Foreword to the Special Issue: "Renewables and Diversification in Heavily Energy Subsidized Economies"

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Obtaining the appropriate fuel and technology mix in an economy is difficult enough without compounding it with the consequences of heavily subsidized energy prices for certain fuels and technologies. Governments choose to provide low-priced energy because they believe access to energy is an essential precondition for improved social welfare and that their citizens cannot afford to pay the full cost of energy provision until the economy has developed sufficiently. While the welfare argument is strong, the mispricing of energy can lead to distortions that occur whether prices are below marginal production (acquisition cost) or below world market prices (opportunity cost). These distortions will be painful to unwind in the future.

Countries that import energy, such as India or China, ran into this limitation when global commodity prices increased dramatically in the middle of the last decade. That was also precisely when their citizens could least afford to pay the higher prices. Countries that were lucky enough to be endowed with sufficient energy resources to be major exporters, such as those in the Middle East, were able to cross subsidize domestic consumption from export revenues. However, the resulting economic imbalances were revealed when commodity prices fell during the last few years leading to price reform initiatives such that domestic prices would in the future reflect international markets.

The argument for deploying renewable energy sources (renewables), which are not yet competitive on an unsubsidized basis versus the costs of incumbent fuel and/or energy technology systems, is that it is better to trade a smaller short-term loss of welfare against a larger loss in the future caused by climate change. In the years ahead, many foresee technology improvements that will reduce the cost of renewables to a level where there will be no need for the trading of short-term and long-term welfare losses. Instead, deployment of renewables will be welfare enhancing.

There are many places where hydro and geothermal energy are already cost competitive so this discussion is mostly about solar and wind technologies (and bioenergy), which are enjoying declining costs to a point where they can be competitive in terms of the energy they supply, even if not yet in the ancillary services required to meet the reliability threshold that consumers expect. Explicit and implicit subsidies for fossil fuels raise the bar for investments in more fuel-efficient combustion technologies and, to an even greater extent, renewables. Today's challenge is for them to be cost competitive at a time when governments and consumers can least afford the simultaneous costs of price reform, investments in efficiency and deployment of renewables.

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This special issue provides a range of relevant insights from around the world that can help policymakers in heavily energy subsidized economies to chart the most welfare enhancing (or least welfare damaging) path to reform their energy markets and diversify energy systems. This special issue may also benefit policymakers, practitioners and researchers in rich, developed economies where historical distortions survive in their energy markets, yet there is a need to maintain or restore efficient and profitable market conditions.

Contributing authors have provided applied theoretical and empirical papers to this special issue, covering an array of topics and analyses across the range of traditional primary and secondary energy sources, such as crude oil, petroleum products, coal, natural gas and electricity generation. The applied theoretical and analytical contributions are expected to yield insights to policymakers in designing new policy scenarios for renewables development and economic growth. The empirical studies impart important lessons from examining recent market data, supporting or disputing some of the positions and recommendations in current policy debates. The general conclusion of this Special Issue is that there is no 'one-size-fits-all' recipe for all markets and all countries. As such, we have selected papers offering thought frameworks, new data and analytical approaches that can contribute to the goal of devising efficient, diversified markets for energy to underpin continued economic growth, particularly in developing economies. It is quite obvious that one cannot cover all the relevant topics in a single volume and we have opted for quality, even if at the expense of breadth.

We have grouped the contributions into four main streams: (i) effects of subsidy policies on the fuel mix and environment; (ii) impact of renewables subsidies on the macro economy; (iii) renewables penetration in the electricity market structure; (iv) effects of renewables promotion policies in advanced economies.

Effects of subsidy polices on the fuel mix and environment

Much of the discussion on fossil fuel subsidies focuses on them working against efforts to limit greenhouse gas emissions and the present value of future welfare loss from climate change. However, there are significant costs that are more immediate and local in their impact. One only has to read about air quality events in major cities such as Beijing and New Delhi to see how such concerns can focus policymakers' attention. ***Lucas Davis*** quantifies the environmental cost of global fuel subsidies, focusing on gasoline and diesel. Using assumptions about supply and demand elasticities, he estimates that current subsidies cause $44 billion in external costs annually. These include $8 billion from carbon dioxide emissions, $7 billion from the impacts of local pollutants, $12 billion from traffic congestion and $17 billion from accidents. Davis concludes that government incentives for alternative fuel vehicles are unlikely to cost-effectively reduce the overall level of these externalities as they do little to address traffic congestion or accidents, and only indirectly address carbon dioxide and local pollutants.

The 'natural' fuel mix in an economy is, among other factors, a function of the prices of energy commodities. Policies such as support subsidies distort this, but at what cost? ***Jorge Blazquez, Lester C Hunt and Baltasar Manzano*** construct a macroeconomic model of oil subsidies and renewable energy in Saudi Arabia and simulate the impact of reducing energy subsidies. The analysis suggests that, by displacing oil that might otherwise be exported, investment in renewables is welfare enhancing. With the integration costs of renewable technologies, households' welfare is maximized at around 30–40% penetration. However, a policy in favor of renewables could increase the dependence of the Saudi economy on oil because, all else being equal, a larger share of GDP would be linked to oil exports and exposed to oil price shocks. There is a risk that placing

significantly more oil onto the international market (presumably, if lead times prevented it being accommodated) would have a negative impact on the oil price and thus, could offset the potential gains from the renewables policy.

Chen Zhan-Ming addresses the welfare impacts of energy subsidies in China, quantifying their range and distributional impact on the economy. He finds that the lower boundary estimation of annual energy subsidies of China was equivalent to 0.22–0.37% of GDP or 0.95–1.21% of government expenditure, during the period 2010–2014. The way in which subsidies were targeted at rural grids and transportation resulted in 72% being distributed to residents in 2012 with the urban poor benefiting most from the resulting lower food and dwelling costs. Generally speaking, the overall energy subsidies are shown to be slightly regressive, leading to the conclusion that energy subsidy reform can simultaneously help achieve the narrowing of the wealth gap and relieve budgetary pressures on government expenditures.

Still focusing on China and examining subsidies through the lens of price caps on producers rather than preferential prices for consumers, ***Bertrand Rioux, Philipp Galkin, Frederic Murphy and Axel Pierru*** model distortions in the electricity sector. They evaluate the potential gains from subsidy reforms and the impact of price caps on the economy, particularly of coal fired generation and wind power. The authors show that caps on the price at which technologies can be bid into the grid create distortions in electricity dispatch and introduce a need for subsidies and cross-subsidies for the market to clear. The annual cost of operating the system is 45 billion RMB more than the lowest cost option. Increasing wind capacity can help alleviate distortions created by the price caps, ceteris paribus, with no significant impact on coal consumption. They find that the feed-in tariff was set at a slightly higher level than would otherwise have been necessary.

Impact of renewables subsidies on the macro economy

The energy economies of the US, EU and China could be expected to yield different responses to policies that encourage renewables as well as technology and demand shocks. ***Amedeo Argentiero, Tarek Atalla, Simona Bigerna, Silvia Micheli and Paolo Polinori***, estimate and use a Bayesian DSGE Model to assess renewables policies in these three large economies. They study the effects of different renewables deployment support policies, in the presence of such shocks. Their results suggest that a final output total factor productivity (TFP) shock generates a much stronger effect on production in the US, where the share of energy is higher, than in China and the EU. However, a shock in renewables TFP, instead, produces a higher renewables growth in the EU than in the US and China. This seems to support the EU's favorable policy attitude toward renewables incentives. Based on the relative fuel and technology diversification and flexibility in the three economies, the authors show that the EU has a comparative advantage for reaching renewables grid parity compared to the US and China, which are more fossil fuel dependent.

Improvements in the efficiency of thermal generation plants will reduce greenhouse gas emissions, particularly if such programs involve switching from oil-fired power generation to combined cycle gas turbines (CCGTs). Following the Paris Accord, most heavily energy subsidized economies have committed to reducing their GHG emissions and switching to CCGTs can provide a welfare enhancing path to achieving this aim. ***David Newbery*** discusses the pricing of electricity and renewables policies in these heavily energy subsidized economies, where energy subsidies cost on average 4% of GDP in 2014 and resulted in inefficient consumption and lock-in risk. The author presents evidence on the magnitude and impacts of oil, gas and electricity subsidies, and discusses how the electricity sector can be weaned off subsidies, enabling CCGTs and unsubsidized renewables to reduce carbon emissions without damaging the macro economy. He suggests that,

starting with retail pricing reform, wholesale electricity and gas prices can then be allowed to rise to their efficient level, at which point unsubsidized renewable electricity becomes a realistic prospect in many of these countries.

Support for the gradual approach to increasing the share of renewables is provided by ***Tarek Atalla, Simona Bigerna, Carlo Andrea Bollino and Rolando Fuentes***, who model the impact of the gradual adoption of renewables on the welfare of consumers. They do this by constructing a theoretically founded measure of the true cost of living and an equivalence scale for the household sector for 64 countries representing over two-thirds of the world population, based on a weather database of heating and cooling degree days. The authors also simulate the outcome of alternate scenarios of renewables implementation in 2035, taking account of different RES prices. Their results can help in assessing the related welfare implications of a gradual transition from fossil fuels to renewables.

Renewables penetration in electricity market structures

It would be easy to turn a blind eye to other priorities in electricity market regulation in order to promote renewables penetration. However, this may come at a cost. ***Daron Acemoglu, Ali Kakhbod and Asuman Ozdaglar*** present a model of competition in electricity markets with renewables, tackling the issue of how generators react to the diversification of energy portfolios in an oligopolistic energy market. They show that thermal generators, with some control over renewable supplies, are able to offset the price declines due to renewables. They strategically reduce their conventional energy supplies when renewables supply is high. Consequently, large companies with diversified energy portfolios may be welfare reducing.

There are debates about whether penetration of zero marginal cost renewables into liberalized electricity markets requires a roll back of competition or the introduction of additional markets to value attributes beyond simple dispatch of energy. Two examples of the creation of additional instruments illustrate this second approach. In their paper, ***Friedrich Kunz, Juan Rosellón and Claudia Kemfert*** discuss the introduction of Nodal Pricing into the Mexican New Electricity Market through financial transmission rights (FTR). Changing a subsidized zonal pricing system to a full nodal pricing regime could improve the efficiency of electricity system operation although the resulting price modifications might also reallocate economic surplus across producers and consumers. In the paper, the authors calculate nodal prices for the Mexican power system, and further analyze how allocations of FTRs can be used to mitigate resulting distributional effects and provide a basis for the reformulation of currently regressive subsidies in a progressive way.

In another example of creating market instruments to overcome the challenge of energy only dispatch with zero marginal cost renewables, ***Cynthia Bothwell and Benjamin Hobbs*** discuss the merit of the capacity markets, as the penetration of variable renewables in electricity markets grows. Using Electric Reliability Council of Texas (ERCOT) data, they use a market equilibrium model to quantify the resulting loss of efficiency as being as much as 0.37% of total generation costs where there are no other subsidies, but increasing to as much as 6.3% when combined with renewables tax credits. Efficient capacity market designs should reward producers based on their marginal contributions to system adequacy, considering how renewables penetration affects the timing of net load peaks.

Effects of renewables promotion policies in advanced economies

The final three papers draw on examples from Germany, which many acknowledge has pursued renewables support policies with more vigor than any other major economy. We include

them, despite most advanced economies not exhibiting heavily subsidized energy prices, because the lessons from these examples provide generally applicable insights for policymakers in economies that are diversifying their energy systems. Furthermore, even advanced economies suffer from distorted energy subsidies and it would be incorrect to suggest that the problem of such polices applies only to developing economies.

Christoph Boehringer, Florian Landisy and Miguel Angel Tovar Reanos discuss the cost-effectiveness and incidence of renewables promotion in Germany over the last decade. They combine computable general equilibrium and microsimulation analyses to investigate the economic impacts of Germany's renewables policy, finding that the regressive effects could be attenuated by alternative subsidy financing mechanisms, reducing the overall cost for the economy by 5%. They also find that, from a distributional perspective, replacing the current scheme with higher value-added taxes turns out to be attractive as the poorest households benefit the most.

Mark Andor, Manuel Frondel, and Colin Vance present the case of Germany's Energiewende—the country's ambitious plan to transform its energy system—analyzing how increasing costs are decreasing the consumers' willingness-to-pay (WTP) for it. Using recent stated-preference surveys, they estimate the households' WTP for green electricity (based on two models: closed-ended questions about the 2020 target and open-ended questions about WTP changes over time). The results from both models reveal a strong contrast between the households' general acceptance of supporting renewable technologies and their specific WTP for green electricity.

Andreas Voss and Reinhard Madlener analyze the auction schemes, bidding strategies and the cost-optimal level of promoting renewables electricity in Germany. They consider pay-as-bid and uniform pricing and single and multiple bids, amid uncertainty. The authors show that greater uncertainty regarding the market clearing price increases the project value, as this additional uncertainty can be used to raise the probability of obtaining a higher level of remuneration by an adjusted auction strategy. The first-price auction can generate additional profits by placing a second, higher bid with a low probability of success. Investment cost uncertainty can have either a positive or a negative impact on the project value, depending on the auction parameters.

The papers contained in this special issue cover a wide range of topics relevant for a variety of actors dealing with the issue of energy subsidy-induced market distortions. KAPSARC feels strongly about these issues, hence its sponsorship for this special issue. We believe that further analysis is needed on this critical field of research in energy economics and related areas, leading to better policy design and business strategy. We hope readers will find something useful in this issue that provokes further thought and, better still, action. The contributions have certainly whetted our appetite and helped define an agenda for future research.

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