to consider for robust valuation include time scale and statistical significance. Chapter 3 focuses on how the underlying market structure plays a role in portfolio construction and valuation. It introduces a concrete example of pricing options using the Heston stochastic volatility process. It also discusses various tools used for stochastic optimization including stochastic dynamic programming (SDP), Hamilton-Jacobi-Bellman (HJB), and martingale duality. The latter method is applied for valuing a natural gas storage facility. Last, Chapter 4 presents a case study for each of the four selected energy structures.

Part II contains more theoretical material. In Chapter 5, Mahoney identifies the qualitative features of stochastic processes to be retained for robust valuation. In Chapter 6, he shows how

econometric standard techniques can break down in practice. In Chapter 7, he introduces the numerical methods for valuation of energy products and finishes with relevant ideas on the subject of dependency modeling. In Chapter 8, he considers the modeling of joint dependency using copulas.

Mahoney is an experienced energy quant, who clearly displays a mastery of energy finance modeling in his book. The reader must have an advanced technical background in financial mathematics and econometrics, and knowledge of energy structures to truly grasp his ideas. As an experienced practitioner, Mahoney introduces a book full of substance to the literature of energy finance. Although Mahoney provides sufficient context to understand the applications to energy market valuation, he obviates theoretical and implementation details. He assumes that readers should be either familiar with these details or be able to consult them from other references.

Stylistically, the book has minor flaws that can be distracting. There is a repetitive use of the colloquialism "so to speak." There is overuse of parenthesis and footnotes. There is lack of clarity with some notation. Abbreviations are not always spelled out from the start. Despite these minor stylistic flaws, Mahoney's book is a great reference for anyone with an advanced technical background and an interest in energy finance.

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The Impact of Climate Policy on Environmental and Economic Performance: Evidence from Sweden, by Rolf Färe, Shawna Grosskopf, Tommy Lundgren, Per-Olov Marklund, and Wenchao Zhou (Abingdon: Routledge, 2017), 145 pages, Hardback. ISBN 978-1-138-84747-7; eISBN 978-1-315-72680-9.

Since 1990, Sweden has changed energy tax and environmental tax levels repeatedly, with different tax rates imposed on different sectors at different times and with some of those tax rates currently among the highest in the world. Sweden has also been part of the European Union's ETS system for greenhouse gas emissions since its beginning in 2005. Sweden is thus an interesting test case for other countries seeking to reduce emissions of greenhouse gases and other pollutants through economic policy instruments, in that the widespread application of such instruments, and the variation in the range in stringency of these instruments, provides experience that other countries can draw on as well.

In *The Impact of Climate Policy on Environmental and Economic Performance*, the authors examine some of the Swedish experiences. The book is the outcome of a project funded by the Swedish Energy Agency, but many of the conclusions have bearing outside Sweden as well. The authors have been able to use detailed firm-level data that cover the entire 1990-2008 period for their analyses, permitting detailed econometric study of many of the issues involved.

After an introductory chapter which describes Swedish environmental policy from 1990 onward, and the datasets used, the authors move on to a chapter describing their theoretical and empirical framework. The theoretical approach is to use distance functions to model the technologies involved (where damaging emissions are modeled as undesirable or bad outputs rather than as inputs to the production process, as is sometimes done in other studies) and for the empirical analyses the two main efficiency measurement methodologies (data envelopment analysis and stochastic frontier analysis) are primarily used. This theoretical and empirical framework provides an overarching structure to the analyses carried out in the book, but the authors could perhaps have done even more with this; despite the common framework, the subsequent chapters differ enough in their empirical specifications (in the time periods used, in explanatory variables used, and in the general approaches used) that at times the book reads more like a collection of related papers rather

than as a single text. However, even if the individual studies described could have been even better integrated into a joint study, the studies are all well motivated and contribute importantly to shedding light on the issues involved.

In many cases, the studies in the book entail analysis of issues where most economists would expect, on theoretical grounds, that a specific relationship will hold but where the study helps understand how strong (or weak) that relationship is empirically. Thus, in the third chapter of the book (the first of the empirical chapters) the authors study whether including environmental improvement measures in productivity assessments matters for the outcome. Environmental measures have become progressively more stringent in many countries, including Sweden, and this has presumably led to lower production but also improved environmental performance. On theoretical grounds one would therefore expect that excluding improved environmental performance from indicators of productivity development (as is often done in practice) will lead to a downward bias in those indicators. This will, in turn, lead to underestimates of overall technology growth and potentially also mis-estimates of relative productivity improvements between different sectors. However, this chapter helps demonstrate the importance of this issue in practice, by showing clearly how different the estimated productivity outcomes for individual sectors are depending on how (and whether) environmental performance is included.

Similarly, in the fourth and sixth chapters, where the effect of emissions taxes (and other means of pricing emissions, such as ETS or the Swedish NO_x fee) on emissions is studied, one would expect to see that putting a price on carbon dioxide or other pollutants will affect firms' behavior and lead to reduced emissions. However, the authors are able to show in the fourth chapter, not only that carbon taxes affect behavior, but also that they have a greater impact on behavior than equivalent fuel price increases – possibly because carbon taxes signal cost increases yet to come, in a way that fuel prices do not. In the sixth chapter, where the authors compare prices on different emissions, the authors find (unexpectedly) that the Swedish NO_x fee may actually have little impact in practice. This is because in almost all firms the CO_2 and SO_2 taxes (and the shifts in firm behavior caused by these taxes) lead to reduced NO_x emissions as well, leaving very few firms that would increase their NO_x emissions even if the fee on this particular pollutant were reduced. To a less dramatic extent, this appears to be the case for SO_2 as well; for many firms, the CO_2 tax (or, since 2005, the ETS price) alone achieves more or less the same changes in behavior that all three emissions prices currently achieve together.

In the fifth chapter, the authors study the effects of environmental policy on profit efficiency. The popular Porter hypothesis suggests (in its strong form) that stricter environmental policies could actually lead to improved firm-level efficiency, by forcing firms to reexamine their production methods and, as a side benefit of this, identifying better ways of doing things. This is a proposition that most economists have traditionally rejected, on the grounds that firms seeking to maximize their profits should be reexamining their production methods continuously anyway, and should thus already have identified those better ways of doing things. The authors find no effect of carbon taxation on profit efficiency; this contributes to the growing empirical literature showing that there is little support for the strong version of the Porter hypothesis. Conversely, policymakers do not need to worry that they might reduce efficiency by implementing higher environmental taxes. However, while the authors find no impact on profit efficiency from mandatory measures aimed at improving environmental performance, they do find an impact from voluntary corporate governance measures. Thus, more or less in line with the traditional economic analysis of this issue, firms with more active corporate governance seem to identify more profitable ways of doing things on a regular basis.

In the short seventh and final chapter, the authors present a simple cost-benefit framework for assessing how and whether firms are likely to respond to increases in emissions taxes. They investigate this issue with a numerical application to the Swedish pulp and paper industry. Even with some fairly extreme assumptions about these firms' ability to respond in the short term to higher taxes (i.e. firms are assumed to be unable to change, not only their capital stocks, but also their use

of labor and of different fuels), there are firms that can reduce their emissions sufficiently so that their tax costs would decline more than their abatement costs would increase. In more realistic applications, where the assumed ability for responding is greater, an even greater share of firms would presumably choose to reduce emissions rather than pay higher taxes.

Sweden has experimented widely with economic policy instruments in the environmental area in the past decades, applying a wide range of different emissions tax levels and tax structures for different pollutants and different sectors. The book exploits this variation in policies, together with a wealth of firm-level data, to study some of the key outcomes. In other countries where similar data are available, analysts will be able to draw on these studies as examples of how to carry out similar work, and even for countries where such data are not available, these studies can at least provide an indication of how such policies would work in practice. By and large, the studies reported in this book find that these economic policy instruments work: firms can and do respond to the incentives that these instruments create, and the instruments affect the environmental issues that they are intended to affect without distorting firms' behavior in unwanted ways. Ultimately, the picture painted by the studies in this book is therefore a hopeful one, both for Sweden and for other countries seeking to implement stricter environmental policies. Both analysts and policymakers should thus find the studies reported in this book useful.

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Energy Economics: Energy Efficiency in China, by Yi-Ming Wei and Hua Liao (Cham, Switzerland: Springer, 2016), 339 pages. ISBN 978-3-319-44629-5. E-book ISBN: 978-3-319-44631-8.

Improving energy efficiency is considered to be one of the cost-effective measures to meet the climate change mitigation target and guarantee energy security. Wei and Liao's volume is an apt contribution to this popular topic in academia. I highly appreciate their systematic analysis and illuminating discussion on China's energy efficiency, an issue of both regional and global importance.

This book begins with an overview of the energy development in China and the rest of the world. Prospectively, energy demand will surge in the future, and so will the investment in energy resources to ensure energy supply. Positively, most regions in the world have witnessed decreases in energy consumption per unit of GDP. Such trends are attributable to structural changes in regional economies and technological progress. Meanwhile, the authors also draw our attention to the inequality in per capita energy consumption. As a violent contrast, when energy is reserved for luxurious lifestyles and recreational purposes in developed countries, most people in developing countries are still struggling to reserve energy for basic living needs. Thus, the resulting energy poverty and induced health issues are acute in developing regions. Wei and Liao, in this chapter, visualise the energy structural changes in the G7 and BRIC member countries. The key message of this chapter, in my view, is that primary energy production in developing countries like China and India hinges upon their resource endowment, whereas in developed countries, it is greatly affected by government policies.

The authors also point out that China's economic development is characterised by "energy-intensive" growth. What boosts the growth of the energy-intensive sector, as well as the ever-increasing emissions in China is the potential excessive production capacity, the urbanisation and reconstruction of rural areas, and Chinese people's updated consumption preferences. The authors point out that China has accelerated its reform in energy management and diversification of energy supply. In the interim, high uncertainty regarding future energy demand, insufficient high-quality per capita energy resources and global climate change are the challenges imposed upon China's energy

development strategy. The "most important first step" to tackle the aforementioned challenges is to improve energy efficiency. This should be the rationale behind the writing of the book, I presume.

One of the highlights of this book is the second chapter on measuring energy efficiency. It presents the analytical instruments for the dissection of the issues in the following chapters. The academic community is yet to reach a consensus on the definition of energy efficiency. Additionally, the existing literature doesn't seem to differentiate the goals of energy targets from the ways to achieve them. Based on these theoretical gaps, the two scholars conduct a critical, systematic analysis of the seven popular indexes used to measure energy efficiency in the literature, highlighting the potential problems associated with these indexes.

Chapters 3 to 9 form the spine of the book, in which China's energy efficiency issues are studied from different perspectives. In Chapter 3, the focal question is how economic structural change impacts energy macro-efficiency, i.e. energy intensity. Methodologically, Wei and Liao combine a number of approaches, such as input-output analysis, Divisia decomposition analysis and the regression analysis, to study the interactions between economic growth and energy consumption in China. One interesting result is that national income distribution structure plays a vital role in the rapidly growing energy use in China.

Chapter 4 and 5 scrutinise the energy use in several sectors like residential, transport, buildings and electricity. In the next chapter, Wei and Liao elucidate how price affects oil demand in China. They argue that the oil demand elasticity is relatively low in China in comparison to the developed countries, and suggest the strengthening of China's market mechanism. In the meantime, the low substitution price elasticity of coal in China is positive news to its emission mitigation efforts. The ensuing two chapters primarily compare the energy efficiency in different regions in China as well as a cross-country comparison.

These chapters should enable readers to grasp the broad picture of global energy consumption. The huge heterogeneous efficiency gap in the energy consumption of different regions gives great incentives to save energy even with the current level of technology. In the discussion of the residential energy consumption, the authors put several demographic factors under the spotlight, including population growth and urbanisation. Energy use in public transport is dominated by petroleum use, although the energy intensity of which has declined substantially. As for energy consumption in the building sector, the management of electricity use should be the focal point because electricity use accounts for over half of the total energy consumed. In the electricity sector, the pricing mechanism could be another prevailing factor in addition to supply and demand.

The last chapter addresses how China can develop a low carbon economy, based on the results presented in the preceding chapters. Wei and Liao highlight five aspects in China's low-carbon development, with China's socio-political conditions taken into consideration. First, short-term and long-term strategic plans in alignment with China's unique conditions have to be formulated; second, the optimisation and upgrade of China's industrial structure should be accelerated; third, the independent development of low-carbon technology through R&D is in order; fourth, the construction of a low-carbon consumption model is imperative to the whole society; last, international cooperation is instrumental to China's low-carbon development strategy.

Though inspiring as this book strikes me, I have some reservations after reading it. First, the string of literature on parametric estimation—for instance, stochastic frontier analysis that is becoming one of the standard tools in energy economics for efficiency analysis—deserves more space in the chapters. Next, the growing literature on the effectiveness of efficiency instruments implemented appears to be in absence, as the book dwells on the measurement of energy efficiency and the decomposition of various social-economic factors contributing to the efficiency changes. Moreover, I would be delighted if the authors could share their insight into the consumption of coal, the paramount energy source in China, apart from oil demand. Finally, I am curious about the authors' take in the series of efficiency standards implemented by both the central and local governments to reduce energy waste in construction, household appliances and automobiles, which

eludes this book on China's energy efficiency initiatives. Admittedly, the demand-side management is occasionally mentioned in some chapters, further discussion on this issue may be beneficial to future policy design, notwithstanding. I am looking forward to the updates in these aspects in the next edition of the book.

Generally, this book curates much valuable materials pertinent to energy efficiency in China, in spite of the omissions mentioned in the previous paragraph. It well serves as a handbook for the student of energy economics, professionals, researchers and policymakers, who are concerned with China's energy efficiency policies.

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