

# Fracking and Structural Shifts in Oil Supply

*W. D. Walls<sup>a</sup> and Xiaoli Zheng<sup>b</sup>*

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In this paper, we provide econometric estimates of the supply relation for groupings of U.S. oil producers that differ in their use of hydraulic fracturing. We find that fracking is associated with i) supply responses that are asymmetric with respect to price increases and decreases; ii) a much larger supply response with respect to price rises than is the case for non-fracking producing regions; and iii) a faster speed of adjustment to price changes. Because shale oils accounted for about one-half of U.S. oil output, these attributes of tight oil supply have important implications for the world oil market, particularly if tight oil represents marginal production. We now enumerate these implications: First, price increases cause a rapid increase in tight oil output, making fracking American oil producers a primary beneficiary of price increases. Second, price decreases cause a much smaller decrease in tight oil output; even in a falling price environment, the decrease of tight oil output is limited. These features of post-shale-boom U.S. oil supply are helpful in explaining the impotence of OPEC policy actions intended to i) drown fracking U.S. oil producers in their own oil and, ii) thereby elevate and stabilize the world price of crude oil.

The implications of fracking supply asymmetries on the ineffectiveness of OPEC at managing oil markets are predicated on stable oil demand and tight oil producers accounting for incremental production. When oil demand collapses, as occurred beginning mid-Winter 2020 due to the Covid-19 virus-induced global lockdown, these high-cost producers would be expected to exit the market when oil prices fall below sustainable average variable cost. The supply asymmetries are only relevant when tight oil production through fracking is economically viable. When oil demand eventually returns—and oil prices have already risen substantially from the lows of late April 2020—the assets from bankrupt shale producers, such as Chesapeake Energy and Whiting Petroleum, are likely to once again to be called into production. If and when the tight oil producers with asymmetric supply relations are the incremental producers—the analysis set out in this paper will provide insight about the comparative statics of world oil markets.

## Price Formation in Auctions for Financial Transmission Rights

*Jeff Opgrand,<sup>c</sup> Paul V. Preckel,<sup>d</sup> Douglas J. Gotham,<sup>e</sup> and Andrew L. Liu<sup>f</sup>*

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For nearly 20 years, participants in competitive electricity markets have been able to purchase a financial derivative called a Financial Transmission Right (FTR). FTRs are considered a fundamental component to efficient electricity market operation because they serve as a hedging device by both power producers and load-serving entities (LSEs). Yet, FTRs' existence has been underscored by multiple controversies. Among FTRs' controversies is this: they tend to sell at a price in the auction that is less than what the FTR ends up being worth. This is an important issue because

a University of Calgary.

b Corresponding author. Shanghai University of International Business & Economics. E-mail: xzhengsh@gmail.com.

c Corresponding author. Economist, Office of Energy Policy and Innovation, Federal Energy Regulatory Commission. E-mail: jopgrand@gmail.com.

d Department of Agricultural Economics, Purdue University. E-mail: preckel@purdue.edu.

e State Utility Forecasting Group, Purdue University. E-mail: gotham@purdue.edu.

f Department of Industrial Engineering, Purdue University. E-mail: andrewliu@purdue.edu.

the revenue raised in FTR auctions is passed through to electricity ratepayers, meaning lower auction prices translate to lower revenue pass-through to electricity ratepayers via their electricity bills.

Why do FTRs sell for a price less than their realized value? In our paper, we begin with the conceptual idea that financial speculators who trade FTRs demand, on the margin, a trading premium for purchasing a risky asset. The reason for the trading premium is a combination of a risk premium and the recovery of transaction costs associated with trading such a complex product. However, a trading premium demanded by FTR buyers alone is not enough to understand price formation in FTR auctions. For a comprehensive understanding of FTR auction price formation, we must also consider the supply side of the FTR auction market. In most U.S. competitive electricity markets, the supply side of FTR auctions is determined by something called the Auction Revenue Rights (ARR) process.

Our paper, entitled “Price Formation in Auctions for Financial Transmission Rights,” provides a conceptual framework for understanding the role of ARRs in determining equilibrium FTR auction prices. The paper includes an empirical study which explores whether variation in ARR management strategies across ARR paths helps explain differences between an FTR’s auction price and its realized value in the PJM Interconnection.

The main finding in our work is that as more FTRs are supplied to the auction through the ARR process, equilibrium auction prices decrease. This is an intuitive yet important finding given that decreasing auction prices directly harm electricity ratepayers. The policy implications of this paper include rethinking the ARR mechanism as a way to reimburse electricity ratepayers for the congestion rent they pay in the energy market.

## **Export Growth - Fuel Price nexus in Developing Countries: Real or False Concern?**

*Kangni Kpodar,<sup>a</sup> Stefania Fabrizio,<sup>b</sup> and Kodjovi Eklou<sup>c</sup>*

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In many developing countries, despite the current favorable environment of relatively low international oil prices and the debate on climate change, tight control on domestic fuel prices is still prevalent, often giving rise to large subsidies. A major bottleneck to fuel subsidy reform is that policymakers are concerned about the consequences on export-oriented sectors, which typically drive economic growth, bring in foreign exchanges and are potential large employers.

Against this backdrop, this paper investigates how a rise in domestic fuel prices affects export growth in a sample of 77 developing countries over the period 2000-2014, taking advantage of an original fuel price database compiled by Kpodar and Abdallah (2017). Our analysis focuses on three main questions: (i) does an increase in domestic fuel prices hamper a country’s export performance? (ii) is there any heterogeneity related to energy dependency and access to alternative source of energy? and (iii) does this effect vary with the temporal horizon?

We find that domestic gasoline or diesel price increases have a negative effect on real non-fuel export growth. But, while this negative impact is mild or non-significant for countries with a low energy dependency ratio, it becomes significant and sizeable for countries with high energy dependency ratios, arguably where energy inefficiencies are more pronounced. Further, the adverse effect of fuel price increases on exports declines with better access to electricity. Furthermore, in-

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a Corresponding author: International Monetary Fund and FERDI, 1900 Pennsylvania Ave NW, Washington, DC, 20431, USA. Email:kkpodar@imf.org

b International Monetary Fund, 1900 Pennsylvania Ave NW, Washington, DC, 20431, USA. Email: sfabrizio@imf.org

c International Monetary Fund, 1900 Pennsylvania Ave NW, Washington, DC, 20431, USA. Email: keklou@imf.org

investigating large fuel price shocks suggest that they do not necessarily have disproportionately large effects on export growth. Finally, in disentangling the short-run and medium to long-run impact, the findings suggest that the adverse effect of fuel price shocks on export growth is short-lived. It is mostly concentrated within the first two years after the shock and becomes weak and non-significant thereafter. Nevertheless, this could translate into a permanently lower level of exports unless the medium-term efficient gains from better allocation of resources materialize.

This paper tackles important gaps in the existing literature such as the scarce evidence on the energy prices-competitiveness link in developing countries, the lack of cross-country studies allowing to draw broad policy conclusions relevant for a large group of countries, and the limitations in existing studies which do not control for macroeconomic factors that matter for export dynamics, or do not explore how the energy prices-competitiveness link may change with the temporal horizon.

As for the policy implications, countries seeking to increase domestic fuel prices (whether it is in the context of a subsidy removal plan or it is driven by higher international oil prices) should consider, when appropriate, mitigating measures and structural reforms that focus on reducing energy inefficiencies and enhancing access to other sources of energy, which should help a long way in minimizing potential adverse consequences of higher fuel prices on exports. Access to credit is critical to enable firms to undertake the investments needed to switch to a more energy efficient technology. Fiscal space permitting, boosting infrastructure spending, including to support adequate and reliable access to electricity, would be beneficial to the productive sectors.

## **A Compound Real Option Approach for Determining the Optimal Investment Path for RPV-Storage Systems**

*Benjamin Hassi,<sup>a</sup> Tomas Reyes,<sup>\*</sup> and Enzo Sauma<sup>b,c</sup>*

Several countries are promoting renewable energy sources and discouraging fossil-fuel-based energy generation. On the one hand, these initiatives have resulted in a large integration of non-dispatchable energy sources, such as solar power, which, in turn, is demanding more flexibility in order to balance power supply and demand. On the other hand, the adoption of energy storage systems has expanded rapidly in recent years, mainly due to the observed decrease in the cost of batteries. In this context, the implementation of systems combining solar photovoltaic (PV) modules and batteries has significantly increased at the residential level.

The use of residential PV-Storage systems (RPV-Storage systems) may produce large economic and operational benefits to the owner. In addition, an increase in the RPV-Storage systems' penetration rate should translate into social and environmental benefits for the entire society. Unfortunately, the current methodologies to determine the optimal investment path for RPV-Storage systems do not consider some important real-world flexibilities that these projects offer.

This paper proposes a new method, called Compound Least Squares Monte Carlo (CLSM), to value both the flexibility of delaying the investments and the option of expanding the capacity of both PV modules and batteries during the evaluation horizon of a RPV-Storage system in a compounded way, considering the household can invest in different PV modules and battery capacities over a period of time and then add more PV modules and/or batteries.

a Department of Industrial and Systems Engineering, Pontificia Universidad Católica de Chile, Santiago, Chile.

b Department of Industrial and Systems Engineering and UC Energy Research Center, Pontificia Universidad Católica de Chile, Santiago, Chile.

c Corresponding author. Tel. +56 2 2354 4272. E-mail: esauma@ing.puc.cl

To show the applicability of the methodology, we implemented the model to analyze the economic viability and the optimal investment path of a RPV-Storage system in Chile. The household has the option to invest directly in multiple RPV-Storage combinations and remain in that state for the rest of the evaluation horizon, or she/he can make multiple investments, upscaling to states with higher solar power production or larger battery capacity.

The results show that the household should invest in a RPV-Storage system in 60% of possible future scenarios. Additionally, our results suggest that, on average, in 36% of future scenarios it is optimal to invest in two steps or more, taking advantage of the option to postpone part of the investment until more favorable future scenarios occur. And even more importantly, the analysis of the value of the compound flexibility shown in this work suggests that investors should use the proposed CLSM method in the economic valuation of multi-stage projects, otherwise they could make sub-optimal decisions.

## **Increasing or Diversifying Risk? Tail Correlations, Transmission Flows and Prices across Wind Power Areas**

*Johannes Mauritzen,<sup>a</sup> and Genaro Sucarrat<sup>b</sup>*

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Before wind power became a mature technology, generation tended to be built out in countries and regions that provided financial support, such as Denmark and Northern Germany in Europe and California in the United States. This often meant that wind power was geographically concentrated.

Wind power costs have come down dramatically in the previous decade, and onshore wind power is often competitive with traditional generation in many areas. This has meant that wind power capacity has been built up in many more locales, often in countries or regions adjacent to each other. Given available transmission capacity, such geographic dispersion can act as a form of diversification: Mitigating the risks that stem from wind power's intermittency. When there is less wind power in one place, power can be transferred from a neighboring area where the wind is blowing.

However, experience from other asset classes--both real and financial--have shown that risks that appear to be diversified away in normal times, may show strong correlations during extreme events. In the context of electricity markets with high penetrations of wind power, the risk that has been most explored is the systemic risk that may come from periods of low wind power generation leading to a shortfall of generation relative to load. Yet there is also a risk of too much wind generation. If wind is highly correlated across areas at high production times, then it could have the effect of driving down the price towards the short-run marginal cost of wind power--near zero. This price risk is born by wind power producers, but also owners of other generation assets that face lower-than-expected prices and more price volatility. There is also a risk born by the power system as a whole, as excess generation can lead to increased balancing costs and expensive curtailment. The extra uncertainty around prices and electricity market operations can lead to a higher cost of capital, with adverse effects on further investments.

In this article we study data from Denmark and Sweden: Two countries with large wind power penetrations, which are connected through both large physical transmission capacity as well as through the common Nordic electricity market. We use hourly data from 2016 and 2017 on wind

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a Corresponding author: Department of Economics, BI Norwegian Business School, Nydalsveien 37, N-0484 Oslo, Norway.

b Department of Economics, BI Norwegian Business School.

power production, electricity prices, transmission capacities and flows. We particularly focus on the eastern price area in Denmark, called DK2, consisting of the island of Zealand, where the Copenhagen metropolitan area is located. This price area lies between and has large transmission links to both the western Danish area, which contains large amounts of wind, and the southernmost Swedish price area, which also has a high penetration of wind power.

We first present some descriptive evidence that suggests that for much of the distribution of wind power generation, geographic dispersion of wind power can have a diversifying effect. Correlations between wind power production--even in adjacent areas--are relatively weak. However, a marked difference appears in the 90th decile of the distribution of wind power production. Wind power production at the highest deciles in a given price area are strongly correlated with wind power production in adjacent areas. This suggests that the pattern of power flow, congestion in the network, and marginal price effects may be substantially different in these tail periods compared to average marginal effects.

To more formally explore the patterns of wind power distribution on prices and flows, we develop a flexible but also simple and robust methodology: A dynamic decile group model. We decompose the price and flow variables that serve as our dependent variable into deterministic and stochastic components. Then, instead of estimating an average marginal effect of wind power, we allow the effect of wind to vary by decile of production.

Our modeling reveals wind power's nuanced effects on pricing and exchange on the electricity market. Wind produced in DK2 at low deciles tends to have little to no effect on prices. Instead, the main effect of wind power in this area is a linear effect on net exchange towards the Swedish price area, which in turn is connected to the flexible hydro power in the Swedish northern price areas. However, at the highest decile, when wind power is highly correlated across areas and there is a high probability of congestion in the transmission network, wind power tends to have an out-sized effect on prices.

In summary, this article contributes to the literature on investment and integration of wind power in power markets in several ways: 1.) We provide evidence for geographic diversification of wind power production at moderate levels of production in the areas of the Nordic market with the highest penetrations of wind power. 2.) We provide evidence that this diversifying effect fails to hold at the highest quantiles of production when wind power production becomes highly correlated across adjacent areas. 3.) We devise a novel econometric model that takes into account the dynamics and seasonality in the power market time series while allowing the effects of wind power to vary over the distribution of production. 4.) We add support to previous findings of a disproportionately stronger effect of wind power on prices at the highest quantiles of production and extend these findings to show that these results are highly dependent on the pattern of transmission and congestion in the system.

## **The Long Norwegian Boom: Dutch Disease After All?**

*Knut Anton Mork<sup>a</sup>*

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After oil was discovered on the Norwegian continental shelf in 1969 policy makers have made major efforts to avoid the Dutch disease. The research literature, based mainly on data through the end of the 20<sup>th</sup> century, has mostly found these efforts to be successful. Contrary to the typical Dutch-disease case, Norwegian manufacturing employment has not fallen much faster than that of

a Department of Economics, Norwegian University of Science and Technology (NTNU), Trondheim, Norway, knut.anton.mork@ntnu.no

neighboring countries, and manufacturing productivity has risen at least as fast as theirs. The tax system is sufficiently market friendly to maintain oil-company interest while enabling the government to collect the entire resource rent. These funds have been shunted into the Government Pension Fund Global (GPFG), and a fiscal rule strictly regulates their spending to amounts corresponding to the real financial return on the fund.

However, the experience since the turn of the century has uncovered important faults in the Norwegian success story. This paper looks at data from the Norwegian petroleum-investment boom of 2000 – 19. Mainly because of the effects of depletion, which raised the amount of investment needed for each barrel of oil developed, this boom took off *after* the peak of Norwegian oil and gas production. The boom radically raised oil companies' demand for goods and services. Furthermore, oil companies on the Norwegian shelf showed a strong preference for dealing with domestic suppliers despite the absence of import restrictions.

The resulting demand pressure hitting the non-oil (mainland) economy did not raise employment, which was full in the first place, but lifted product prices and wages compared to those of neighboring Sweden, counted in the same currency. The wage increase was not driven by superior productivity improvements and significantly exceeded the increase in Norwegian consumer prices over those in Sweden.

This increase in the Norwegian cost level not compensated by adjustment in nominal exchange rates was exactly the kind of real currency appreciation that is considered the main cause of Dutch disease. In particular, the combination of high wage levels and downward wage stickiness is likely to cause major adjustment problems once the boom ends. The oil-driven increase in private-sector earnings also means that part of the resource rent was diverted to the private sector. Rather than all of it going to the government, about half was diverted. Despite the impressive accumulation of funds in the Government Pension Fund Global, this means that the government's plans for rent management have been far from successful.

## **Climate Change and the Vulnerability of Germany's Power Sector to Heat and Drought**

*Alexander Golub,<sup>a</sup> Kristina Govorukha,<sup>b\*</sup> Philip Mayer,<sup>b</sup> and Dirk Rübhelke<sup>b</sup>*

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Being a main contributor to greenhouse gas emissions in the EU, the electricity sector itself is vulnerable to climate change. Consequently, the impacts of extreme weather events and the resilience of the energy sector have become the subject of regulatory initiatives and ongoing research. The summer of 2018 provided a preview of possible adverse developments, as it was characterized by an enduring heat wave accompanied by droughts in various regions throughout Europe that lasted until the end of autumn. During this period, France and Germany reported multiple cuts in nuclear and coal-based electricity generation.

This study aims to contribute to a better understanding of the potential effects of high temperatures and droughts on power systems, thereby improving the electricity sector's risk-preparedness. The findings highlight vulnerabilities in the operation of thermal generation capacities and identify assets that are subject to high risk. Our analysis is based on extensive meteorological and power market datasets covering temperature and drought data for the last 40 years, as well as power

a American University, Massachusetts Avenue 4400, NW Washington, DC 20016.

b Technische Universität Bergakademie Freiberg, Schloßplatz 1, 09599 Freiberg, Germany.

\* Corresponding author. E-mail: kristina.govorukha@vwl.tu-freiberg.de.

plant outages and locations. We present evidence of a higher frequency of power plant outages in the context of droughts and high temperatures.

Using real options analysis, we provide estimates of current economic damages as the risk-adjusted cost of outages. This allows us to assess the risk-adjusted economic costs of climate change for the German electricity sector for the current composition of the power system. Our results can be applied when assessing the need to renovate or decommission old capacities, considering the costs of renovation. The results of our analysis are essential for the further calibration and estimation of the economic damage functions for specific locations of thermal power plants, which are necessary to estimate the future economic costs from climate change.

The methodology proposed in the paper should help to navigate the transformation of the energy system based on a holistic approach to decarbonization and adaptation. Our analysis shows that an exclusive focus on cost-efficient decarbonization of power generation might result in an assets allocation that is in turn less resilient to the effects of climate change. Thus, when designing future system structures, decision makers should consider the possible effects of climate change on the system and not only the system's effects on climate change.

## Structural Transformation Options of the Saudi Economy under Constraint of Depressed World Oil Prices

*Salaheddine Soummane,<sup>a</sup> Frédéric Gherzi,<sup>b</sup> and Franck Lecocq<sup>c</sup>*

Economies depending on oil exports face a critical development issue as climate policy implementation would cause global oil demand and prices to decline. Our research aims to provide new insights about economic diversification options of the Kingdom of Saudi Arabia (KSA) in response to rapid global climate action inducing depressed oil price prospects. To do so, we extend the compact model of Soummane et al. (2019) into a multi-sectoral framework with explicit representation of the secondary distribution of income and the consecutive debt accumulation. We build structural change scenarios that reflect the KSA's Nationally Determined Contribution (NDC) to global climate action in addition to its overarching Vision 2030 economic orientation programme.

Our investigation maps two polar diversification strategies: *Continuity* of the expansion of energy-intensive industries (minerals, petrochemical, and cement), with extended public support in the form of low regulated energy prices; Alternatively, *Transformation* via a structural shift towards low-carbon activities, namely services (tourism and financial services) and manufacturing, which allows considering the gradual adjustment of domestic energy prices and complementary fiscal reforms. In both scenarios, structural change hangs on implicit sets of public policies that impulse export boosts.

Over its projection horizon to 2030, our numerical modelling associates the proactive diversification strategy of *Transformation* toward non-energy-intensive sectors and fiscal reforms with higher growth and lower unemployment than *Continuity* of expansion of energy-intensive in-

a Corresponding author. Centre International de Recherche sur l'Environnement et le Développement. CIRED, AgroParisTech, CIRAD, CNRS, EHESS, Ecole des Ponts ParisTech, Univ Paris-Saclay, UMR 8568, Nogent-sur-Marne, France. E-mail: salaheddine.soummane@kapsarc.org.

b Centre International de Recherche sur l'Environnement et le Développement. CIRED, AgroParisTech, CIRAD, CNRS, EHESS, Ecole des Ponts ParisTech, Univ Paris-Saclay, UMR 8568, Nogent-sur-Marne, France. E-mail: gherzi@centre-cired.fr

c Centre International de Recherche sur l'Environnement et le Développement. CIRED, AgroParisTech, CIRAD, CNRS, EHESS, Ecole des Ponts ParisTech, Univ Paris-Saclay, UMR 8568, Nogent-sur-Marne, France. E-mail: lecocq@centre-cired.fr.

dustries. By structural change and through reforms of energy prices, *Transformation* succeeds in containing domestic energy consumptions, whereas *Continuity* inflates them significantly beyond real economic growth. Besides, the energy-price increases of *Transformation* induce partial decarbonization of energy supply that leads to stabilization of Saudi CO<sub>2</sub> emissions, ending at a level largely below that of *Continuity* emissions. Lastly, through cuts in energy subsidies and gradual fiscal reforms, *Transformation* considerably improves public budget outlooks by restoring surpluses from 2025 on, and succeeds in maintaining a creditor position of the government net debt throughout the projection horizon. In this regard, *Continuity* proves a dead-end by failing to hedge against the IEA-projected 2025 downturn of the international price of oil associated with the global peak in oil demand under its Sustainable Development Scenario, thus inducing substantial public deficits and the consecutive accumulation of a net public debt ultimately challenging the sustainability of the *Continuity* oil-driven development model.

Our analysis informs current domestic debates with high policy relevance. Our findings demonstrate the potential economic, social, and environmental benefits to Saudi Arabia of a more diversified economy in the context of global climate action depressing the oil price.

## **Are Energy Endowed Countries Responsible for Conditional Convergence?**

*Matthew E. Oliver<sup>a</sup> and Gregory B. Upton, Jr.<sup>b</sup>*

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We present a simple yet compelling contrast in economic convergence (and non-convergence) patterns across two distinct samples of countries: those with and without significant fossil fuel (FF) resource endowments, which we consider to be plausibly exogenous.

Among countries with FF endowments, we find evidence of both absolute and conditional convergence in both GDP per capita and consumption per capita, as indicated by standard  $\beta$ - and  $\sigma$ -convergence tests. By contrast, we find little to no evidence of convergence among countries without FF endowments. This pattern—convergence among FF-endowed countries and nonconvergence among non-endowed countries—is robust to changes in the sample period and to controlling for potential ‘resource curse’ effects, and is consistent across measures of physical capital, human capital, and total factor productivity.

We discuss potential implications of our results for both economic development and decarbonization policies. As developed economies worldwide pursue policies to reduce demand for FFs in an effort to reduce their carbon footprints, developing economies with significant reserves in the ground might face lower global prices for these resources. Any reduction in the value of FF resources might negatively impact the ability of these countries to develop. On the other hand, lower prices may reduce the cost of development through channels such as electrification and access to transportation. Thus, the potential distributional and growth effects on the developing world of climate policies implemented by the developed world are complex and multi-faceted

a School of Economics, Georgia Institute of Technology. E-mail: [Matthew.oliver@econ.gatech.edu](mailto:Matthew.oliver@econ.gatech.edu).

b Corresponding author: Center for Energy Studies, Louisiana State University. E-mail: [Gupton3@lsu.edu](mailto:Gupton3@lsu.edu).



# **An Empirical Analysis of the Bid-ask Spread in the Continuous Intraday Trading of the German Power Market**

*Clara Balaridy<sup>a</sup>*

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Electricity can be traded in the short-term bilaterally or in a centralized market. The quality of a market may be measured by its liquidity: the ability to quickly buy or sell power for an amount of time. This information is crucial for a market participant in its choice to participate in the centralized market because illiquidity may be interpreted as an implicit transaction cost. In this paper, I examine the question of the liquidity of a continuous market for electricity: when is the liquidity maximum during a trading session and what are the main drivers or it?

In Germany, most of the short-term power trading (about 88% in 2015) is done the day before delivery during the day-ahead auction. The remaining volume is traded during a continuous based market – also called intraday continuous market, which occurs from after the day-ahead up to the delivery. The increase of renewable sources creates more uncertainty on the generation side which explained the increasing trend of the volume traded on the continuous market. This market is then an interesting case for a continuous market with increasing renewable generation, particularly in the context of the expansion of the continuous market in Europe thanks to the pan-European harmonization projects.

This research aims to bring the questions of the market microstructure literature to the power market literature. Both literatures are dense, but the microstructure one mainly focuses on traditional financial markets such as securities or stocks while the power market literature does not deal much with microstructure issues. This paper want to start to fill this gap using a unique dataset.

Using the complete order book of the German continuous power market, I measure the liquidity of the market using the bid-ask spread as a proxy. The bid-ask spread is the difference in price between the best seller offer and the best buyer offer. It can be interpreted as a premium in order to be immediately executed.

In a first part, I reconstitute the order book of the market and represent the behavior of the bid-ask spread and market depths over an average trading session. I find that the bid-ask spread has a “L-shape” along the trading session: at the beginning of it, the bid-ask spread is large due to the uncertainty away from the delivery. As the trading session progresses, the bid-ask spread decreases. Most of the liquidity of the market is concentrated during the last hours of the trading session. This result is in line with the fact that 80% of the trading occurs during the last 3 hours of the trading session. On average, the local bid-ask spread is of 3.5€/MWh.

In a second part, using a reduced-form equation, I express the bid-ask spread by its four main drivers: the risk, the adjustment needs, the activity and the competition on the market. I find that an increase of the market volatility (measured by the weighted price standard deviation) increases the bid-ask spread. When there is a need for adjustment due to a load, solar or wind forecast error, the bid-ask spread gets narrow. When there is more activity (measured by the load) or competition (measure by the Herfindahl Index), the bid-ask spread decreases.

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a Université Paris-Dauphine, PSL Research University, LEDa, [SDFi]. E-mail: clara.balaridy@gmail.com.

## How May National Culture Shape Public Policy? The Case of Energy Policy in China.

*Philip Andrews-Speed<sup>a</sup>*

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Many factors shape the development and implementation of public policy. These include political ideologies, the structures and systems of governance, state capacity, demographics, societal values and norms, and level of economic development. As a result, public policy has become an object of study in many disciplines, including political science, economics, public administration, law, sociology and anthropology. Nevertheless, a number of scholars have claimed that public policy analyses have generally failed to take into account societal culture adequately. Those studies that have focused on the role of culture have been directed more at the engagement of publics in the policy process than on the way the state formulates and implements policy.

This paper explores how aspects of national culture may play a role in shaping the way in which public policies are designed and implemented using the example of energy policy in China. The analysis follows two lines of reasoning. The first involves exploring the link between culture and cognition and highlights certain characteristics of traditional and contemporary East Asian and Chinese cognition. An individual's cognitive style determines how they perceive, analyze and solve problems. The societal context of an individual, including the prevailing culture, is one of several factors that plays an important role in shaping their cognitive processes. Neuroscience research shows that brains of individuals from different cultures operate in different ways, even to solve the same problem. Further, recent advances in genetics have revealed that such differences can be reflected in the genes. This would allow some shared cognitive features in a society to persist over long periods of time, as we see in China. Thus one should not be surprised if those analyzing and solving policy problems take quite different approaches in different cultural contexts.

The second line of reasoning lies in how a society's political and legal cultures may determine the nature of policy solutions and how they are implemented. Political culture shapes the manner in which political power is legitimized and exercised. This is closely related to legal culture which determines how the political elites and wider society perceive the role of law, and how the law and legal instruments may be used or not used to implement policy decision. One again, aspects of a society's political and legal cultures may have deep historical roots, as is the case in China.

China's energy policies over the last 40 years display a combination of pragmatism, incrementalism, internal contradiction and ambiguity. These features are consistent with evidence from experimental psychology and ancient history that the development of Chinese and East Asian cognitive styles over the past 2,000 or more years have taken a path distinct from Western civilizations with their Greek philosophical heritage. That is not to deny a significant degree of commonality between cognitive styles, not least due to historically recent interactions. Rather, differences do exist and may sometimes be expressed in the design of public policy.

China's imperial traditions of national governance date back thousands of years and only ended officially in 1911. However, the Chinese Communist Party (CCP) regime has adopted many of the attributes of the imperial political and legal cultures. It runs a highly centralized system of administration, in principle at least, with no formal constraints on its power. As was the case with past Emperors, the CCP's legitimacy derives from meeting the needs of the people such as energy supply. Following imperial practice, during the opening up of the economy in the 1980s and 1990s

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a Energy Studies Institute, National University of Singapore, Singapore 119620. E-mail: [esicpa@nus.edu.sg](mailto:esicpa@nus.edu.sg); [cpandrews-speed@hotmail.com](mailto:cpandrews-speed@hotmail.com)

the CCP released its tight hold over much of the economy but retained control of strategic industries, especially those that yielded rents. In the past it was salt, today it is energy. However, President Xi is reversing this trend by demanding Party loyalty from all enterprises, public and private. China's legal traditions are also thousands of years old. Despite significant reform over the last 40 years, the current legal system retains some features from the past. Notable in the energy sector is an almost complete absence of litigation concerning the failure of local governments or grid companies to promote renewable energy.

These lines of argument have a number of important implications for public policy in general and energy policy in particular. In the case of China, we should not expect substantial changes in the way the country is governed, especially in sectors like energy which are seen to be strategically important. Referring Oliver Williamson's three levels of institutions, not only will new rules that govern transactions be constrained by the wider institutional environment, but the institutional environment itself will be constrained by the prevailing culture. As a consequence, most change in Chinese public policy will be incremental and follow a path peculiar to the country and its culture.

Barring a major political or economic crisis, we should expect the governance of China's energy sector to show a high degree of continuity. The contradictions within policy statements between the importance of the public sector and the usefulness of markets will persist. State ownership will predominate. Whilst energy and carbon markets may develop gradually, they will be subject to significant distortions as well as to policy reversals by the central government as it seeks to regain control. Energy is too important to be subject to market forces and the central government and the Party will remain the final arbiter. The economic regulation of these emerging markets will lack independence. Command and control instruments will endure as the preferred tools for policy implementation and judicial processes will likely play only a minor role in curtailing the malpractices of local governments and state-owned enterprises.

The wider implications of this study is that culture plays a significant role in public policy in any country, sub-national jurisdiction or society, though the nature and potency of the constraints will vary depending on the specific history and culture. The significance of these observations is that they render even more challenging the task of transferring public policy models between countries with different cultures. A further inference is that the "China model" of energy and economic governance is not easily exportable to other countries. That is not to say that specific achievements such as the deployment of renewable energy are not replicable, but rather that the manner in which this was achieved has been peculiar to China. Likewise, each society with its own political, legal, intellectual and social culture will address public policy in its own way.