

Commentary

KAPSARC's Contribution to Evaluating the Impact of Price Controls

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The European Journal of Operational Research has just published a paper, “[Measuring the effects of price controls using mixed complementarity models](#)” (2019). It detailed a series of innovative modeling approaches developed by KAPSARC researchers over the last six years. The models were used to study the effects of administered energy prices in Saudi Arabia and assess the potential benefits of price reform. This commentary gives an overview of that research, including its motivation, coverage and findings.

At the start of the project, it seemed to us that Saudi Arabia’s energy price reforms would primarily serve the country’s long-term objective of increasing the amount of domestically produced oil made available for export by reducing its domestic consumption. The Chatham House report, “Burning oil to keep cool,” and Jadwa Investment’s report, “Saudi Arabia’s coming oil and fiscal challenge,” both released in 2011, argued that the Kingdom’s domestic oil consumption, if left unchecked, would ultimately exceed its national production. Deregulating energy prices incentivizes investment in energy-efficient equipment in all sectors, and in renewables and nuclear energy in the power sector, leading to large oil savings and consequential economic gains for the country. Later, with the fall in international oil prices at the end of 2014 and the consequent loss of oil export revenues, the budgetary significance of Saudi Arabia’s domestic oil sales increased. To some extent, the perceived purpose of the price reform shifted from saving oil to relaxing the government’s budget. Of course, decision-makers were also concerned about the potential effects of the domestic energy price reform on other macroeconomic indicators such as inflation, employment, industry competitiveness and household welfare. KAPSARC has also been working on these issues using macro-econometric models, but that research falls outside the scope of this commentary.

Our work on price controls has focused on administered prices and price ceilings on intermediate and final consumption products. These controls are common in many emerging economies and were once common in developed countries. A price is administered when it is fixed by the government and is subject to a ceiling when the government sets a maximum value for it. For instance, in Saudi Arabia, domestic energy prices are administered, and the prices of cement and some agricultural and food products are or were subject to ceilings.

Most of the literature predating the research outlined here was relatively outdated and focused on iterative methods developed in linear programming: the traditional approach to energy modeling. It was clear to us, however, that recent approaches to modeling complex economic equilibria offered new and interesting possibilities. The prospect of methodological innovation and the timeliness of the topic for Saudi Arabia (and many other countries, as shown by the recent global wave of energy price reforms) constituted the ingredients of a promising research project. The project started in 2013 with the development of the KAPSARC Energy Model (KEM). The team initially comprised Walid Matar, Frederic Murphy, Axel Pierru, Bertrand Rioux, and Yves Smeers, with Abdullah Al-Jarboua, Hossa Al-Mutairi, Philipp Galkin, Shreekar Pradhan, and David Wogan joining later.

Because energy prices in Saudi Arabia are fixed by the government, the Saudi energy system cannot be represented as a straightforward linear program since the assumption that the price of a product equals its marginal cost or marginal value does not necessarily hold. The Kingdom's energy system can, however, be represented as a regulated competitive equilibrium. For this reason, KEM was developed as a multi-sector equilibrium model that handles administered prices in a mixed-complementarity formulation. The KAPSARC article, "[A tutorial on building policy models as mixed-complementarity problems](#)" (2016), provides a non-technical overview of KAPSARC's modeling framework and its relevance for building policy models.

When we designed our first two policy studies, "[Lowering Saudi Arabia's fuel consumption and energy system costs without increasing end consumer prices](#)" (2015), and "[Efficient industrial energy use: the first step in transitioning Saudi Arabia's energy mix](#)" (2017) (initially released as KAPSARC discussion papers in 2014 and 2015, respectively), we thought that prices for the industry and utility sectors would be deregulated first, and prices for households would be reformed later. Both studies thus examined a set of policy scenarios where end consumer prices were unaltered. Our assumption was proven wrong, however, as the first reform, implemented in January 2016, covered both intermediate and final uses of energy. We were right though to assume that a gradual deregulation of prices would be the preferred option (our "gradual deregulation scenario").

The first study used a long-term static version of KEM, calibrated to 2011, which allowed additional investment with the benefit of hindsight. In other words, it considered what would have happened if utilities and industrial firms had been able to revisit 2011 with the incentives provided by alternative pricing policies and add new infrastructure to the pre-existing facilities.

One of the scenarios assumed the full deregulation of inter-sectoral energy transfer prices. In this scenario, the electricity and water sectors buy a barrel of Arab Light at US\$107.8 (the average international price in 2011) instead of US\$4.24 (the administered price in 2011). Another scenario (the "investment-credit scenario") required solving a mathematical program with equilibrium constraints (MPEC), a problem at the frontier of applied operational research. This scenario showed that a modest increase in inter-sectoral fuel transfer prices is sufficient to produce economic gains, close to those achieved by deregulating transfer prices, when complemented by credits for investments in solar and nuclear power generation capacities. This presents an alternative approach to the classic recommendation of deregulating inter-sectoral fuel prices in situations where the conditions for successful liberalized markets do not exist.

The study concluded that the policies examined would have potentially generated annual economic gains exceeding US\$23 billion in 2011, or about 4% of Saudi Arabia's gross domestic product. The distribution of these gains showed that the government would be the biggest winner because it would receive incremental oil export revenues.

Scoping out the long-term economic gains of fuel price reform was only the first step in the project. Decision-makers were also interested in the



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What is the impact of price controls on regional electricity trade?

transitional effects of gradual price reform. Our 2017 study, “[Efficient industrial energy use: The first step in transitioning Saudi Arabia's energy mix](#),” addressed this. It used a dynamic version of KEM to project Saudi Arabia’s energy balances until 2032 under various price reform scenarios. It illustrated that a managed transition would not compromise the economic benefits of price reform. The scenarios examined revealed a decrease in the domestic consumption of oil and gas in 2032 by up to 2 million barrels of oil equivalent per day compared with the baseline scenario.

Both policy studies hitherto mentioned were presented to various policymaking and academic circles inside and outside the Kingdom prior to the initial 2016 price reform. The project’s subsequent studies focused on end-user price reform. One such study, “[Jointly reforming the prices of industrial fuels and residential electricity in Saudi Arabia](#)” (2017), benefited from the Saudi Electricity Company’s support. This study was accompanied by parallel work aiming to determine households’ response to price changes through estimating elasticity values.

Another key question for policymakers was, what would be the impact of price controls on regional energy trade? And what was the potential value of the Gulf Cooperation Council (GCC) Interconnector beyond preventing blackouts? It was widely thought that low administered prices on fuels used for electricity generation were key barriers to regional movements of electricity. The reasoning behind this was that countries are unlikely to want to incur the costs of exporting the value of their subsidies. To address these questions in depth, we expanded KEM, adding the electricity and water sectors of the other GCC countries and the existing cross-country transmission lines. Our study, “[The costs and gains of policy options for coordinating electricity generation in the Gulf Cooperation Council](#)” (2019), confirmed that domestic fuel subsidies are the key economic barrier to regional electricity exchange, from which all GCC countries benefit. It showed that, under the right economic conditions, the use of the Interconnector could generate an annual collective gain of US\$1.1 billion.

In all the studies we have conducted, our modeling approach has been able to capture all relevant market specificities. It could replicate, for example, the following characteristics of Saudi Arabia’s natural gas market. Saudi Arabia does not import any natural gas, and all its domestically produced natural gas is consumed within the country. A low administered price for natural gas, combined with the Kingdom’s constrained production, means that domestic demand exceeds the available supply and the market does not clear. If the market were deregulated, it would clear at a price higher than the administered price. Therefore, at the administered price, the available supply has to be allocated to the major gas-consuming sectors. The government allocates quotas of natural gas using sectoral demand estimates and business plans presented by gas-consuming organizations. Our 2015 study found that the existing quota allocations were close to optimal for the existing pricing system. This was unsurprising, as the basis for granting allocations of natural gas has been to favor those projects likely to add most value to the Saudi economy.

We also formalized the idea that unmet demand could be divided into two components: actual rationing (customers without allocations whose demand would still be positive at the market-clearing price) and excess

rationing (customers without allocations who would not buy natural gas at the market-clearing price). Designing an efficient allocation plan requires the ability to distinguish between both types of customer. Here, rationing takes the form of an economic curtailment (not a physical shortage) since most natural gas customers can buy substitutes, albeit at higher prices. Note that the functioning of the Saudi natural gas market might change in the future with the prospect of increased domestic production and liquefied natural gas (LNG) imports.

The methodological approach we initially developed for Saudi Arabia can be applied to other countries. China was a natural choice as it is a large energy consumer, is the biggest importer of Saudi oil, and has layers of domestic pricing and market policies. Our study, "[How do price caps in China's electricity sector impact the economics of coal, power and wind? Potential gains from reforms](#)" (2017), focused on China's National Development and Reform Commission's (NDRC's) caps on the price a power generator can charge a utility. The caps are differentiated by technology and region. The study found that the caps impose an annual cost of US\$7 billion, alter the generation and fuel mixes, and require subsidies for the market to clear. They also incentivize market concentration so that generators can cross-subsidize power plants. The study has been presented to various Chinese governmental and academic organizations. Our second China study, "[The economic impact of price controls on China's natural gas supply chain](#)" (2019), assessed the distorting effects of the price ceilings imposed on China's domestic natural gas market. Just after the study's release, market analysts reported a surge in the volume of trucked LNG in China. A Bloomberg article, "Welcome to gas pipelines on wheels" (Nov. 5, 2018), citing our study, attributed this surge to China's domestic price controls.

Our methodological paper mentioned in the introduction to this commentary, "[Measuring the effects of price controls using mixed complementarity models](#)," formalizes the approach for modeling control prices in multi-sector models. It shows how to measure and interpret the levels of disequilibrium induced by price controls when rationing occurs. It also shows how to reduce the disequilibrium with a least-cost combination of subsidies and how to determine the most economically efficient allocation plan under rationing. The methodological developments detailed in the paper provide countries with the means to evaluate the cost of their price regulations, and to evaluate the trade-offs of policies that either deregulate prices entirely or improve the economic efficiency of price controls.

Saudi Arabia has already increased its domestic energy prices twice, in 2016 and 2018. The domestic price of gasoline is now close to the international market price. The issue of price controls is thus of less importance to Saudi Arabia than it used to be. However, as reported in the Financial Times on Apr. 17, 2019 ("Argentina unveils price controls to tame inflation"), although the deregulation of domestic prices seems to be a global trend, some countries have recently followed a reverse path. We hope that the body of methodological knowledge built by KAPSARC will continue to serve economists and modelers working on these issues. We will continue to pursue our research efforts and further develop KAPSARC's expertise on domestic energy price regulations. KAPSARC is currently involved in an ongoing and challenging project to expand the scope of KEM to include the rest of Saudi Arabia's economy. This is being achieved through building an integrated top-down, bottom-up, hybrid model.

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KAPSARC papers on price controls

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About the Commentary

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About KAPSARC

The King Abdullah Petroleum Studies and Research Center (KAPSARC) is a non-profit global institution dedicated to independent research into energy economics, policy, technology and the environment, across all types of energy. KAPSARC's mandate is to advance the understanding of energy challenges and opportunities facing the world today and tomorrow, through unbiased, independent, and high-caliber research for the benefit of society. KAPSARC is located in Riyadh, Saudi Arabia.

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