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WORD FROM THE DIRECTOR

EUROPEAN UNIVERSITY AT ST. PETERSBURG

Dear readers,

The year 2018 has been remarkable for the ENERPO Research Center for several reasons:

Firstly, we welcomed two new members to our team: Olga Teplova, affiliate researcher, and Vanille Dabal, intern. Olga Teplova holds a Bachelor of Science and a PhD in Economics from St. Petersburg State University of Economics and Finance (FINEC). She also holds a Master's degree in Economics and Organization of Enterprises from the economic faculty of the Warsaw University of Life Sciences that was supported by the Erasmus Mundus Scholarship. Vanille Dabal hails from France where she studies political sciences at Sciences Po. Additionally, she holds a Master's degree in International Relations form St. Petersburg State University (SPbU), and studied a semester at the American University in Washington, D.C.

Moreover, we successfully organized our Third Clean Energy Forum that is now becoming more and more important in St. Petersburg, getting attention from Moscow and other Russian regions as well as from abroad.

Lastly, we have enhanced our online presence with the ENERPO Facebook page 'Enerpo Research Center' and a specific website for the Clean Energy Forum http://enerpo.tilda.ws/cleanenergy2018. Follow us and stay tuned for our new projects in 2019!

Indeed the ENERPO Research Center has ambitious plans for 2019: to continue the dialogue on climate risks for municipalities, to share our expertise in Clean Energy policies and Green Finance best practices, to launch new initiatives around Smart Cities in Russia, and to enhance the local educational debate on climate change in St. Petersburg, including with international stakeholders. To do so, ENERPO is also releasing a brand new educational project in March 2019, titles 'The Month of Energy', in which we aim to give open lectures on hot energy and climate topics in the trendiest places of the city! I wish you an interesting read and hope that we will be seeing more students from EUSP publish their papers in this ENERPO Journal. With your support, we will be able to do even more, therefore please come with your ideas!

Yours sincerely,
Maxim Titov

Executive Director, ENERPO Research Center

CLEAN ENERGY FORUM 2018: ENERGY AND CLIMATE CHANGE: RISKS, STRATEGIES AND POSSIBILITIES

Vanille Dabal

Abstract

On November 29th 2018, the ENERPO Research Center at the European University at St. Petersburg held the Third International Forum on Clean Energy. The Forum aimed to create a dialogue about clean energy and climate change: risks, strategies and possibilities. This report presents the main statements from the conference's experts, who addressed Russia's energy future, the role of the business sector in the transition to clean energy sources and the question of climate change in the city of St. Petersburg.

Keywords: clean energy, energy mix, natural gas, oil, energy efficiency, climate change, SDG, Russia, energy policy, innovation, business, corporate strategy, CSR, St. Petersburg climate policy

The Third International Forum on Clean Energy was held by the ENERPO Research Center at the European University at Saint Petersburg on November 29th 2018. This year the forum gathered representatives of business, state, and non-commercial organizations, as well as from academia, in order to discuss the transition to clean energy. Themes covered during the sessions ranged from green financial tools and the Russian position regarding international environmental politics to corporate and state strategies concerning green energy, as well as the current climate risks for Russian cities.

This conference report presents the main statements and the key messages from the conference's experts, which are divided into three categories: Russia's energy future and the transition to clean energy sources, climate change in the city of St. Petersburg, and the role of the business sector in climate strategy planning.

This report is written under the Chatham House rules and therefore names are not disclosed. Should the reader need any additional information, please contact the ENERPO Research Center.

Vadim Volkov, Rector of the European University at St. Petersburg, during the Clean Energy Forum 2018. (Photo: @EUSP)

RUSSIA'S ENERGY FUTURE AND THE ENERGETIC TRANSITION

The concept of ʻenergy transitionʻ is a global trend: nowadays, many countries have taken initiatives to foster clean energy resources and renewables, encourage decarbonization and to compel change in consumer behavior. At the Clean Energy Forum, participants discussed Russia's incentives with regards to global climate policies and raised the question of whether the country could stand as an energy leader in the world in the short, medium and long term. Whether or not the non-ratification of the Paris agreement remains an issue, the wind of change is already blowing in the country since the government recently approved the socio-economic forecast for Russia until 2036, which includes low carbon development of economic activities.[1][2] Binding legislative and institutional measures are furthermore to be implemented to increase energy efficiency and the development of renewable energy sources. The question is how ambitious state regulation will be in order to cope with existing challenges and maximize opportunities.

Proof that the Clean Energy Forum has acquired notoriety since its first edition in 2015, this year the ENERPO Research Center was proud to welcome Alexey Kulapin, Director of the State Energy Policy Department (Ministry of Energy of

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1 Davydova, A., 2016. What's holding Russia back from ratifying the Paris climate agreement? The Conversation, [online] 27 September. Available at: <http://theconversation.com/whats-holding-russia-back-from-ratifying-the-paris-climate-agreement-64842>

2 Ministry of the Economic Development of the Russian Federation, 2018. Forecast of the socio-economic development of the Russian Federation for the period up to 2036. [In Russian] Available at: <http://economy.gov.ru/minec/about/structure/depMacro/201828113>

the Russian Federation), as a key speaker.[3] According to Kulapin, despite the country's availability of hydrocarbon resources and the 'green' energy balance, Russia is paying close attention to the development of renewable energy sources.[4] Indeed, the presence of environmental non-governmental organizations (NGOs), experts and state officials guaranteed a useful political debate in this first session.

The key messages and recommendations of the participants:

- There is a lack of understanding of climate change issues at the top and middle of Russian politics as well as a gap between decision makers and experts.
- The politicization of climate change in Russia is most likely to hinder the country's ambitions, as NGOs dealing with climate issues are subject to the constraints of Russian and international funding. Adding to that, strong lobbying from large businesses to maintain the status quo prevents an effective dialogue.
- The consequences of global decarbonization on the Russian economic and energy sectors are underestimated, as well as the benefits of international cooperation with regards to climate issues. This is why this is important to have an honest debate and trigger political change.
- Federal laws have to be designed in a way to create an integrated system for controlling greenhouse gas emissions in Russia. Only through effective regulation will the country be able to make its economy more efficient, sustainable, and resilient to the consequences of climate change; improve the competitiveness of its products in the global economy, ensure innovation; stimulate an energetic transition to low-carbon sources and reduce air pollution.

Alexey Kulapin, Director of the State Energy Policy Department (Ministry of Energy of the Russian Federation), speaking at the Clean Energy Forum 2018. (Photo: @EUSP)

3 Ministry of Energy of the Russian Federation, 2018. Alexey Kulapin participated in the "Clean Energy Forum. [In Russian] 29 November. Available at: <https://minenergo.gov.ru/node/13316?fbclid=IwAR09lLZC9kEK7geLFjQZl-fuE8SwnokEu7uiaQmyufE7t5Y_Zs7Aj0b8hceo>

4 In particular, he stressed that today the Russian fuel and energy balance meets the requirements of the 'low-carbon world': about half of the electricity generation comes from the cleanest 'traditional' energy source - gas, and another third comes from hydro, nuclear and solar power plants.

THE BUSINESS SECTOR: A PRACTICAL VIEW ON CLIMATE CHANGE?

Since the Paris Agreements were adopted in 2015, there has been a substantial increase in the level of corporate commitments to preventing and fighting climate change. Environmental actions undertaken within the framework of 'corporate social responsibility' (CSR) were the cornerstones of the Forum's second session. By exposing the corporate strategy of their companies, the participants proved that firms have a greater understanding of climate change and related opportunities than often assumed. Nowadays, numerous major corporations have demonstrated strong leadership by adapting their business model to cope with environmental issues. These developments do not exclusively concern the energy sector since companies from such sectors as construction, agribusiness, or minerals mining have also implemented a fair amount of projects to limit the impact of their production on the environment. Their purposes are clear: not only do they reduce their carbon footprint but also to achieve great savings by improving their energy efficiency, thus increasing profits and meeting reputational goals. To some extent, their engagement allows them to position themselves as a key actor in the ecological transition, as they can provide tools in the form of expertise, financial support, or partnerships with the public sector to trigger effective change.

The key messages and recommendations of the participants:

- Actors in the private sector need to understand what they would earn by raising their level of commitment to sustainable production and whether it is important to them. Important steps to be taken in this regard are risk and opportunity planning, long-term target setting, extending sustainability to the value chain, harnessing innovation and technology and maintaining good governance.
- Environmental management should be coupled with transparent effective reporting in order to minimize corruption, improve competitiveness, and create incentives to maintain sustainability efforts. Companies should embrace the motto that a better environmental management brings less environmental risks and thus a better consumer demand and access to financial resources (thanks to additional profits that can be made from a specific demand unreached before).
- Ratings on the ecological responsibility of large Russian companies (especially in the oil and gas sector) can, on the long-term, constitute an instrument of cooperation between the business sector and society in order to achieve environmental goals. In this regard, the involvement of NGOs in sustainability reporting would be beneficial to ensure transparency and legitimacy.
- The role of that new technologies will play in carrying out innovative projects is critical. What is more, sectors such as transportation will be the first to undergo a technological revolution, which will change the way

cities work. Cities are the key client of the 'revolution of the future', thus companies in the oil and gas sector should carefully follow developments with regards to mobility and infrastructure.

CLIMATE CHANGE AND THE CITY OF ST.PETERSBURG

One of the conference's key themes this year was climate change and its consequences in the city of St. Petersburg. Amongst the participants, the local authorities of St. Petersburg were present to raise the issue of climate change for the development of the city. Indeed, between the 1970s and now Indeed, between the 1970s and now, temperatures in Russia have risen 2.5 times more than globally. As a matter of fact, it is generally agreed upon that due to its position and lay-out, climate change will critically affect citizens' future prospects and will tremendously increase natural hazards in the city of St. Petersburg. As a result, long-term repercussions in the sectors of transportation, engineering, urban planning, and human health are expected to be significant. Adaptive measures to reduce CO2 emissions have already been undertaken, such as the reconstruction, replacement and reorganization of heating systems in some areas of the city, replacing coal or oil with natural gas for heating. However, more concrete action is needed especially in terms of environmentally sustainable city planning, in order to maintain existing efforts, safeguard the climate and protect the city and its inhabitants.

The key messages and recommendations of the participants:

- There should be initiatives to raise the level of awareness amongst the population and decision makers with regards to climate change-related risks by improving existing regulations and public administration actions as well as by considering climatic factors in future city planning and socio-economic policies.
- A climate strategy for the city should be created with the general objectives to create conditions for improvement; assess and mobilize the city's potential to act against climate change; design actionable mitigation measures; and to prevent risks for the urban sector, ecosystems and public health.
- Russia should also look at developing a strategy at the local and regional level, consistent with the available resources, coupled with a model of risk management.
- Simple actions can be undertaken to meet current goals, such as more environmental education on climate change and its effects, and the implementation of functional interaction at the policy-making level.

As a result of the discussions, the Forum participants concluded that a timely and well-thought-out transition from traditional fuels to clean energy represents a key mission for states and society on the way to sustainable development. The first session gathered a variety of stakeholders that focused on the political debate concerning Russia's climate strategy, while during the second session very practical actions with regards to climate change were addressed. The difference of the discourse was striking, and it appeared that the business sphere has indeed a better understanding and strategy concerning environmental issues than the public sector. More specifically, concrete actions exist and are already efficiently being carried out at lower levels.

Overall, the two sessions underlined that gatherings such as the Forum remain necessary to facilitate a dialogues at and between all levels and sectors, to highlight existing actions and to exchange best practices and provide good examples, and finally to understand how to mobilize all the actors towards the question of climate change. In this regard, we believe that one of the main tasks of the ENERPO center is to trigger dialogue in order to improve decision-making mechanisms in regards to the energy transition.

Vanille Dabal

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COP 24, KATOWICE 2018, UNITED NATIONS CLIMATE CHANGE CONFERENCE

Maxim Titov

Abstract

The 24th Conference of Parties of the United Nations Framework Convention on Climate Change (COP 24) took place in Katowice, Poland, in December 2018. Maxim Titov, the Executive Director of the ENERPO Research Center, was one of the many high-level attendees of the conference. For the ENERPO Journal, he shares his experience and takeaways from the conference.

Keywords: COP24, Katowice, Paris Climate Agreement, INDCs, Russia's climate policy

As an attendee of the COP24, I am happy to share my impressions following the conference that I attended thanks to the kind invitation from the organizers of the Russian Pavilion. This year, the Russian Pavilion was organized with the support of the Ministry of Natural Resources and Environment of the Russian Federation and the Climate Partnership of Russia. It was my second UN climate conference: a year before I took part in the COP 23 held in Bonn, Germany, therefore I had the chance to compare both events.

Large Russian businesses, together with climate scientists, NGOs, environmental foundations and government organizations, were well presented at the Russian Pavilion in Katowice. The two-week agenda of the Russian Pavilion was devoted to different specific topics such as The Forest Day of Russia (December 4th), Russian climate science (December 5th) and the Day of Low Carbon Materials and Technologies (Dec 11th). Notably, Ruslan Edelgeriev, the Adviser to the President of the Russian Federation and the Special Envoy for Climate, opened the December 12th session on 'Russian State Energy Policy in the Context of Sustainable Development', where he confirmed the high level of commitment of the Russian Government to implement the Paris Climate Agreement.

In the past, Russia has expressed a strong commitment to address climate change threats at the COP 21 in Paris. However, while attending a special climate event at the UN General Assembly in 2016, Alexander Bedritsky, the then Special Adviser on Climate Issues to the President, claimed that: "Russia will not artificially speed up the ratification process of the Paris Agreements." Russian officials justified that the country needed more time to evaluate the effects of a commitment to the Paris Agreements on the economy. Indeed, the Government wanted to draft a low-carbon development strategy before the decision on ratification would take place. As a matter of fact, the climate debate is still ongoing within the country. The main opposition to more commitments towards climate change comes from large private business, mostly from the coal and steel sectors, which fear that a quick ratification and the introduction of carbon prices would result in negative social and economic consequences, such as unemployment in the coal mining regions.

As for the energy sector, large oil and gas producers in Russia just avoid to openly support or object to the Paris climate agreement. Some senior officials at the Federal Government level support and pronounce themselves in favor of ratification. The 'pro-climate' position is heavily supported by NGOs as well as some businesses. There is, in particular, a consensus-like opinion that Russia has to sustain efforts to address the country's energy inefficiency – as a major step towards securing greenhouse gas emissions reductions.

It is important for the fifth's largest emitter of the world to ratify the Paris agreement together with other big emitters. Russia would in this way secure a right to vote and take decisions during the new round of international climate negotiations at the COP 25, to be held in Chile in 2019. But most importantly, by showing its readiness to fight environmental challenges, Russia will confirm its role as a global player and improve its relations with the West. Now at COP 24, Edelgeriev's words seemed to confirm this idea, making the Russian Pavilion an important addition to the event.

To put this debate in perspective, it is important to consider that according to the latest climate reports, Russia is facing increasingly stronger climate change impacts such as deadly storms in Moscow and river flooding in the South. Indeed, over 10 million people in Russia are under immediate climate-related risks, and there is thus a strong need for climate adaptation strategies such as better early warning systems and more modernized infrastructure. The negative effects of climate change are already costing the country 30 to 60 billion rubles ($530 million to $1 billion) yearly. Overall, awareness is growing that we have to ensure a sustainable future for the generations to come and need solutions to help businesses and homeowners in order for them to manage our precious resources in a more sustainable way.

Resource-intensive manufacturing sectors like cement and heavy machinery production are facing a need for process improvements and equipment upgrades that save energy and water. Small businesses, like bakeries and furniture companies, also have to invest in modernized machinery to cut fuel use and increase output. Buildings account for almost half of global energy usage, therefore homeowners and property managers have to find solutions as of how to lower utility bills through energy-efficient renovations.

Presently, banks and leasing companies are starting to finance technological modernization, especially in the energy and resource efficiency sectors by investing in small hydro, wind, and solar solutions. In fact, managing the impact of climate change and reducing its damage will require an urgent and coordinated effort from both the public and private sector, and particularly from financial institutions.

In addition to discussing the aforementioned developments and devoting considerable attention to the concept of sustainable development and climate change issues at large, a critical sector was way better represented at this COP than at any previous editions: education. In fact, the Russian Pavilion at the COP 24 put a strong emphasis on the role of education in sustainable and low carbon economic development. For instance, on Thursday December 13th, the Education Day agenda was devoted to different innovative learning programs and initiatives and my colleagues and I were proud to be invited to represent the European University during the morning session on 'Education for Sustainable Development'.

Dr. Nikita Lomagin, Academic Director of the ENERPO Program, presented EUSP's approach in how it engages in the sustainability dialogue through the ENERPO MA and its students. He described the structure of the Program that was initially built around oil and gas geopolitics, but that has undergone significant changes over the past few years, as more information and business cases on sustainable energy and the climate aspect of energy politics were added to the curriculum.

As for me, I presented on the ENERPO Research Center and its focus on clean energy, green finance and sustainable development. In addition, I explained the need for municipal and government officials to receive vocational training on climate change and sustainable development; this would help them to prepare climate adaptation and mitigation strategies in order to cope with the negative consequences of climate change, something that is becoming increasingly urgent in Russian cities.

Another colleague from EUSP, Professor Olga Bychkova, Head of the Center for Science and Technology Studies, presented our educational project on the 'Russian Arctic: People and Infrastructure'. This complex project has received support from the Russian Presidential Foundation in the form of a grant, which has allowed us to study the peoples and infrastructure of the Russian Arctic Zone and create a learning platform for schoolchildren and their teachers. The main goal of the Arctic project is to address the existing stereotypes by providing more information about the real life in the Arctic, whilst raising awareness on the importance as well as the vulnerability of the region.

Finally, at the end of the session, our moderator Angelina Davydova, an environmental journalist, Director of the Office of Environmental Information and a Hubert H. Humphrey Fellow, shared her experience of designing training programs for the media to address the question of how to inform and write about climate change and environment. According to Davydova, environmental subjects are often complicated for Russian media, and that despite growing interest in the topic, there are few journalists with a proper understanding of the specifics of climate issues and environmental sustainability. In example, managers of large media have thus far shown reluctance to publish comprehensive materials that may have a lot of technical details about the climate or air pollution. In order to get more engagement from the media sphere on these issues, there is a need to connect the environmental stakes and risks to economics, and also to highlight the negative material consequences for people and infrastructure. Only through such methods will there be a greater chance to be published and engage effectively with the audience. The training program helps journalists to identify such information first-hand and compose high quality informative materials in order to establish more engagement as quickly as possible.

Maxim Titov

Executive Director of the ENERPO Research Center. Maxim is a climate finance professional with 12 years of experience managing projects at the International Finance Corporation (World Bank Group) in Eastern Europe, Central Asia, the Middle East and North Africa. He has a successful track record designing climate finance programs for financial institutions, trainings for bankers, effective advocacy and public policy, marketing and communication campaigns. Most recently, Maxim served as Project Manager to undertake a market assessment of the clean energy sector in Jordan with the Global Green Growth Institute.

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OIL SUPPLY SHOCK: A SYSTEMIC ANALYSIS

Simone Cameli

Abstract

In 1973, the OPEC countries' decision to drastically cut oil production resulted in a true apocalypse for Western Countries. Can history repeat itself? What would happen if, today, OPEC Countries suddenly stopped oil production? In order to know this, we constructed a quantitative model of the world oil market. To overcome the limitations of mainstream macroeconomic models in capturing the true complexity of modern oil market, we used a Systems Dynamics approach, modeling a complex system characterized by non-linear relationships among variables and thus by an emergent behavior. After simulating a scenario of high stress on the model, we concluded that the effects of an oil supply shock nowadays would completely differ from 1973. The reason for this different behavior can be found in three main factors: the important structural change in world oil market, the reconfiguration of Western countries' energy mixes, and the implementation of ad hoc policies, both at the national and at the international level.

Key words: Renewable energy sources, distributed generation, Russian Arctic

The 1973 "oil shock" was an event that undoubtedly changed the course of history, showing for the first time the hidden menaces of energy interdependence and exposing in a dramatic way the vulnerability of energy systems. The main question the present study tries to answer is: "Could history repeat itself?" In other words, could there be another oil shock analogous to 1973 on day? What if exactly the same conditions that caused the 1973 Oil Shock would merge again? Could we expect the same dramatic consequences or something completely different? This article will start by providing a brief excursus over the First Oil Shock, in order to understand its dynamics, as well as its importance and magnitude. Then, we will expose the methodology underlying the systemic model we built in order to simulate the modern-days world oil market. After that, we will show the results of our study, i.e. what happens, according to the model, in the case of a sudden oil supply shock. Finally, we will discuss and interpret these results.

HISTORICAL EXCURSUS: THE 1973 OIL SHOCK

The First Oil Shock is usually regarded as a reaction triggered by the American decision to support Israel during the Yom Kippur War. On October 6, 1973, Egypt and Syria suddenly attacked Israel with the hope to avenge their defeat during the Six Days War.[1] When the US decided to intervene in the conflict in support of Israel, some Arab countries retaliated by using the 'oil weapon'. In fact, immediately after the American intervention, six oil exporting countries – Iran, Saudi Arabia, Iraq, Kuwait, United Arab Emirates and Qatar (all members of the Organization of the Petroleum Exporting Countries (OPEC) – unilaterally decided to set the official price of oil at $5,11 per barrel. The day after this decision was taken, the Organization of Arab Petroleum Exporting Countries (an independent organization from OPEC, which however shares the majority of its members with OPEC itself) cut production by 5% and established at the same time a 'selective embargo' directed at those countries that were actively helping Israel. Finally, in December 1973, the whole OPEC set the benchmark price for oil at $11,65 per barrel.

To better understand the First Oil Shock, however, we should overcome the above-mentioned, simplistic cause-effect dynamics. Indeed, we should regard it as the culmination of a broader, long-term process of social, economical and political shift taking place within the oil-rich countries. Albeit formally the colonial system had collapsed, the main Western oil companies, the so-called 'Seven Sisters', kept exploiting post-colonial countries' oil resources thanks to virtually eternal concessions, and, furthermore, had formed a powerful cartel able to keep oil prices low.[2] From the 1950s onwards, however, oil-rich countries started to question the long-term concessions structure of the oil industry, advocating instead a right to sovereignty on natural resources for the states in which they were located.[3] Founded in Baghdad in 1960, OPEC was the practical transposition of this idea: in fact, it was aimed at counterbalancing the monopsony constituted by the 'Seven Sisters' with a monopoly made of the oil-richest countries in the world (initially Iran, Iraq, Kuwait, Saudi Arabia and Venezuela). As a result, gradually, oil-exporting states started to acquire more and more power in terms of having a price-setting mechanism. This process accelerated in the 70s; between 1970 and the First Oil Shock's eve, the oil price had moved from $1,80 to $3,07 per

1 Gawyrich, G.W., 1996. The 1973 Arab-Israeli War: the Albatross of Decisive Victory. Fort Leavenworth: Combat Studies Institute, US Army Command and General Staff College.

2 Sampson, A. 1975. The Seven Sisters: the Great Oil Companies & the World They Shaped. New York: Viking Press.

3 Garavini, G., 2015. From Boumedienomics to Reaganomics: Algeria, OPEC, and the international struggle for economic equality. Humanity: An International Journal of Human Rights, Humanitarianism, and Development, 6(1), pp. 79-92; Dietrich, C.R.W., 2016. 'First Class Brouhaha': Henry Kissinger and Oil Power in the 70s. In: Bini, E., Garavini, G. and Romero, F., ed. Oil Shock: The 1973 Crisis and Its Economic Legacy. London: Tauris. pp. 37-56.

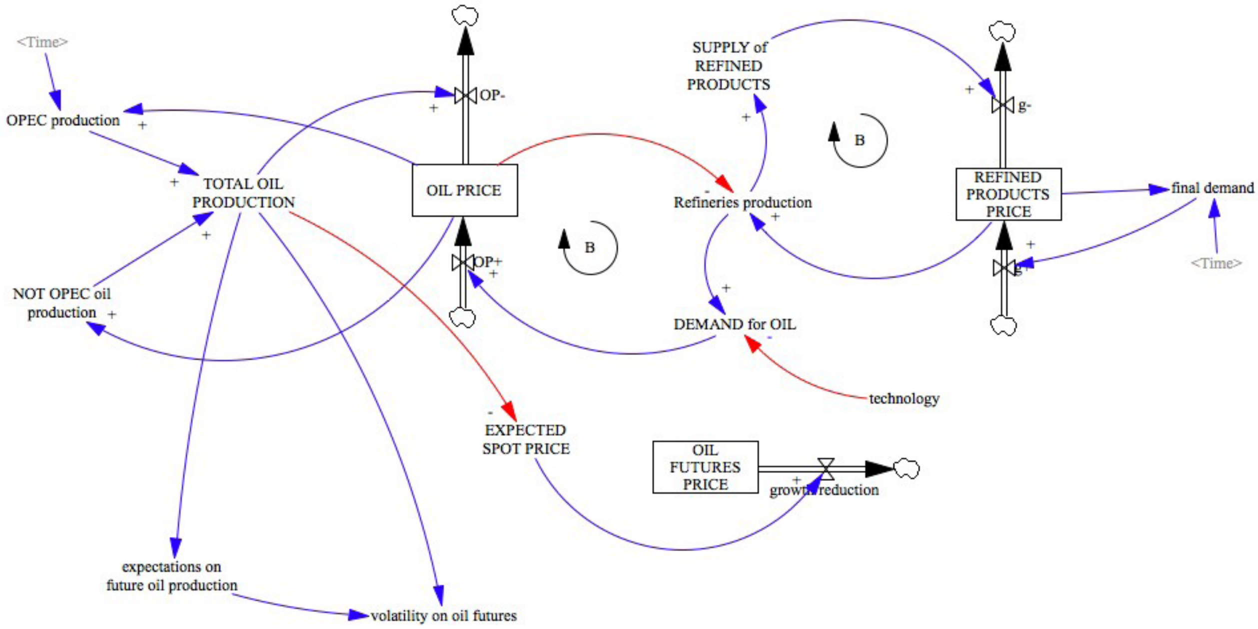

Figure 1: the systemic model of oil market.
Source: author's elaboration using the Vensim software.

barrel.[4] In this perspective, thus, the American decision to help Israel during the Yom Kippur War should not be seen as the sole trigger, but more as the so-called straw that broke the camel's back. OPEC's decision to unilaterally set the benchmark price marked a pivotal point for oil market's history, demonstrating that OPEC had the effective power to control oil prices. The 'age of the Seven Sisters' had come to a sudden end, and the 'age of OPEC' had started.[5]

From October 1973 to February 1974, in just four months, the oil price increased four-fold. The impact on Western economies was devastating. As Leonardo Maugeri points out in his book 'The Age of Oil':

"Given oil's centrality to industrial economies, this revolution helped bring the curtain down on the most extraordinary period of development ever registered by the advanced countries, opening the door to a severe stagflation that hit the non-oil-rich developing countries as well. [...] the endless lines of cars at undersupplied gas stations in the United States, and the various programs intended to limit the use of cars, central heating, and lighting in Europe and Japan shaped the collective psychology of the people of the industrial countries, threatening their already precarious belief in an even-better future that now appeared to be at the mercy of a group of countries they knew almost nothing about."[6]

This dramatic event put Western economies in need to overcome the binary, 'chess-like' strategic mentality of the Cold War to face a more subtle form of confrontation, facing a radically new weapon taking its tremendous power not from brute force but rather from that net of economic relations encompassing the whole world. Indeed, the main lesson we can draw from the First Oil Shock is that the developing of long-distance, mutually- interacting relationships – i.e., a growing degree of systemic complexity, presented radically new challenges that our traditional paradigms were not able to address.

METHODOLOGY

Today the world is far more interconnected, and thus far more complex, than it was in the

1970s. The main differences between today's oil market and that of 1973 can be ascribed to two main categories: dimensions and structure. Since the early 1970s, the oil market has grown at a spectacular rate: the world oil demand was approximately 55 million barrels per day in 1973, while today it is almost 95 million barrels per day.[7] At the same time, the market today is way more competitive than it was in the 1970s. Indeed, although OPEC still retains an important share of world oil production, it now has to face prominent competitors such as Russia, the United States and a handful of European producers.[8] What is far more important, however, is that the very structure of the market has been significantly altered in comparison to the 1970s, specifically when we look at the commoditization of oil and the

4 *Garavini, G., 2015. From Boumedienomics to Reaganomics: Algeria, OPEC, and the international struggle for economic equality.*

5 *Fattouh, B. and Sen, A., 2016. The Past, Present, and Future Role of OPEC. In: Van de Graaf, T., Sovacool, B.K., Ghosh, A., Kern, F. and Klare, M.T., ed. 2016. The Palgrave Handbook of International Political Economy of Energy. London: Palgrave MacMillan. pp. 73-94.*

6 *Maugeri, L., 2006. The Age of Oil: The Mythology, History, and Future of the World's Most Controversial Resource. Westport: Praeger.*

7 *OPEC, 2017. OPEC Annual Statistic Bulletin. [pdf] Available at: <https://www.opec.org/opec_web/static_files_project/media/downloads/publications/ASB2017_13062017.pdf> [Accessed 3 February 2019].*

8 *OPEC, 2017. OPEC Annual Statistic Bulletin.*

emergence of a financial market for oil-backed derivatives.[9]

Therefore, in order to model the impact of a sudden decrease in OPEC oil production, the author has constructed a systemic model of the world oil market (Figure 1). The quantitative methodology adopted was firstly proposed in the 60s by the seminal works of Jay Forrester and developed greatly in the last decades, resulting in a field known as Systems Dynamics.[10] We believe this method to have more explicative power than traditional macroeconomic models. Instead of using deterministic, general equilibrium models, we build this simple, abstract systemic model by identifying the main variables in the market and connecting them in a net of relationships able to capture to a closer detail the interdependence of the system's actors. The solutions for the non-linear equations involved have been calculated by Vensim software, simulating the global, 'emergent' behavior of the system. The model is structured in three main, mutually interacting sub-systems: the physical oil market, the refined oil products market and the financial market (i.e. the so-called 'paper oil market').

The physical oil market is the global market in which oil is physically exchanged. The physical oil market described in the model is the abstract representation of the functioning of a global commodity market such as the New York Mercantile Exchange or the InterContinental Exchange. In these markets, the price of oil is established by global demand and global supply. In his 1991 book 'The Prize', Daniel Yergin perfectly described it:

"Once it had been Standard Oil that had set the price. Then it had been the Texas Railroad Commission system in the United States and the majors in the rest of the world. Then it was OPEC. Now price was being established, every day, instantaneously, on the open market, in the interaction of the floor traders on the Nymex with buyers and sellers glued to computer screens all over the world."[11]

An increase in global demand will drive the price up, while a decrease in global demand is likely to reduce prices. Insofar, we suppose a positive relationship between demand and price. At the same time, demand itself is influenced by the price. The higher the price, the lower the demand, while the lower the price, the higher the demand. The combination of the positive relationship between demand and price with the negative relationship between price and demand generates a balancing feedback loop. On the other hand, we postulate a negative relationship between supply and price (since an excess of supply reduces prices) and a positive relationship between price and supply (the more the price increases, the more manufacturers are willing to produce). So we have another balancing feedback loop.

These two loops (demand and supply) work together to move the price up or down in order to reach equilibrium. More specifically, the global supply of oil is constituted by the world total production of oil. For this study's purposes, the world total production is simply the algebraic sum of OPEC's and not-OPEC countries' production whilst demand is given by the need of the refinery industries.

The refined oil market is the local, national market of oil-derivate products, such as gasoline, distillate fuels, hydrocarbon gas liquids, etc. The focus here is on the price of oil-derivate products. This price is the equilibrium status resulting from the interaction of the demand and supply feedback loops. Demand is represented by the final demand of petrochemicals. It exhibits a certain degree of seasonality and it is inelastic in the short-term.

Analytically, to model these assumptions we used a time-dependent cosine function whose height is loosely dependent on price, meaning that even a huge change in refined oil products' price will impact demand to an almost-negligible extent. Supply is constituted by the output of the refineries. It is interesting to note that refineries are part both of the demand loop of the physical oil market and of the supply loop of the final products market. Therefore, they are simultaneously positively influenced by the petrochemicals price and negatively influenced by oil prices. This layout is the quantitative translation of the qualitative description provided by Salvatore Carollo in his work 'Understanding Oil Prices': "Refineries are the linkage between the two markets. Through the refining system the alignment or divergence of the two markets takes place."[12]

Finally, we have the financial oil market. The establishment of a global market for oil led also, starting from the 1980s, to the gradual development of a range of financial derivatives.[13] This market grew at a spectacular rate, ultimately detaching completely from its material underlying asset. For example, during 2008-2010, the magnitude of oil futures market was 27 times the value of physical oil market.[14]

Again, for simplicity's sake, we restricted the enormous range of oil-backed financial derivatives to focus only on futures. Futures are basically agreements to buy or sell a certain quantity of a determined commodity whose physical delivery will take place in the future.[15] At the beginning, this type of contract was developed by sellers and buyers in order to protect themselves against the fluctuations in the oil price. Ultimately, however, futures proved to be a powerful speculative tool, and the vast majority of transactions nowadays are driven by speculation on the expected price, rather than being aimed at mere protection of investment. It is clear that expectations play a crucial role in the fu-

9 Goldthau A. and Witte J.M., (2010), Global Energy Governance: The New Rules of the Game, Brookings Institution Press, Washington DC; Carollo, S., 2012. Understanding Oil Prices. Chichester: Wiley.

10 Forrester, J., 1961. Industrial Dynamics. Cambridge: MIT Press; Pruyt, E., 2013. Small System Dynamics Models for Big Issues: Triple Jump towards Real-World Complexity. Delft: TU Delft Library.

11 Yergin, D., 1991. The Prize: The Epic Quest for Oil, Money & Power. New York: Free Press.

12 Carollo, S., 2012. Understanding Oil Prices.

13 Parra, F.R., 2004. Oil Politics: A Modern History of Petroleum. London: Tauris.

14 Carollo, S., 2012.

15 Law, J. and Smullen, J., 2008. Oxford Dictionary of Finance and Banking, Oxford: Oxford University Press.

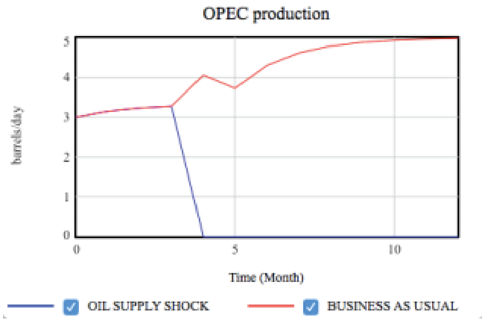

Figure 2: OPEC production

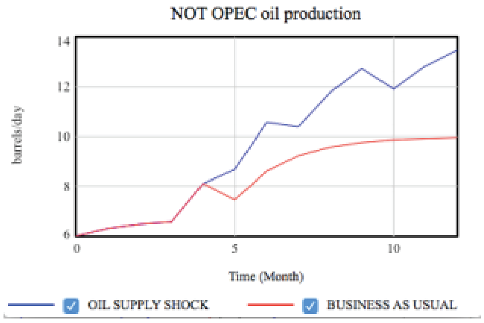

Figure 3: not-OPEC oil production

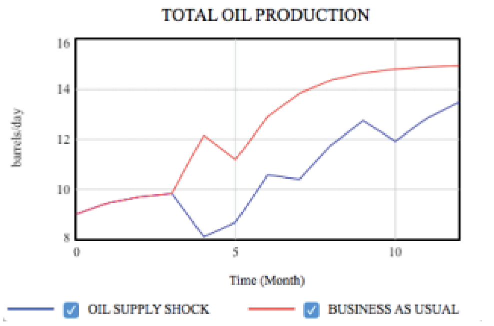

Figure 4: total oil production

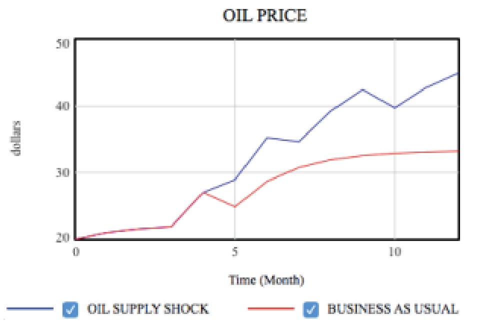

Figure 5: oil price

tures market. If the market expects an increase in oil prices, oil futures price will rise. On the other hand, an expected decrease in price will lead to a drop in futures prices. The idea that futures prices constitute a truthful proxy of market expectations has several limitations, but it constitutes a widely used approach and, for this study's purposes, its degree of trustworthiness is acceptable.[16]

Oil production is usually assumed to be the main driver of oil prices, and coherently all information about it is likely to have a big impact on the financial expectations about future oil prices. Thus, we postulate a negative relationship between oil production and expectations: after the announcement of an increase in production, market actors would probably expect that the price of oil will be lower tomorrow than today due to an increase in supply, and vice versa. Given the above-mentioned relationship between expectations about oil and oil futures price, this will move the futures price accordingly.

To provide a more significant analysis of the "paper oil" market, we also tried to estimate the levels of volatility of oil futures. So, we added to the model the variable 'expectations of future oil production', simply defined as the total oil production in the future. This layout is meant to reflect the common expectations formation process in the financial market.
Usually, expectations about future oil production are made starting from the historical series and extending it forward. Since modeling this would have been too complex for the scope of this paper, we assumed that market operators simply expect the near future to be similar to the present. This has the same effect of adding a delay in the expectations: market actors need time to adjust their expectations to a sudden change in production. We furthermore assume that the volatility on the futures market depends on a biased matching between expectations and actual production. To put this in other words, volatility is higher when production behaves in a way unpredicted by market operators. Accordingly, in the model, volatility is defined as the absolute value of the difference between expectations and actual production: the wider the gap, the more volatile the market is in the short term.

RESULTS

In order to simulate the effects of a huge oil supply shock on the model, we supposed, for simplicity's sake, that at time 4 OPEC's oil production simply goes to 0, and this level of production is maintained for that time on (Figure 2).

Figures 2, 3, 4 and 5 show the behavior of physical oil market variables. The red trend depicts the business-as-usual scenario, in which no supply shock takes place. The blue trend, on the contrary, shows the distortions caused by a sudden and radical decrease in OPEC's production.

As forecasted by traditional economic analysis, a dramatic reduction in total supply (Figure 4) provokes a sustained increase in oil price (Figure 5). Given that the oil supply shock takes place at time 4, in just three months the price

16 *Baumeister, C. and Kilian, L., 2014. What does the market think? A general approach to inferring market expectations from futures prices. [pdf] Available at: < https://www.tse-fr.eu/sites/default/files/TSE/documents/sem2016/EEE/kilian.pdf> [Accessed 3 February 2019].*

skyrockets from approximately $28 to $35 per barrel on a stable path of growth towards a new equilibrium which is substantially higher than the one of the business-as-usual scenario.

The spectacular rise in oil prices causes an increase in oil production from not-OPEC oil- producing countries (Figure 3). These countries try to profit from the hike in oil prices by increasing production, and the consequent growth in total oil supply has the effect of gradually smoothing the increase in price, which in the long term reaches its new equilibrium.

by mainstream economic models. Indeed, the relationship between oil prices and petrochemicals prices is linear only in specific cases. In other cases, issues that are solely pertinent to the oil refining industry (such as maximum capability, logistical or technologic factors) can greatly influence production decisions, therefore determining a behavior for refined products market that can differ completely from that which drives the oil market.[18]

Taking these constraints into account, we made two assumptions about the refining system: firstly, production

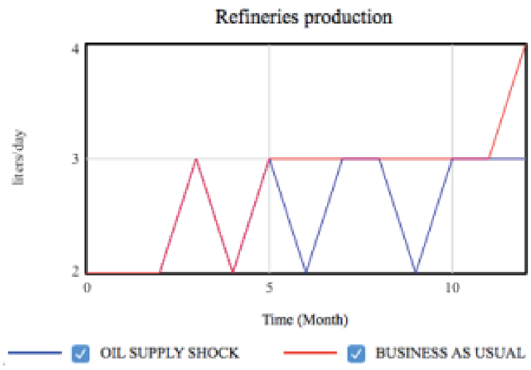

Figure 6: Refineries production

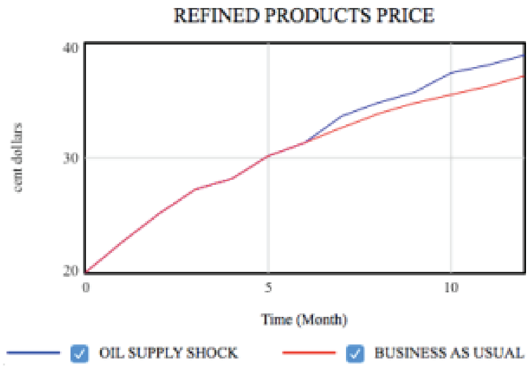

Figure 7: price of petrochemicals

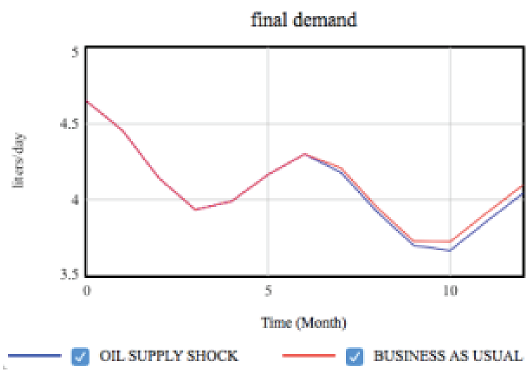

Figure 8: final demand

Figure 6, 7 and 8 show the trends in refineries production, the price of petrochemicals and the final demand according to the model. Their behavior vis-à-vis the oil price hike allows us to explore the diffusion of the shock originated in the physical global oil market to the oil derivate products. Here the analysis differs significantly with respect to common macroeconomic interpretation, in which the oil price is assumed to directly influence the aggregate supply function by increasing the mark-up.

The refining system is the key to understanding oil market behavior: oil prices do not have a straightforward influence on aggregate supply, for the simple reason that oil is useless if not refined.[17] This layout has more explicative power since it overcomes the deterministic chain suggested

decisions are taken at the beginning of every month, and, secondly, refineries can produce only integer quantities of output. These assumptions are meant to reflect the fact that refineries' production level is not fluid and flexible, but discrete and rigid instead. Indeed, refineries are committed to the production level they have chosen at the beginning of the month, and therefore they are not able to change the level of output day-by-day. Furthermore, the 'quantized production function', which allows only integer levels of output, is a consequence of the fact that refineries have capacity constraints, efficiency concerns and logistical limitations that significantly reduce their freedom in the choice of production level.

17 *Carollo, S., 2012.*

18 *Bernanke, B.S., 2004. Oil and the Economy. [online] Available at: <https://www.federalreserve.gov/Boarddocs/Speeches/2004/20041021/default.htm> [Accessed 3 February 2019].*

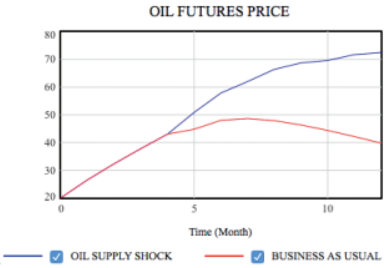

Figure 9: oil futures price

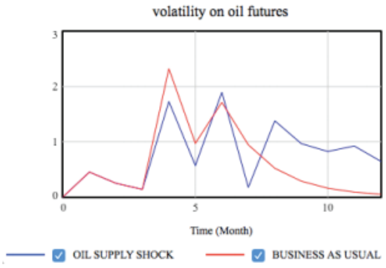

Figure 10: volatility on oil futures

The implications of this structure of the refining system are extremely important. Firstly, this rigid layout means that the refining industry is not able to immediately adapt to a sudden increase in the oil price. Secondly, a discrete production function means that, also if the optimal production choice was lower or higher, they are forced to keep production to the nearest integer level.

This explains the behavior of the refining industry vis-à-vis the oil supply shock: as shown in Figure 6, in the oil supply shock scenario, at time 4 and 5 (the shock takes place at time 4), refineries' production choices for each period are equal to the ones in the business-as-usual scenario. Indeed, the first significant alteration in production decisions takes place far after the oil shock, at time 6, when the refining industry decides to cut production when compared to the business-as-usual scenario.

As a result, the petrochemicals market notices the oil shock with a consistent delay, as it is shown in Figure 7: the refineries' decision to reduce production due to higher raw material costs taken at time 6 reduces the supply of petrochemicals, determining a rise in refined products price. The refining system, in other words, acts as a "buffer" ahead of the systemic shock, making its effects felt in the refined products market only some time later.

Finally, Figure 8 shows the final demand. As stated before, it is characterized by a moderate degree of seasonality and is almost inelastic. In fact, the increase in petrochemicals' price only marginally affects its shape.

Figures 9 and 10 allow us to observe the propagation of the systemic shock to the financial oil market. The announcement of a sharp and unexpected cut in OPEC production provokes a severe increase in the oil futures price (Figure 9). This behavior is coherent with the generally accepted idea that futures prices are an approximately good indicator of the market sentiment: given a sudden reduction in world oil production, market operators expect oil prices to go up in the near future. This upward feeling is reflected in an abrupt change in the oil futures price trend: while in the business-as-usual scenario it would have peaked approximately at time 7 to start decreasing after, a shock in oil supply makes it keep rising, approaching an asymptotic equilibrium at $73 approximately.

At the same time, the level of volatility compared to this increase in the oil price was unexpected. Its paradoxical behavior (note that the business-as-usual levels of volatility are higher than in the oil supply shock scenario!) is mainly due to the fact that, at time 4, also in the business-as-usual scenario a little 'demand shock' takes place, with a sudden growth of demand due to the decision of the refining industry to scale up the output level. In both cases, the market behaves in a way that is unexpected to market operators, who are assumed to simply expect tomorrow's level of production to be equal to that of today. This 'surprise effect' leads to a series of volatility peaks. However, in the oil supply shock scenario we notice an overall level of volatility that is higher than in the business-as-usual scenario.

DISCUSSION

According to the results obtained, if an oil supply shock happened today, its effects would be greatly different from 1973. In that year, OPEC's decision to cut production, raise the posted price and proclaim an embargo against the US and its allies in the Yom Kippur War had a tremendous impact on virtually all Western economies, ultimately pushing them into a deep recession. The magnitude of the success of this move was such that it acquired also a symbolic and emotional meaning. As Giuliano Garavini stated in his 2015 article 'From Boumedienomics to Reaganomics':

"The unilaterally imposed oil price revolution was seen by developing countries as the economic equivalent of the Vietnamese military success against the apparently invincible US army. It was a victory of the poor against the superior technological and economic power of industrialized countries."[19]

In particular, the oil embargo against the US caused extraordinary damages to the economy, ultimately succeeding in almost paralyzing the American industry. The then Secretary of State Henry Kissinger famously said: "We are now living in a never-never land, I am certain, in which tiny, poor and weak nations can hold up for ransom some of the industrialized world." Furthermore, as another demonstration of the tremendous power of the 'oil weapon', it is possible to cite Japan's case, which was forced to modify its position towards Israel in order to be excluded from the embargo.

19 *Garavini, G., 2015. From Boumedienomics to Reaganomics: Algeria, OPEC, and the international struggle for economic equality.*

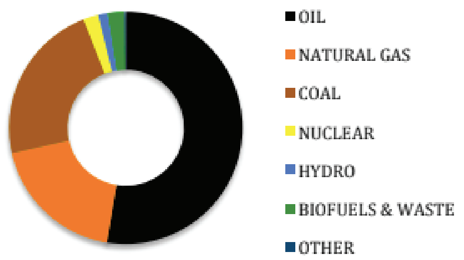

Figure 11: OECD Countries' energy mix in 1973

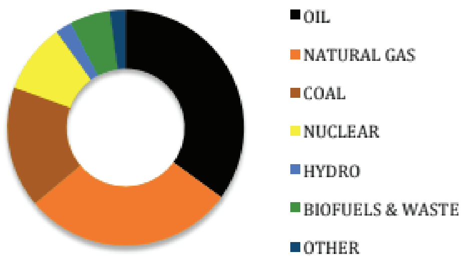

Figure 12: OECD Countries' energy mix in 2018

Nothing similar would happen today, even in the (remote) case of a simultaneous, dramatic cut of oil production among all OPEC countries. The model shows that, while of course the impact would be significant, there would nevertheless not be a total paralysis in industrial production due to refined products scarcity. Thus we can exclude that a situation similar to the one of 1973 (undersupplied gasoline pumps, Government's calls for reduction of energy consumption during winter) would happen again. Presumably, and assuming a political aim behind it, the use of the 'oil weapon' today would fall short of forcing Western countries to change their attitude towards a determined situation.

At this point, a question spontaneously arises: "What are the causes of such different effects between 1973 and today?" The answers to this can be found in three different fields: structural changes in the oil market, energy independence and ad hoc policies.

The main motivation for the relevant difference in the system's behavior in the case of an oil supply shock can be ascribed to the important structural changes the international oil market underwent since 1973. In particular, the most striking difference is the presence of a global market for oil.

In 1973, the international oil market was characterized by a deep polarization between demand and supply: demand was represented by the 'Seven Sisters', which was the oil-consumers cartel, while supply was completely controlled by OPEC, i.e. the oil-producers cartel. For some time, the oil price was determined only via negotiations between these two blocs, which was by all means a rather rigid layout. After 1973, the market became even more rigid, ultimately transforming into a monopoly: the old price-setting mechanism was discarded, and OPEC became able to set the posted price for oil by itself. Furthermore, OPEC had virtually no competitors worldwide: the Soviet Union, albeit extremely oil-rich, did not have access to the international oil market due to the Cold War confrontational climate, while other countries had not yet started to develop their national oil industry.

Today, however, the landscape is definitely different: oil has become what is known as a 'global commodity': a standardized good that can be sold indifferently in every corner of the world. This happens through international oil markets such as the InterContinental Exchange and the New York Mercantile Exchange. In addition to this flexible and dynamic market structure, the oil market today is far more competitive due to the rise of a large number of oil producers. Countries such as Russia, Norway, Brazil and Nigeria are aggressive competitors of OPEC.[20] In short, today oil is a global commodity produced in a large number of countries and freely traded in international markets, where the price is determined by demand and supply. OPEC, therefore, has seen its power in setting prices diminish drastically. So to speak, OPEC 'committed suicide' in 1988, adopting Brent as a new benchmark and therefore surrendering to the reality of a global oil market over which it no longer had control.[21]

The establishing of a global oil market has thus been an epochal turning point in the history of the commodity. In their book 'Global Energy Governance', Andreas Goldthau and Jan Martin Witte perfectly summarized this point (p.5) :

"The existence of a global and liquid market for oil has several important consequences. First, it makes effective oil embargoes literally impossible [emphasis added]. Therefore talk about the oil weapon, which has recently come back into fashion, simply does not make sense. Once oil is sold on the global market, no producer can control where and to whom it goes. [...] Second, given the competitive forces to which the global oil market is subject, price stability through national or even international policy intervention is an unattainable goal. A case in point is OPEC's repeated failure in its attempt to steer global production and, with it, prices. That does not mean that betting on price levels may not force oil prices up or down in the short term. It does mean that the global price for oil is first and foremost a function of market forces and cannot be artificially lowered or increased by policy design in the long term. In fact, attempts to manipulate price levels or otherwise influence the global oil market will prove inefficient and, as demonstrated on occasion, even counterproductive."

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20 Hughes, L. and Gholz, E., Energy, Coercitive Diplomacy, and Sanctions. In: Van de Graaf, T., Sovacool, B.K., Ghosh, A., Kern, F. and Klare, M.T., ed. 2016. The Palgrave Handbook of International Political Economy of Energy. London: Palgrave MacMillan. pp. 487-504.

21 Carollo, S., 2012.

The second factor that can help to explain OPEC's loss of power to a certain extent is the lower degree of dependence on oil in Western countries. Data show that in 1973, oil's share in the energy production of OECD Countries was equal to 52.6%. Coal accounted for 22.6% and natural gas for 18.9% (see Figure 11).[22] Nuclear power, biofuels and renewables globally weighted less than 5%. When looking at this, it is clear that Western countries were hugely reliant on oil for energy production.

Today, the situation has radically changed (see Figure 12). Albeit oil is still the most important source of energy, its share has since fallen to 35%. Natural gas consumption, in turn, increased greatly, accounting nowadays for 29.6% of energy generation in OECD countries. Coal's share furthermore decreased to 17%. The most important change, however, took place when in the fields of nuclear, hydroelectric power and biofuels. Today, almost the 10% of the energy produced in OECD countries is being produced in nuclear power plants. Hydroelectric furthermore doubled its share, and also biofuels and biomass greatly increased their share of energy production, accounting nowadays for 5.7%.[23]

Overall, from an energy standpoint, the exceptional rise of natural gas, nuclear, hydroelectric and biofuels has thus had the effect of making the West less dependent on oil. Is it possible to suggest a causal relationship between this surge in alternative energy sources and the 1973 Oil Shock? We could answer yes. For example, immediately after the Oil Shock, US President Richard Nixon launched 'Project Independence', a long-term program aimed at reducing the United States' dependence on foreign-produced oil.[24] From a broader perspective, the 1970s were a period in which the dramatic demonstration of the unreliability of oil suppliers was combined with the birth of ecological concerns. The apocalyptic scenarios caused by the Oil Shock seemed to support the dark predictions of the Club of Rome's seminal 'Limits to Growth', which, as the first to attack the theoretical assumption that 'endless growth' was attainable, put at the center of the debate the question of the finiteness of resources and so the mathematical impossibility of a perennial growth of consumption.[25] This thus marked the beginning of the quest for sustainable development, which implied a need for new, non-depletable energy sources. The exceptional development of nuclear energy in the most advanced economies of the world can in these terms also be seen as a response to the need for a sustainable, more reliable source of energy.

Finally, the last factor needed to explain OPEC's loss of power can be found in the establishment of policies and regulations specifically designed to address oil supply disruptions, both at the national and at the international level. Indeed, we could say that the lesson imparted by the 1973 Oil Shock has been learned.

For example, let us take the United States' case. In 1975, US Congress passed the 'Energy Policy and Conservation Act', introducing measures to counteract possible oil supply shocks, the most important one being the establishment of the so-called 'Strategic Petroleum Reserve', which is a storage network able to store up to 1 billion barrels of oil to be used in case of severe and durable interruption of oil supply to the US.[26]

At the international level, the most important example in this sense is undoubtedly the establishment of the International Energy Agency (IEA). Just like OPEC itself was established to counteract the power of the cartel of the International Oil Companies, the IEA was founded in an attempt to oppose OPEC's monopolistic power. The IEA's goal is to ensure energy security and energy cooperation between OECD countries by providing the expertise needed for the States to implement comprehensive energy policies, improve energy management and coordinate collective cooperation in energy-related issues. The most important achievement of IEA is the obligation of its entire membership '[...] to hold emergency oil stock equivalent to at least 90 days of net oil imports. In case of a severe oil supply disruption, IEA members may decide to release these stocks on the market as part of a collective action'.[27]

These types of policies, together with stronger international cooperation, the diffusion of energy-related knowledge and a better management of energy flows is the most enduring legacy of the 1973 Oil Shock, and constitutes an interesting demonstration of the property of this complex global system to learn from past errors and to adapt accordingly.

CONCLUSIONS

This study's aim was to explore the vulnerability of energy systems by simulating a large- scale oil supply disruption similar to the 1973 Oil Shock. In order to do so, a systemic model of the world oil market was constructed. The model was articulated in three main sub-systems, i.e. the physical oil market, the refined products market and the 'paper' oil market.

The oil supply shock was implemented by simulating a sudden, drastic reduction of OPEC's oil production. As a result we observed, as expected, an increase in the oil price and a surge in not-OPEC oil production. On the other hand, due to the specific characteristics of the refining industry, the sys-

22 IEA, 2017. Key Energy World Statistics. [pdf] Available at: <https://www.iea.org/publications/freepublications/publication/KeyWorld2017.pdf> [Accessed 3 February 2019].

23 Idem.

24 Richard Nixon Foundation, 2016. Project Independence. [online] Available at: <https://www.nixonfoundation.org/tag/project-independence/> [Accessed 3 February 2019].

25 Meadows, D.H., Meadows, D.L., Randers, J. and Behrens, W.W., 1972. Limits to Growth. Washington DC: Potomac Associates.

26 Congress of the United States of America, Energy Policy and Conservation Act. [online] Available at: <https://www.congress.gov/bill/94th-congress/senate-bill/622> [Accessed 3 February 2019].

27 IEA. History of the IEA. [online] Available at: <https://www.iea.org/about/history/> [Accessed 3 February 2019].

temic shock affected the petrochemical's market only with a significant delay, confirming the decisive role of refineries as the trait d'union between the two markets, and therefore reaffirming the need to take into account the peculiarities of this system in order to provide a better knowledge of the oil market. In the financial oil market, the systemic shock was reflected as an increase in the oil futures price and in a growth of the levels of volatility.

The behavior of the system proved to be substantially different in comparison to 1973. We provided three main explanations for the disappearance of OPEC's 'oil weapon'. Firstly, the changes implemented after 1973 altered the fundamental structure of the market, making successful embargoes impossible and significantly reducing OPEC's power to set prices. Secondly, the important differences between 1973's and today's energy mix in the Western countries, with a relative reduction of the reliance on oil for energy production, made countries simply less reliant on oil and thus less vulnerable to shocks. Thirdly, the existence of ad hoc policies developed both at the national and at the international level in the wake of the 1973 Oil Shock in order to address oil supply disruptions seem to have had a positive effect, greatly enhancing countries' ability to mitigate the heaviest effects of possible shocks.

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WIND ENERGY PROJECTS THROUGH THE LENS OF SUSTAINABLE INVESTORS

Olga Teplova

Abstract

In the aftermath of the financial crisis, governments introduced a new regulatory perimeter for the capital markets and banking sector. But rigid legislative framework alone cannot reshape the course of the financial system; therefore, an industry-driven and financially justified model aimed at low-carbon-economy and transparent financial sector is needed. This paper presents an approach for extra-financial investment analysis based on industry-specific sustainability codified accounting standards released in November of 2018 by the Sustainability Accounting Standards Board (SASB). The paper is also an attempt to clarify by means of SASB standards the defining features of a Socially Responsible Investment (SRI) strategy in contrast to conventional investment approach. Wind energy sector is chosen for the analysis

Key words: SRI strategies, ESG criteria, wind energy project, wind turbine manufacturers, SASB accounting standards.

Although the concept of sustainable investment has been on the rise in the last decade, much has to be done in order to make this concept economically viable and legally defined in the future. Publication of the UN Principles for Responsible Investments in 2006 heralded the scaled-up implementation of Socially Responsible Investment (SRI) strategies by institutional investors in developed countries. By January 2019 the number of signatories reached 2204 with assets under management of over US$80 trillion.[1] These principles and guidelines represent a voluntary commitment on behalf of institutional investors to incorporate environmental, social and governance (ESG) issues into the investment process.

Despite the acknowledgment of the important role played by sustainability principles and approaches in the aftermath of the 2008 financial crisis, to date there is no commonly accepted sustainability indicators and definitions known to the financial sector and its regulators. Without a convenient yardstick for classifying 'green' investments and without a reliable set of indicators, the concept of sustainability in the financial sector is doomed to remain just an ancillary service provided by banks, insurance companies and pension funds, rather than a business model that ensures a transition to sustainable economic growth. In order to solve this problem, the European Union (EU) has established an Action Plan with the objective "to introduce common sustainable finance taxonomy to ensure market consistency and clarity."[2] The green financial strategy of the Chinese government purports to encompass not only the banking sector, which is traditionally seen as a main transmission channel of funds to the economy, but also the capital markets that are underdeveloped in China compared to the banking system. In 2016, China launched the so-called 'Guidelines on Establishing the Green Financial System,' which are aimed at increasing the accessibility of environmental information, setting criteria for a classification of green industries and reducing of the funding costs for sustainable projects.[3] According to the Guidelines in question, part of the answer to the environmental problems in China rests with the development of rating metrics and updating existing rating methods that would conjoin traditional and green credit ratings.[4]

At the moment, several on-going industry-driven initiatives that are aimed at better disclosure of ESG risks and their impact on financial performance might be mentioned, e.g. the Financial Stability Board established an industry-led task force, the Task Force on Climate-related Financial (TCFD), which attempts to define the environmental ('E') metrics needed for disclosure of climate-related financial information. In addition, the Sustainability Accounting Standards Board (SASB) is active in the broad area of ESG indicators and released a complete set of 77 industry-specific sustainability codified accounting standards. This last initiative falls into the research area of this article.

What makes the approach of the SASB so unique against the background of other disclosure initiatives in the ESG domain? First of all, many frameworks and task forces give too much weight to the ecological or climate aspects in the evaluation of ESG risks for investment projects. One example is the Carbon Disclosure Project (CDP), where the emphasis

1 *UNPRI, 2019. Signatory directory. [online] Available at: https://www.unpri.org/searchresults?qkeyword=&parametrics=WVSECTIONCODE%7c1018 [Accessed 22 December 2018]*

2 *EU High-Level Expert Group on Sustainable Finance Final Report, 2018. Financing a Sustainable European Economy [pdf] Available at: https://ec.europa.eu/info/sites/info/files/180131-sustainable-finance-final-report_en.pdf [Accessed 24 December 2018]*

3 *Research Bureau of the People's Bank of China and the UNEP Inquiry into the Design of a Sustainable Financial System, 2015. ESTABLISHING CHINA'S GREEN FINANCIAL SYSTEM. [pdf] Available at: https://www.cbd.int/financial/privatesector/china-Green%20Task%20Force%20Report.pdf https://www.cbd.int/financial/privatesector/china-Green%20Task%20Force%20Report.pdf [Accessed 24 January 2019]*

4 *Research Bureau of the People's Bank of China and the UNEP Inquiry into the Design of a Sustainable Financial System, 2015. ESTABLISHING CHINA'S GREEN FINANCIAL SYSTEM Ch. 8 Establish a Green Rating System. [pdf] Available at: https://www.cbd.int/financial/privatesector/china-ecgfs-8Green%20Rating.pdf [Accessed 20 January 2019]*

is put on the environmental ('E') component, or the above-mentioned TCFD, which can also be cited as an example of climate-oriented approach. Although the climate agenda is of paramount importance for the investment analysis in the context of Paris Agreement, a more comprehensive approach, which includes the social ('S') and governance ('G') components as well, must be taken when looking at investment projects. The SASB standards ameliorate this narrow focus on only one of the sustainability topics by providing a set of recommended ESG indicators for 77 different industries.

Secondly, the SASB standards look at the ESG factors that are most likely to have a material impact reflected in the financial statements. For many years, sustainability has been an opaque and detached term used for marketing purposes. Yet a recent study of 400 institutional investors from Europe and the Americas conducted by RI and UBS Asset Management has shown that an overwhelming majority of respondents (70%) are assured that ESG factors have material impact on investments.[5] Equally important, 43% of respondents noted that the integration of ESG factors might significantly contribute to positive financial returns. For this reason, the integration of sustainability should not only belong to the responsibilities of the Corporate Social Responsibility (CSR) or marketing department in a company but should also be taken seriously by the risk assessment division.

Undoubtedly, these two factors, namely a multifaceted approach and the financial materiality of indicators, represent the bedrock of integrating ESG in corporate proceedings in a comprehensive and sustainable way. At the same time, the application of SASB standards has to be considered with a grain of salt. Despite the fact that the standards are a codified version of ESG issues for a wide range of industries, they are to be integrated on a voluntary basis and dedicated to encourage environmental, social and governance metrics into investment analysis, rather than mandate them. Nevertheless, the business-sourced and investor-related approach provided by SASB encourages seeing the set of indicators in a broadly positive light; therefore, this tool will be used to demonstrate the application of one of the SRI strategies, namely integration of ESG criteria.

There is a vehement debate over how to demarcate the perimeter of green or sustainable investments. Indeed, the most daunting challenge is how to discern conventional investment approaches, such as in the wind energy industry or in any other renewable technology included as a part of an investment portfolio, from an SRI strategy that is looking for a way to factor non-financial indicators into investment analysis. Both investment strategies are beneficial to the low-carbon economy, but the effect is different as the latter considers a broader scope of factors in defining whether an investment can be deemed sustainable. This article is an attempt to delineate the term of sustainable investment analysis on the basis of wind turbine manufacturers by means of ESG integration.

SRI STRATEGIES: ESG INTEGRATION

At the outset it should be noted that an SRI strategy represents a profit-driven approach to factor non-financial considerations into investment analysis.[6] SRI represents an alternative approach to internalize environmental externalities and provide the social return, without compromising the risk-adjusted financial return. As of yet, the modern taxonomy of SRI strategies includes six approaches: negative and positive screening, best-in-class approach, active shareholder policy, thematic screening and integration of ESG criteria. The latter will be scrutinized in this article by looking at how integration of ESG criteria might be applied towards wind turbine manufacturers.

According to the definition given by the Global Sustainable Investment Review (GSIA), ESG integration represents 'a systematic and explicit inclusion by investment managers of environmental, social and governance factors into financial analysis'.[7] This process entails a calculation of various indicators in three domains: environmental metrics aimed at reporting an emissions reduction, resource use, and cleantech innovations; social metrics aimed at monitoring shareholders relations and execution of CSR strategy; as well as metrics aimed at monitoring an engagement with communities and workforce. On the global scale, the lion's share of SRI investments is based on negative screening ($15 tn.), followed by ESG integration ($10 tn.)[8]. ESG integration has achieved the leading position in the Anglo-Saxon countries and Asia, excluding Japan. It should be noted that the application of ESG criteria does not eliminate the conventional approach based on the assessment of financial feasibility and positioning in the industry. As shown in Figure 1, the ESG approach opens up additional dimension for the investment analysis, enhancing the industry specific and financial analysis. Nowadays, investors are dealing with new sort of risks such as climate change, the tainted reputation of the asset management industry in the aftermath of the 2008 financial crisis and the active participation of different stakeholders in the business decision-making process. This raises the question of how these risks might be addressed and whether the relationship between ESG integration and corporate financial performance (CFP) exists. Many studies have confirmed underlying presumptions about a positive ESG impact on CFP.[9] Moreover, it turns out that this effect remains stable over time and can be amplified in the long run.

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5 *RI Research and UBS, 2018. ESG: Do you or Don't you? [online] Available at: https://www.esg-data.com/ [Accessed 22 January 2019]*

6 *Shapiro, J., 1992. Social Investing: Origins, The Movement since 1970. New York: Holt & Co.*

7 *GSIA, 2016. Global Sustainable Investment Review. [pdf] Available at: http://www.gsi-alliance.org/wp-content/uploads/2017/03/GSIR_Review2016.F.pdf [Accessed 24 December 2018]*

8 *Idem*

9 *Friede G., Busch T. and Bassen A., 2015. ESG and financial performance: aggregated evidence from more than 2000 empirical studies. Journal of Sustainable Finance & Investment, 5:4, pp. 210-233.*

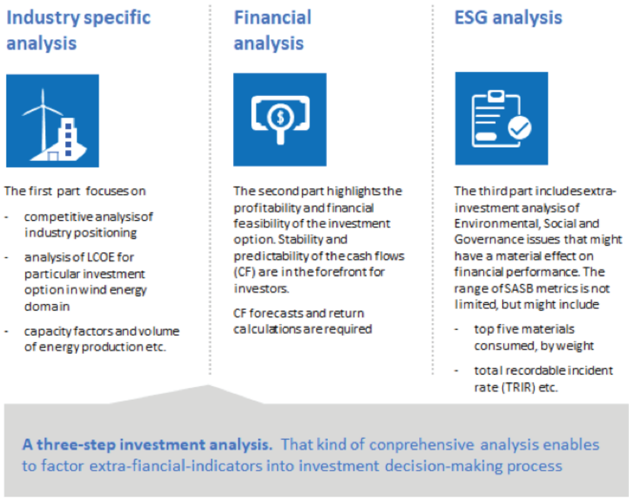

Figure 1. Integration of ESG criteria into the investment analysis for the wind industry

Source: Author's elaboration based on SASB standards

At the moment, integrating ESG factors into analyses of listed equity investments is the most frequently used SRI practice by investors.[10] Thus, what makes an ESG approach so appealing to investors? First of all, an ESG strategy used for the construction of an equity portfolio is endowed with great potential due to its flexibility. Investors can easily adopt this strategy without compromising risk-adjusted returns and or radically changing the conventional approach of investment processes. The set of metrics is defined by the institutional investors themselves and can be easily adjusted depending on the sustainable investment policy. Secondly, the ESG approach might help investors to not only address sustainability issues, but also 'to come back on track' in times of economic turbulence, since companies that are committed to ESG approach are better positioned on the market compared to their peers and generate a higher return in market downturns.[11] Thirdly, this approach might be applied to a whole spectrum of industries, including those with a 'green' label, in order to define the market leaders in terms of sustainability. For instance, companies that operate in the renewable energy sector by essence are entitled to gain a reputation of environmentally friendly investment option compared to the conventional energy sector. Yet, how can we discern which companies generate extra sustainable value in addition to reduced GHG emissions? Part of the answer rests with the ESG strategy that enables the comparison of such companies in one industry, in our case wind turbine manufacturers, by using the financially material set of sustainable indicators.

Wind turbine manufacturers are indeed at the forefront of addressing sustainability issues in the wind energy sector, such as the environmental externalities (noise pollution; electromagnetic interference; visual intrusion), community pushback, resource efficiency and others, as well as economic issues such as capacity factor and capital expenditures[12]. The investor's interest in wind industry is steadily increasing, and this trend is likely to be sustained due to continued demands for emissions reductions by among the public and the proliferation of energy security policies in both developed and developing nations (see Figure 2). The pace of development in the whole industry and the demand on behalf of project developers depend on the ability of turbine manufacturers to design and produce an innovative product that would fulfill the sustainability and economic requirements of wind project developers. Therefore, the analysis of the wind turbines manufactures is of paramount importance for the industry in general. In addition, most of turbine manufacturers offer an extra service for the whole life cycle of wind projects, including operational and maintenance service. For these reasons, the turbine manufacturers are at the heart of this article, in order to scrutinize whether they adhere to the disclosure and management metrics recommended by SASB.

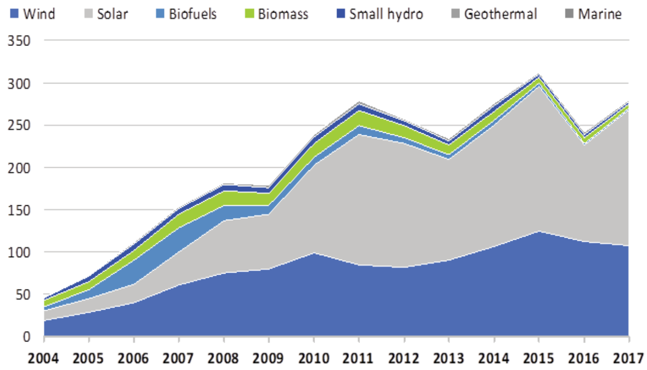

Figure 2. Global new investment in Renewable energy, by technology, $ bn

Source: Frankfurt School-UNEP Centre/BNEF.[13]

As shown in Figure 1, investment processes by means of an ESG strategy entails three steps: industry specific analysis and financial analysis that are underpinned by the ESG analysis. For the purpose of this article, the SASB Sustainability Accounting Standard "WIND TECHNOLOGY & PROJECT DEVELOPERS" is used to demonstrate the defining features of ESG approach.[14]

INDUSTRY SPECIFIC ANALYSIS: DEFINING FEATURES OF THE WIND ENERGY MARKET

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10 *UN PRI, 2016. A practical guide to ESG integration for equity investing. [pdf] Available at: https://www.unpri.org/listed-equity/a-practical-guide-to-esg-integration-for-equity-investing/10.article [Accessed 24 December 2018]*

11 *Staub-Bisang, M., 2012. Sustainable investing for institutional investors: risk, regulations and strategies, New Jersey: Wiley.*

12 *Boyle, G., 2012. Renewable Energy: Power for a Sustainable Future, Third Edition. UK: Oxford University Press.*

13 *Frankfurt School-UNEP Centre/BNEF, 2018. Global Trends in Renewable Energy Investment 2018. [pdf] Available at: http://www.fs-unep-centre.org (Frankfurt am Main) [Accessed 24 December 2018]*

14 *SASB, 2018. Sustainability Accounting Standard WIND TECHNOLOGY & PROJECT DEVELOPERS. [pdf] Available at: https://www.sasb.org/standards-overview/download-current-standards/ [Accessed 24 December 2018]*

The wind energy industry is made up of manufacturers producing turbines or their components (blades, towers, gearbox, etc.), project developers, utility-based or independent generators, as well as engineering companies. Wind turbine manufacturers might be treated as key actors, especially since SASB released a research brief named 'Wind Energy' that stated that the lion's share of the revenue comes from manufacturers.[15] Moreover, according to Bloomberg, "The Big Four" (Siemens Gamesa RE SA, Vestas WS, Xinjiang Goldwind Science & Technology Co. of China, General Electric Co.) totaled 54% of the wind turbine manufactory industry global revenue in 2017 (see Table 1), which, in turn, signifies a high concentration in the market.[16] constant vigilance on behalf of investors due to the opaque structure of the supply chain and nascent stage of storage and renewable energy industry development.

Given the fierce competition among various energy sources, prices might be the key determinant for the winners in this race. From this standpoint, onshore wind has an edge over other renewable sources, since it has reached the goal of the world's lowest-cost energy source for power generation in 2018. As a matter of fact, onshore wind has outstripped the cheapest conventional energy source, natural gas (US$41–74 per MWh), with an unsubsidized LCOE range of US$29–56 per MWh.[19] The difference might be even more astonishing when comparing with the subsidizing onshore wind of $14/MWh.

Company	Siemens Gamesa	Vestas	Goldwind	GE	Enercon	Envision	Nordex	Senvion	Suzlon	Guodian UP	Ming Yang	Sewind	Other
Commissioned - Onshore (GW)	6,83	7,71	5,43	4,85	3,09	2,69	2,85	1,48	1,36	1,24	1,07	0,5	7,80
Commissioned - Offshore (GW)	2,69	0	0,21	0	0	0,2	0	0,44	0	0,01	0,07	0,56	0,62

Table 1. Top 10 wind turbine manufacturers in 2017
Source: Bloomberg, 2018.[17]

Due to the intermittent nature of wind energy, the development of wind projects is inextricably linked with storage technologies; therefore, the development of storage solutions is equally important for the growing share of renewables in the energy mix. According to the Lazard's report LCOS 3.0, Lithium-ion technology remains the least costly option among others and continues to decline in terms of Levelized Cost of Storage (LCOS), driven by the improved efficiencies and a rapid expansion and development of the supply chain. However, shortages in commodity supply and lifted pricing levels might impose limitations and represent an impediment for the continued buoyant development of the storage sector. For instance, lithium production has reached almost a 50% increase from 31,9 to 44,7 thousand tons of lithium content over five-year period 2013-2017 due to price spikes.[18] According to the BP Statistical Review of World Energy 2018, rare earth metals (REM) production has also increased by 30% between 2010 and 2017. Markets for cobalt, lithium and REM require a

Furthermore, unsubsidized wind generation costs have fallen 69% over the 10-year period from 2009 to 2018, driven by material declines in the pricing of system components and improvements in efficiency (see Figure 3).[20]

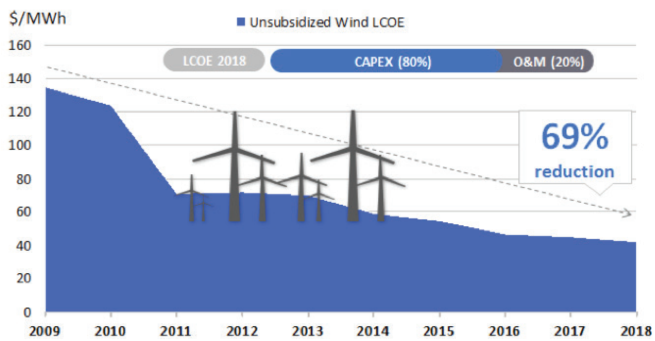

Figure 3. Historical development of unsubsidized wind LCOE
Source: Adapted from Lazard 12.0

By breaking down the expense structure of on-shore wind energy by capital cost (CAPEX), fixed, variable Operation and Maintenance (O&M) costs and fuel costs, the investors will find out that CAPEX account for almost 80% of total LCOE, whereas the CAPEX of gas technologies fluctuate from 39% to 63% in the cost structure. Therefore, wind projects are capital intensive and require high up-front payments. In contrast to conventional energy projects, renewable energy

15 SASB, 2015. Industry Brief WIND ENERGY, Sustainable Industry Classification system (SICSTM) #RR0103

16 Bloomberg, 2018. These Four Power Giants Rule the World's Growing Wind Market. [online] Available at: https://www.bloomberg.com/news/articles/2018-02-26/these-four-power-giants-rule-the-world-s-growing-wind-market [Accessed 24 December 2018]

17 Bloomberg, 2018. These Four Power Giants Rule the World's Growing Wind Market.

18 BP, 2018. Statistical Review of World Energy: Section Key materials for the changing energy system. [pdf] Available at: https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2018-full-report.pdf [Accessed 22 December 2018]

19 Lazard, 2018. Levelized Cost of Energy Analysis (LCOE 12.0). [pdf] Available at: https://www.lazard.com/media/450784/lazards-levelized-cost-of-energy-version-120-vfinal.pdf [Accessed 24 December 2018]

20 Lazard, 2018. Levelized Cost of Energy Analysis (LCOE 12.0).

Table 2. Sustainability Disclosure Topics & Accounting Metrics for the top three wind turbine manufacturers **ESG metrics***	**Top wind turbine manufacturers**		
	SG	Vestas	Goldwind
Total recordable incident rate (TRIR) and fatality rate for (a) direct employees and (b) contract employees	◐	●	◐
Average A-weighted sound power level of wind turbines			
Backlog cancellations associated with community or ecological impacts		◐	
Description of efforts to address ecological and community impacts of wind energy production through turbine design (Discussion and Analysis)	◐		●
Description of the management of risks associated with the use of critical materials		●	
Top five materials consumed, by weight		●	
Average top head mass per turbine capacity, by wind turbine class			
Description of approach to optimize materials efficiency of wind turbine design (Discussion and Analysis)	◐	◐	◐

● - The information is disclosed ◐ - The information is partially disclosed

Source: the author's elaboration, based on Sustainability Accounting Standard WIND TECHNOLOGY & PROJECT DEVELOPERS

** The 'top four' has been transformed in a 'top three' due to that fact that a separate Sustainability report for GE wind energy is missing on the web-site of GE (only the Integrated Summary Report is available, but it does not provide comparability with the reports of other wind manufacturers).*

projects do not entail fuel costs: fuel costs might reach up to 50% in the gas LCOE structure. In the best case scenario, this figure might equal 32%. Independence from volatility on the markets for fossil fuels significantly improves financial attractiveness of wind installations in the long run.

FINANCIAL ANALYSIS

Although an in-depth analysis of financial performance is beyond the scope of this article, it may be worth remembering that renewable energy investment (projects) in general and wind installations in particular are evaluated by using commonly accepted methods in the financial industry, such as profit/costs comparison, IRR, NPV, payback period and sensitivity analysis. The capacity factor (the ratio of the actual output to the potential output if the wind turbine would operate at its maximum capacity) is the key driving force used for the projection of cash flows regarding wind projects. From a theoretical standpoint, equity valuation of wind turbine manufacturers will fall into one of the four methodological groups: asset-based, market-based, earnings-based and cash flow based. Regardless of the chosen method, the investors have a chance to enhance their return on investment and other key financial ratios by introducing a sustainable dimension to the investment analysis. When it comes to wind turbine manufacturers, management of material costs, reduction of environmental externalities by redesigning of blades or tower and sustainable supply chain might improve the results of financial valuation and shorten the payback periods for wind energy projects.[21]

SUSTAINABILITY-RELATED ANALYSIS: ESG STRATEGY

Renewable energy comes at a price and this price includes not only the commonly known determinants of LCOE, but also ESG factors that might distort the forecasted cash flows, the balance sheet, or change the cost structure. Compliance with the SASB standards is in line with ESG integration strategy and might significantly contribute to environmental and social risk mitigation, what in turn might result in improved financial performance. SASB standards are intended for use in communications to investors regarding sustainability issues that are likely to impact corporate ability to create value over the long term.[22] For the wind energy sector, a dashboard of 8 Sustainability Disclosure Topics & Accounting Metrics is generally suggested, which are divided into four broad categories (see Table 2). More specifically, the range of ESG metrics fall into one of the following sustainability topics: occupational health & safety, ecological impacts of project development, materials sourcing and material efficiency.

This part of the article aims to scrutinize whether the 'top four' wind turbine suppliers have already been disclosing information required by the SASB Sustainability Accounting Standard.[23] Once the standards are adopted by the "big four" (controlling over 50% of the wind turbine manufacturers), newly adopted sustainability disclosure practices are expected to penetrate the rest of the market. As a matter of fact, the laggards might be driven out of the playing field by sustainability-oriented investors.

At this point, a test screening of three key market leaders in the wind turbine industry has shown that the leading companies would not be able to comply with the SASB metrics. An exception might be made for Vestas that is ahead of the curve compared to its peers in terms of ESG reporting. Based on the sustainability reports, 'the top three' wind turbine manufacturers disclose with vigor qualitative metrics, such as description of efforts to address ecological and community impacts through turbine design and description of approach to optimize materials efficiency of wind turbine design, whereas the disclosure of quantitative SASB indicators is limited. But given the fact that SASB standards are brand new and ESG disclosure is at the nascent stage of development, these companies are on the right track.

Wind manufacturers are cognizant of the fact that optimization of production process in terms of resource consumption and emission of pollution is a key factor for keeping costs down. In one way or another, companies are trying to address the issue of resource efficiency by disclosing energy and water consumption, GHG emissions and waste and resource management. One example is Goldwind, which has changed the traditional steel tower structure to reduce the amount of steel consumed and to improve the height of the tower for the better output.

Wind manufacturers cannot be decoupled from their supply chain. Although the turbine manufacturers might not be

21 SASB, 2015. Industry Brief WIND ENERGY.

22 SASB, 2018. Sustainability Accounting Standard WIND TECHNOLOGY & PROJECT DEVELOPERS.

23 The analysis is based on the latest available sustainability reports of wind manufacturers in question, namely Siemens Gamesa sustainability report 2018, Goldwind sustainability report 2017 and Vestas Wind Systems A/S "Sustainability powers development" 2017.

directly involved into the development of wind projects, in most cases they provide extra O&M services at the operational stage in addition to the sale of turbines. SG, Vestas and Goldwind are no exception in this. Moreover, the O&M part of the business is characterized by higher margins.[24] It's in the best interests of the manufacturers to disclose the safety record of operations that have an impact on reputational risks and demand for its turbines. Companies in question reflect these data in the sustainability reports, although sometimes in a different way compared to SASB standards. For example, Goldwind reports on the number of working day losses due to work-related injuries.

One of the main objectives of the manufacturers is to design turbines in such a way that enables them to mitigate the noise, control the so-called light-shadow flickering and to protect birds. Falling far short of this goal might jeopardize the construction of the project and cause a pushback on behalf of the affected communities. The importance of these issues might be exemplified by the protests against onshore wind park organized by local residents of Yuanli Township, Miaoli County, in Taiwan in 2013. To dispel the fears of residents about the low-frequency electromagnetic radiation and noise, as well as to clarify the complaints, the wind farm project was suspended for several years. For this reason turbine manufacturers heavily invest in R&D to address environmental externalities and try to establish a good rapport with communities. Companies also profess support for establishing dialogue platforms, and these initiatives are explained in detail in sustainability reports. For instance, in the case of SG, community engagement is covered by the CSR Master Plan 2018-2020, which is approved by top management and the Audit, Compliance and Related-Party Transactions Committee.

The sustainability reports of Vestas and SG are reputed to be of high quality and in compliance with CSR best practices and international standards, such as the Global Reporting Initiative. In addition, both of these companies are included into leading sustainable indices (FTSE4Good series, Ethibel Excellence Europe Index etc.) due to strong ESG practices. Goldwind's sustainability reporting strategy also deserves approbation, although it stands out bleakly against European practices. As for the SASB standards, companies have time to push this idea further.

CONCLUDING REMARKS

If we were to summarize the immediate outlook in the area of sustainable investments, it appears that the burgeoning demand for to transition to a low-carbon economy and the enhanced awareness about ESG issues among stakeholders have led to an uptake of climate-friendly and responsible investments. At the moment, institutional investors are looking for a convenient yardstick to identify and disclose sustainability-related issues in a way that enables them to tackle financial and reputational risks. SASB, with its codified set of sustainability accounting standards, equipped investors with such a tool that is congruous with the profit-driven model of the companies.

SASB should be lauded for its attempt to ameliorate the fissure between sustainability as a theoretical concept and as a business case. ESG approach that is at the heart of SASB accounting standards provides the investors with a tailored-made solution to the sustainability-related disclosure and management problem. Conversely, the high degree of flexibility and the recommended compliance that resulted from this tailored-made approach in practice is conducive to free-riding. Companies prioritize the disclosure of sustainability indicators that support their image as a responsible economic actor and are not committed to touch upon vulnerable ESG issues. A test screening of top wind turbine manufacturers has confirmed this bifurcated approach towards ESG disclosure.

The findings of the test screening with respect to sustainability reports and their compatibility with the SASB standard WIND TECHNOLOGY & PROJECT DEVELOPERS have been somewhat controversial. On the one hand, the 'top three' do present the qualitative aspect of safety measures, the environmental impacts of wind energy project developments and the material efficiency to the public very openly. On the other hand, the quantitative metrics are barely disclosed in the sustainability reports of Siemens-Gamesa and Goldwind, which might present a significant concern for responsible investors. It's hard to say at this juncture whether this increase in sustainable investments and proliferation of ESG metrics and their subsequent application by institutional investors can be sustained, since the application of ESG metrics is at the nascent stage of development and a protracted historical record is lacking. At the very same time, SASB standards, if applied properly, might become a propulsive force in ESG integration for the institutional investors.

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24 SASB , 2015.

FRANÇOIS LÉVÊQUE ON NATURAL GAS COMPETITION: GAZPROM VS. US LNG AND THE EU ANTITRUST LAW

Vanille Dabal

Abstract

At the latest edition of the ongoing ENERPO Workshop Series, the ENERPO Research Center welcomed François Lévêque, a professor at Mines-ParisTech and Director of the Chair 'Economics of Natural Gas', who presented his work on 'The natural gas competition: the case of Gazprom against liquid natural gas from the United States (US LNG) and the European Union antitrust law'. The research fellow of the Chair, Ekaterina Dukhanina, who is also a PhD candidate at Mines-ParisTech, furthermore presented her work on the integration of the natural gas market. The seminar took place on October 9 th 2018 at the European University at Saint-Petersburg and was attended by faculty, administrators and diplomats.

Key words: natural gas, Gazprom, LNG, USA, European Commission, competition, DG comp, antitrust

Professor François Lévêque during the ENERPO Workshop at the European University at St. Petersburg on October 9th. (Photo: @EUSP)

Professor François Lévêque from Mines-ParisTech led the latest workshop organized by the ENERPO Research Center at the European University at St. Petersburg. Lévêque gave a lecture on natural gas competition in Europe, and highlighted two main issues: firstly, Gazprom is currently experiencing pressure from the entry of new players into the European gas market. This competition, created by the import of Liquefied Natural Gas from the United States (US LNG) into Europe, could eventually result in a possible price war. Secondly, Gazprom is facing an antitrust complaint filed by the European Commission for 'abuse of its dominant position'.

GAZPROM VS. US LNG COMPETITION: A PRICE WAR?

During the workshop, François Lévêque and the audience debated on whether there might be a price war between Gazprom and US LNG following the opening of competition for gas supply in Europe. Different perspectives were explored as to what Gazprom could expect in this matter, ranging from a relocation of part of its exports to Asia, to a strategy of profit maximizing by defending its existing market share in Europe. As for Lévêque, he admitted that it is difficult to assess with certainty that there will be a price war and, more importantly, who would be the winner. The retail price of gas is higher in Asia, which, from a seller's perspective makes it a more interesting market for export both for US LNG and Russian gas. As a matter of fact, it is expected that there will be more and more arbitrage for Europe and Asia in terms of gas supply.

Defending a Price Strategy or a Market Share Strategy?

However, considering that the production of gas in the European Union (EU) is declining and that the EU has initiated important reforms towards a decarbonized economy, the consumption of gas is likely to increase, which would trigger the need for more imports. [1] As a matter of fact, according to Lévêque, Gazprom should certainly defend their market share to maximize profits. Yet, the company could also force their prices on their customer by lowering the number of supplying contracts. A price strategy remains risky as this could provide incentives from the EU's end to increase competition, and import more US LNG at a lower price than Russian gas.

At the end of the day, underlined Lévêque, what Gazprom should fear the most is simply the perverse effect of the presence of another player on the market: even though the US would benefit more from selling their LNG on the Asian markets, the mere existence of the possible competition of US LNG imports in Europe can be sufficient to affect Gazprom's strategy and put a cap on their prices. To resume the case, it is not Gazprom vs. US LNG, but rather Gazprom vs. LNG.

Prospects for the Future of Gas Imports in Europe

Lévêque noted that several scenarios have to be considered regarding the future of gas in Europe by 2025. Firstly, we are likely to be looking at an increase in prices after 2025, especially as the EU fosters a low carbon economy, the result of which will certainly trigger a change in gas demand. Although, it is not clear whether to expect a drop or an increase in gas demand, as it is relayed in a study by the European think tank Bruegel: "Many business-as-usual scenarios foresee increasing gas import demand [in Europe by 2025]; however, all scenarios that implement the requirements of the Paris Climate Agreement lead to a dramatic drop in the demand for natural gas".[2] , For the professor from Mines-ParisTech, in all cases scenario the future of gas import in Europe is very uncertain after 2025.

In addition to the uncertainty of EU gas demand, Lévêque also pointed to some political concerns that could lead to a drop in imports of Russian gas to Europe. Firstly, the Trump administration is putting high pressure on Russian gas through the current sanctions regime and is causing dissension around the Nord Stream 2 pipeline. The EU Member States themselves are not actually unanimous on that matter either and hurdle around the questions of pipelines and transit. Nevertheless, this is a clear hamper on the ease of using Russian gas and has created a lot of uncertainty as to its stability. On top of that, one should remember that the 'clean energy package for all Europeans' is strongly incentivizing the usage of energy sources such as renewables and electricity. Finally, given the state of the relationship between Russia and the EU at the moment, the unpredictable behavior of EU policymakers is also an issue to be considered. In all those cases, we are again certainly looking at more arbitrage between the EU and the Asian market for Russian gas exports according to Lévêque.

Gazprom vs. the European Commission

Another concern that Lévêque highlighted is the antitrust case between Gazprom and the European Commission. This lawsuit was filed against Gazprom by the European Commission in 2015 for breaching EU antitrust rules. As per the official statement, the Commission accused Gazprom of 'pursuing an overall strategy to partition gas markets along national borders in eight Member States', and that 'this strategy may have enabled Gazprom to charge higher gas prices in five of these Member States' (see Figure 1).[3] In May 2018, the Commission then imposed a new set of rules that aim to change the way Gazprom sells gas to Europe, by enabling the free flow of gas in Central and Eastern Europe at competitive prices through:[4]

- No more contractual barriers to the free flow of gas;
- The obligation to facilitate gas flows to and from isolated markets;
- A structured process to ensure competitive gas prices;
- No leveraging of dominance in gas supply.

Although the lawsuit ended up in a settlement with Gazprom in May 2018, one may question the commitments, the possible failures or implementations to be carried out. As Lévêque puts it: "Was the case against Gazprom well founded? Was Gazprom's position on the market an infringement to the EU principles? At the end of the day, is the Commission right or wrong?" To him, it stands proven that there was verifiably unfair and excessive pricing of Russian gas towards the EU Member States, discriminations on the market as well as territorial restrictions, which indeed constitute an infringement of EU antitrust law. Lévêque noted that the case is also a matter of political economy; for the Europeans this is not about competition yet about the good functioning of the internal market.

1 Although considered counter-intuitive to some, the general expectation is that the transtition to a cleaner energy system will for the foreseeable future be strongly tied to an increased usage of natural gas. This is because, due to short response burn cycle, gas functions as the perfect back-up fuel for non-consistent renewables energy sources (solar, wind, etc.) whilst it also burns up to 60% cleaner than coal or oil.

2 Zachmann, G., 2018. LNG and Nord Stream 2 in the context of uncertain gas import demand from the EU. Bruegel, 28 September. Available at: http://bruegel.org/2018/09/lng-and-nord-stream-2-in-the-context-of-uncertain-gas-import-demand-from-the-eu/ [Accessed: 20 October, 2018].

3 European Commission, 2018. Antitrust: Commission imposes binding obligations on Gazprom to enable free flow of gas at competitive prices in Central and Eastern European gas markets. Press release [online]. Available at: http://europa.eu/rapid/press-release_IP-18-3921_en.htm [Accessed: 30 October 2018]

4 European Commission, 2018. Antitrust: Commission imposes binding obligations on Gazprom to enable free flow of gas at competitive prices in Central and Eastern European gas markets.

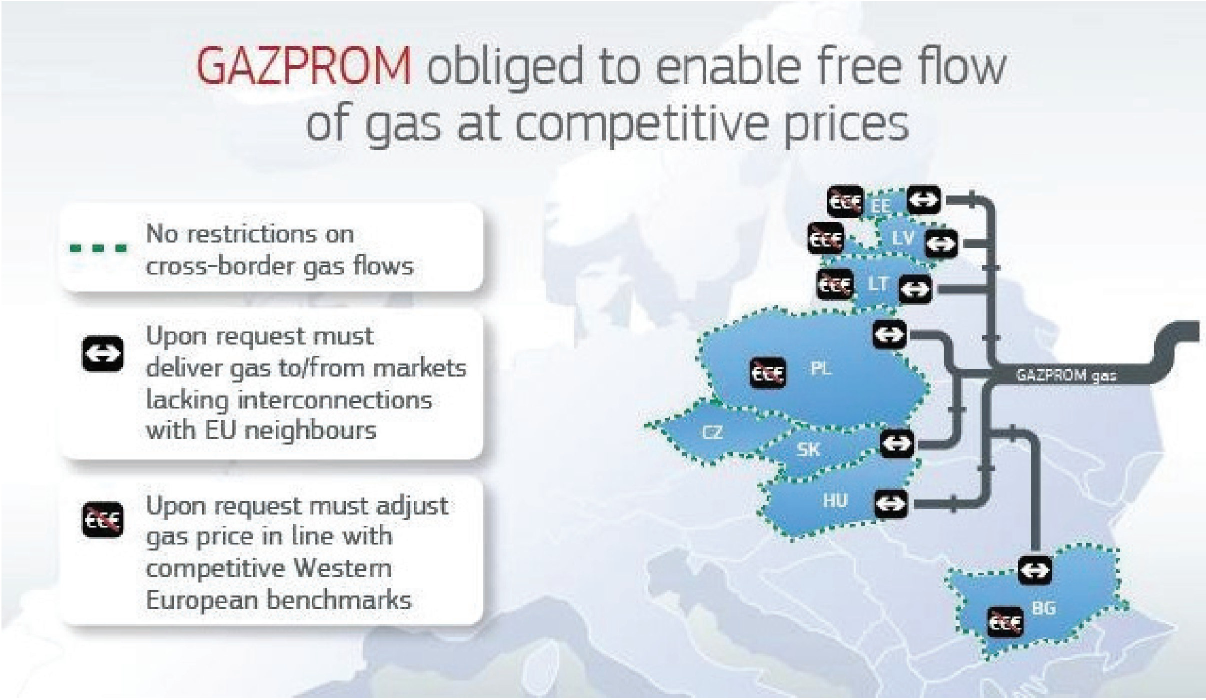

Figure 1. Visualization of the area contested in the latest lawsuit between the European Commission and Gazprom.
Source: European Commission

There are several pro and cons regarding the current issues of the law case, according to Lévêque. Firstly, if the settlement fails, which would result in a situation of prohibition of Russian gas, there would be a restructuration of the gas market in the EU, especially from Gazprom's end, in the form of sales of assets and gas releases, which can be considered a pro. However, this could also lead to damages for the private sector and to a long and uncertain process of readjusting to a new market reality, with the main question being where to find the missing gas. If Europe does receive some commitments from Gazprom's end (which would be the case with a settlement), this would mean an increase of competition (which can be considered a pro), although this competition would essentially be between Gazprom gas and Gazprom gas; they will not be able to monopolize pricing anymore, but would stay the only seller. Nevertheless, Lévêque would consider that to be a win-win situation: it would provide an immediate remedy to an antitrust situation whilst private parties could appeal to the settlement to get damages from litigation. It would also guarantee low prices for Central and East European countries (CEEC), security of supplies for consumers, as well as lower contributions from the Member States. However, it would rather transform the antitrust authorities into regulators, thus changing their function and de facto uncover a failure in the current legislation implementation.

To summarize, the lawsuit provides additional competitive pressure to Gazprom, which is most likely to increase in the future, adding above European gas market remains uncertain for Gazprom due to the openings for LNG in the EU gas market..

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FOSSIL FUEL RENT AND THE ENVIRONMENTAL KUZNETS CURVE: EVIDENCE FROM POST-SOVIET COUNTRIES

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Abstract

The Environmental Kuznets Curve (EKC) describes the relationship between economic growth and environmental degradation. This paper provides the EKC estimation for carbon dioxide emissions using panel data for the 15 countries of the former Soviet Union, spanning the period of 1990–2013. The study reveals a positive dependence between carbon dioxide emissions and fossil fuel rent in post-Soviet countries.

Key words: Environmental Kuznets Curve, former USSR, carbon emissions, panel data, fossil fuel rents, FDI

The fact that environmental pollution is associated with economic development is undeniable. Nevertheless, questions about the form of this dependence and the factors that can have an influence on it remain open. The first relevant studies in this field were initiated in the early 1970s and the most popular method of approach at present is the concept of the Kuznets Curve (KC). This curve is named after the American economist and Nobel Memorial Prize laureate Simon Smith Kuznets, who developed his model in the 1950s and presumed that economic inequality increases in parallel with per capita income to a certain threshold (turning point), after which it begins to decline.[1] The KC and its environmental application, known as the Environmental Kuznets Curve (EKC), were popularized by the works of Gene Grossman and Alan Krueger, Theodore Panayotou, and Nemat Shafik in the early 1990s.[2]

When applied in an environmental framework, the model assumes that the pollution-growth nexus has an inverted U-shape, conform to the shape it takes in the KC. It derives its shape from the idea that at the early stages of their development, a growing economy and industry lead to increased pollution. When a specific income, or 'turning point' is reached, the population will initiate the demand for environmental goods. The latter stimulates growth in cleaner technologies, which then leads to a decline in pollution. This process describes an inverted U-shaped curve. Some authors assert that if the benefits of the technologies that exist at the moment are exhausted in the process of time, then further growth could again lead to increased pollution (in which case we get a second turning point and an N-shaped curve).

Systematic analysis by Grossman and Krueger distinguished three effects relating to the impact of economic growth on pollution: the scale effect (increase in output leads to an increase in pollution), the technical effect (improving production techniques or adopting cleaner technology), and the composition effect (extension pollution-intensive activities as result from change in trade policy).[3]

More recent studies have greatly expanded on these considerations. Namely, it is now presumed that the scale effect does not necessarily lead only to an increase in pollution, as abatement technology could exhibit increasing returns to scale; effective abatement technologies can be economically viable only on a large scale.[4] Moreover, the technical effect increases with economic growth, since the possibility of investment in Research & Development (R&D) increases with the country's level of wealth.[5] Lastly, the composition effect has become associated not only with foreign trade, but also with structural changes in the economy during economic development; pollution increases as the economy shifts from agriculture to industry, but it begins to fall in the transition to a knowledge-based economy.[6] The effect of foreign trade was furthermore supplemented by the pollution haven hypothesis (PHH), which states that developed countries transfer pollution intensive industries to developing countries due to their lower environmental standards, hence growing production and export of such goods from

1 *Kuznets, S., 1955. Economic growth and income inequality. The American economic review, 45(1), pp.1–28.*

2 *Grossman, G.M. and Krueger, A.B., 1991. Environmental Impacts of a North American Free Trade Agreement. National Bureau of Economic Research, [Working Paper]. Available at: http://www.nber.org/papers/w3914; Panayotou, T., 1993. Empirical tests and policy analysis of environmental degradation at different stages of economic development. ILO Working Papers. International Labour Organization. Available at: https://ideas.repec.org/p/ilo/ilowps/992927783402676.html; Shafik, N., 1994. Economic development and environmental quality: an econometric analysis. Oxford economic papers, 46, pp.757–773.*

3 *Grossman, G.M. and Krueger, A.B., 1991. Environmental Impacts of a North American Free Trade Agreement.*

4 *Andreoni, J. and Levinson, A., 2001. The simple analytics of the environmental Kuznets curve. Journal of public economics, 80(2), pp.269–286.*

5 *Komen, M.H., Gerking, S. and Folmer, H., 1997. Income and environmental R&D: empirical evidence from OECD countries. Environment and Development Economics, 2(4), pp.505–515.*

6 *Panayotou, T., 2016. Economic growth and the environment. The environment in anthropology, pp.140–148.*

developing countries will lead to increased pollution there.[7] In addition to these effects, more recent research identifies a number of additional factors that affect the relationship of economic growth to pollution. Among them are population preferences: with economic development, people tend to make ever greater demands for a clean environment and are willing to pay for it and thus environmental regulation is introduced by governmental and non-governmental organizations.[8] [9] Additionally, there is foreign direct investment from developed to developing countries. This can be both a source of leading clean technology but can also influence the host country as illustrated by the PHH since lower environmental standards in developing countries encourage developed counties to transfer polluting enterprises there.[10]

Although there is a wide and varied body of literature on the EKC, the results of which generally suggest that income, energy consumption and trade are indeed significant factors, to the best of our knowledge this literature does not consider geographical features, such as climate and an abundance of fossil fuel resources as a factor.[11] The only exception we found is a 2016 study by Luis Sanchez and David Stern, titled 'Drivers of industrial and non-industrial greenhouse gas emissions', which analyzes the relationship between both industrial and non-industrial greenhouse gas emissions as well as economic growth and other potential drivers for 129 countries over the period from 1971 to 2010.[12] The authors did not find evidence for the existence of EKC in this case. However, their analysis did show a positive relationship between greenhouse gas emissions and economic growth in the case of industrial emissions and overall emissions. The results specifically show that fossil fuel endowment increases the rate of growth of industrial emissions. In addition, the effect of summer and winter temperatures varied for industrial and non-industrial emissions.

However, it is worth noting that an abundance of energy resources and the climate are often taken into account in the GDP studies of energy intensity and CO_2 emissions, detecting the convergence of GDP energy intensity, as well as in the analysis of energy efficiency in the countries and regions considered. The survey 'Convergence of carbon dioxide emissions: a review of the literature', realized by Fredrik Pettersson et al. in 2014 demonstrates convincing evidence in favor of existing CO2per capita convergence in OECD countries, yet elsewhere one can observe divergence or convergence from the level of OECD countries[13] The authors explain this phenomenon by not taking into account such factors as an abundance of energy resources and the climate.

To underline the importance of taking such factors a geography and resource prevalence into account, we can look at the 2015 publication 'Resource Abundance and Energy Intensity: A Cross Country Analysis' by Ismail Soile and Biodun Balogun, in which they revealed that the intensity of energy use in resource-rich countries is very different from that of resource-poor countries[14] In essence, this is because the impact of technological changes and energy prices depend on the availability of energy resources. Indeed, Paul Burke showed that resource-poor countries proceed more quickly to fewer polluting sources of energy due to this nexus.[15] In these cases, climate also is taken into account when modeling the energy demand function and energy efficiency using stochastic frontier analysis.[16]

Given the small amount of studies that take fossil fuel resources and climatic conditions into account when using the EKC, this study makes the following contribution to already existing body of literature on the EKC: we introduce the factor of the abundance of fossil energy resources and climatic features in the context of the classic EKC analysis. In doing so, we focus on the environmental pollution due to CO2 emissions from fuel combustion in 15 countries of the former USSR, which became independent states in 1990-91.

The former Soviet Union (FSU) is particularly interesting to study for several reasons: Firstly, according to the International Energy Agency (IEA), the quantity of CO2 emitted

7 Dinda, S., 2004. Environmental Kuznets curve hypothesis: a survey. Ecological economics, 49(4), pp.431–455; Wagner, U.J. and Timmins, C.D., 2009. Agglomeration effects in foreign direct investment and the pollution haven hypothesis. Environmental and Resource Economics, 43(2), pp.231–256.

8 Roca, J., 2003. Do individual preferences explain the Environmental Kuznets curve? Ecological Economics, 45(1), pp.3–1.

9 Dasgupta, S., Laplante, B., Wang, H. and Wheeler, D., 2002. Confronting the environmental Kuznets curve. Journal of economic perspectives, 16(1), pp.147–168.

10 Gallagher, K.S., 2003. Foreign technology in China's automobile industry: implications for energy, economic development, and environment. China Environment Series, 6, pp.1–18; Wagner, U.J. and Timmins, C.D., 2009. Agglomeration effects in foreign direct investment and the pollution haven hypothesis.

11 Important literature on the EKC includes: Cole, M.A., 2004. Trade, the pollution haven hypothesis and the environmental Kuznets curve: examining the linkages. Ecological economics, 48(1), pp.71–81; Halicioglu, F., 2009. An econometric study of CO2 emissions, energy consumption, income and foreign trade in Turkey. Energy Policy, 37(3), pp.1156–1164; Naranpanawa, A., 2011. Does trade openness promote carbon emissions? Empirical evidence from Sri Lanka. The Empirical Economics Letters, 10(10), pp.973–986; Jayanthakumaran, K., Verma, R. and Liu, Y., 2012. CO2 emissions, energy consumption, trade and income: a comparative analysis of China and India. Energy Policy, 42, pp.450–460; Suri, V. and Chapman, D., 1998. Economic growth, trade and energy: implications for the environmental Kuznets curve. Ecological economics, 25(2), pp.195–208; Choi, E., Heshmati, A. and Cho, Y., 2010. An Empirical Study of the Relationship between CO2 Emissions, economic growth and openness. Economic Growth and Openness, IZA DP No-5304; Managi, S., Hibiki, A. and Tsurumi, T., 2009. Does trade openness improve environmental quality? Journal of environmental economics and management, 58(3), pp.346–363.

12 Sanchez, L.F. and Stern, D.I., 2016. Drivers of industrial and non-industrial greenhouse gas emissions. Ecological Economics, 124, pp.17–24.

13 Pettersson, F., Maddison, D., Acar, S. and Söderholm, P., 2014. Convergence of carbon dioxide emissions: a review of the literature. International Review of Environmental and Resource Economics, 7(2), pp.141–178

14 Soile, I. and Balogun, B., 2015.. Middle Eastern Finance and Economics, Issue 13. Available at: <https://ssrn.com/abstract=2621002>.

15 Burke, P.J., 2013. The national-level energy ladder and its carbon implications. Environment and development economics, 18(4), pp.484–503.

16 Stern, D.I., 2012. Modeling international trends in energy efficiency. Energy Economics, 34(6), pp.2200–2208; Filippini, M. and Hunt, L.C., 2011. Energy demand and energy efficiency in the OECD countries: a stochastic demand frontier approach. The Energy Journal, pp.59–80; Shui, H., Jin, X. and Ni, J., 2015. Manufacturing productivity and energy efficiency: a stochastic efficiency frontier analysis. International Journal of Energy Research, 39(12), pp.1649–1663.

by the FSU has decreased by 1.5 times between 1990 and 2013, while global CO2 emissions increased by a factor of 1.5 in the same period.[17] It is possible to explain CO2 reductions at the beginning of the reviewed period by a significant fall in GDP due to the collapse of the USSR. However, at the end of the period, 11 out of 15 countries had a GDP which significantly exceeded their 1990-1991 level. Secondly, an enormous reserve of fossil fuel lies in the territory of the former Soviet Union. Before the collapse of the USSR, the planned economy of the unified economic space gave each Soviet republic access to these natural riches, while low domestic energy prices (that did not vary substantially country to country) made the incentive for effective energy use very low. In combination with the development priorities fostering heavy manufacturing, the Soviet economy became one of the most energy and carbon intensive in the world. However, recently the situation has changed dramatically as the GDP has been growing in the FSU while carbon intensity has been decreasing. Naturally, this change is not uniform. For instance, some FSU countries have specialized in the production and sale of energy resources while the stocks of energy resources of other countries are limited, and they have to buy them on the international market, further increasing the interest to study the region. Lastly, some of these countries have already shifted from a command to a market economy, while others are still undergoing this process. Processes of rapid liberalization occurred in different fields, including international trade. Three countries joined the EU, which presumes some opportunity for adopting cleaner technologies and to reduce GDP carbon intensity. The fast transition from a common economic space and state ownership of resources to the current situation makes this country sample especially interesting for examining the link between economic growth, pollution and an abundant presence of fossil fuel resources.

Note that EKC studies can be carried out both on a broad sample of countries as well as on regional subsamples. Generally, authors try to use the data for the longest possible period of time, usually from 1960 or earlier. As the FSU came into existence only in 1990-1991, however, as a rule these countries lie beyond the scope of such studies and we are thus bound to limit ourselves to a relatively short timeframe.

To the best of our knowledge, there are few papers dealing with the existence of EKC in the post-Soviet space. Indeed, the effects of de-modernization and militarization were studied.[18] Similarly, the impact of corruption has been explored within the framework of EKC.[19] Furthermore, in their 2016 publication 'The impact of international trade on environmental quality: The case of transition countries', Ferda Halicioglu and Natalya Ketenci supported the EKC hypothesis only in the cases of Estonia, Turkmenistan and Uzbekistan, leaving the majority of the FSU yet unexplored in terms of an EKC analysis.[20]

Therefore, this paper tries to answer the following questions:

- What form does the environmental Kuznets curve take in the FSU countries?
- Does the abundance of fossil fuel resources lead to lower environmental sustainability?
- Does trade liberalization ipso facto lead to higher environmental sustainability?

METHODOLOGY

In order to answer these questions, the authors use the classic EKC equation:

$$\log P_{it} = a + b_1 \log GDPPC_i + b_2 \log GDPPC_i^2 + b_3 \log GDPPC_i^3 + control\ variables + e_i, \quad (1)$$

where P_{it} is pollution in country i in year t, $GDPPC_{it}$ is GDP per capita, i is a country index, t is a year index e_{it} is the error term. In the literature there are three basic variants for the dependent variable: per capita emissions, total emissions and emission intensity. If

$$b_2 = b_3 = 0,$$

we have monotonous rise

$$(b_1 > 0)$$

or decline

$$(b_1 < 0).$$

If $b_2 < 0, b_3 = 0,$

we get the so-called inverted U-shape, which is symmetric with respect to the turning point

$$-\frac{b_1}{2b_2}.$$

If $b_2 > 0, b_3 = 0$ (or $b_2 < 0, b_3 = 0$),

we get the so-called U-shape (or inverted U-shape), which is symmetric with respect to the turning point

$$-\frac{b_1}{2b_2}.$$

If $b_3 > 0, b_2^2 - 3b_3b_1 > 0$

we observe so called N-shape (rising, falling, rising).

Even if the second rising piece is outside the range of data

17 IEA, 2015. CO2 Emissions From Fuel Combustion. Highlights 2015. Available at: <www.iea.org/publications/freepublications/publication/CO2EmissionsFromFuelCombustionHighlights2015.pdf>

18 York, R., 2008. De-carbonization in former Soviet republics, 1992–2000: The ecological consequences of de-modernization. Social Problems, 55(3), pp.370–390.

19 Bae, J.H., Li, D.D. and Rishi, M., 2017. Determinants of CO2 emission for post-Soviet Union independent countries. Climate Policy, 17(5), pp.591–615.

20 Halicioglu, F. and Ketenci, N., 2016. The impact of international trade on environmental quality: The case of transition countries. Energy, 109, pp.1130–1138.

(and we have a simple increasing and decreasing pattern), rise and fall in this case may have different speeds because the EKC does not have to be symmetric. It is possible to estimate (1) in levels or in logarithms.[21]

In this paper, the model used is the N-shaped model, since it is more general and flexible than the U-shaped one. We chose carbon dioxide emissions per capita as the dependent variable, because this global indicator is more suitable for cross-country studies than for instance carbon monoxide, methane, or nitrous oxide.

To investigate the effect of the abundance of fossil fuel resources present in the region we include fossil fuel rent (the sum of natural gas, oil, and coal rents) into the vector of controlling variables.

Note that in the aforementioned paper of Sanchez and Stern, which counts as an outlier in the EKC literature as their analysis was more broad and considered, for instance, industrial emissions separately, the estimated per capita fossil fuel endowments in 1971 were used as a measure of the abundance of fossil fuel, which is a stock variable and not a flow one).[22] Choosing this indicator, the authors follow Catherine Norman, who in her paper 'Rule of law and the resource curse: abundance versus intensity', explores the relationship between the presences of resources and rule of law.[23] In our opinion, such a choice is justified for the investigation of the effect of the resource curse on institutions, as institutions by their nature form over time. However, this is uncertain with respect to a study that seeks to evaluate the influence of natural energy resources on CO2 emissions intensity.

Here, we appeal to the concept of the carbon curse as defined by Jörg Friedrichs and Oliver Inderwildi in their 2013 paper 'The carbon curse: Are fuel rich countries doomed to high CO 2 intensities?', and in which they define that fossil-fuel rich countries follow more carbon-intensive developmental trajectories than (if they were) fossil-fuel poor countries.[24] The authors substantiate the existence of a carbon curse on the basis of the following phenomena: gas flaring, reducing incentives for energy efficiency because of the availability of fossil fuel, disparagement of less dirty energy sources, and uneconomic fuel consumption subsidies. In our opinion, fossil fuel rent is the best means to 'capture' these indicators of the carbon curse phenomenon (aside from gas flaring). Indeed, fuel producing countries have very different break-even points. For instance, a large surplus value after all costs and normal returns without extracting oil, gas, and coal can be the cause of reducing incentives for energy efficiency and provide the luxury of establishing fuel consumption subsidies in domestic countries. Some empirical confirmation of this position can be found in Elina Brutschin and Andreas Fleig's 2016 paper 'Innovation in the energy sector – The role of fossil fuels and developing economies'. This research provides evidence that the higher level of fossil fuel rents is associated with a lower level of innovation in the energy sector.[25]

In addition to fuel fossil rent, which we have discussed in the previous section, we include several controlling variables, such as trade openness (the sum of export and import), since trade liberalization may influence the environment in different ways. To account for countries' energy efficiency level, we consider energy intensity that is the ratio between total primary energy consumption and gross domestic product. We assume a negative effect on emissions. Additionally, it is interesting to include FDI, since the positive effect of FDI on pollution can indirectly speak in favor of the pollution haven hypothesis.

A common opinion is that the strict EU environmental legislation urges its members to reduce polluting emissions, so we include an EU dummy[26] in (1) as a controlling variable.
It seems reasonable to introduce industrialization and urbanization as controlling variables, which indicate demographic pressure on the environment. Although these processes are not identical, they are often joined together because they increase energy use and, consequently, emissions. Industrialization as a rule is measured by the industry share in GDP. The share of GDP from the service sector is also used, but here the opposite effect is expected. Many empirical studies have revealed positive impacts of industrialization and urbanization on environmental pollution.[27]
Despite the common history of the FSU countries, we should also consider their heterogeneity. A division by income level is not suitable because it changed substantially during the period reviewed. An account of the climatic characteristics seems however more promising. Sanchez and Stern note contradictory results arising from the use of temperatures and they resorted to climate types to explain them.[28] We discarded the average summer and winter temperatures in this case, as the size of some countries is such that average temperatures are meaningless.

Therefore, we divided the FSU countries into groups based on the Köppen-Geiger climate classification. Although this could be considered a somewhat general division, as there

21 *For more details on EKC econometric specifications, see: Kaika, D. and Zervas, E., 2013. The Environmental Kuznets Curve (EKC) theory—Part A: Concept, causes and the CO2 emissions case.*

22 *Sanchez, L.F. and Stern, D.I., 2016. Drivers of industrial and non-industrial greenhouse gas emissions.*

23 *Norman, C.S., 2009. Rule of law and the resource curse: abundance versus intensity. Environmental and Resource Economics, 43(2), p.183.*

24 *Friedrichs, J. and Inderwildi, O.R., 2013. The carbon curse: Are fuel rich countries doomed to high CO 2 intensities? Energy Policy, 62, pp.1356–1365.*

25 *Brutschin, E. and Fleig, A., 2016. Innovation in the energy sector – The role of fossil fuels and developing economies. Energy Policy, 97, pp.27–38.*

26 *An EU dummy variable is equal to one if the country is an EU member and zero otherwise.*

27 *Cole, M.A., 2004. Trade, the pollution haven hypothesis and the environmental Kuznets curve: examining the linkages; Poumanyvong, P. and Kaneko, S., 2010. Does urbanization lead to less energy use and lower CO2 emissions? A cross-country analysis. Ecological Economics, 70(2), pp.434–444; Martínez-Zarzoso, I. and Maruotti, A., 2011. The impact of urbanization on CO2 emissions: evidence from developing countries. Ecological Economics, 70(7), pp.1344–1353; Li, K. and Lin, B., 2015. Impacts of urbanization and industrialization on energy consumption/CO2 emissions: does the level of development matter? Renewable and Sustainable Energy Reviews, 52, pp.1107–1122.*

28 *Sanchez, L.F. and Stern, D.I., 2016.*

are several climatic zones on the territory of each country, the authors still felt that this was the most accurate (existing) model to use for the region's division. Our partition is as follows:

- Group 1. Belarus, Estonia, Latvia, Lithuania, Moldova, Russian Federation, and Ukraine;
- Group 2. Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyz Republic, Tajikistan, Turkmenistan, and Uzbekistan.

To some extent, this also corresponds to the division of North/ South or urban/traditional cultures. The method of converting data initially in national currency units to a common currency for the purpose of international comparison is a controversial issue in cross-country EKC analyses. There are two approaches to converting GDP (and other indicators measured in monetary units): purchasing power parity exchange rates (PPP) or market exchange rates. The economic size of a country, especially of a developing country, can be significantly affected by the converting method.

In this study, the choice must be made for per capita GDP and turnover indicators, i.e., export and import. Choosing the market exchange rate seems natural for exports and imports since tradable goods are being traded at market exchange rates. We make the same choice for per capita GDP for two reasons. The first reason is mainly technical: it seems reasonable that all the variables in the regression are converted consistently. The second reason is linked to the issue of data quality. Purchasing power parity is an excellent theoretical concept, yet there are many difficulties in its measurement. Deaton conducted a detailed analysis of the conceptual and measuring difficulties in calculating PPP.[29] These difficulties comprise issues associated with cross-country comparisons of GDP components such as government services, education, health, construction and rental housing. In addition, PPP concentrates on consumer spending, while consumption of the manufacturing sector is practically ignored. Deaton also emphasizes the particular difficulties arising in the calculation of PPP in the countries of the former Soviet Union, which are associated with rapid changes in economic structure and the difficulties of price collection during their liberalization.[30] Finally, it is well known that the use of PPP is most suitable in comparing countries with very different income levels, such as the US and African countries. However, in this case, the income levels among former Soviet Union countries did not differ that much, especially at the beginning of the transition period. Thus, the arguments against the use of market exchange rates outweighed the benefits.

DATA AND MODEL OF THE STUDY

The data for this study comes from the World Bank's World development indicators and the IEA Report 'CO_2 Emissions from Fuel Combustion Highlights'.[31] We used the following indicators:

- *CO2pc – CO2 emissions per capita, (tons CO2 / capita), IEA*
- *GDPpc – GDP per capita, (constant 2010 US$), WDI*
- *RENTS – fossil fuel rent (sum of natural gas, oil, and coal rents (% of GDP)), WDI*
- *EI – energy intensity level of primary energy (MJ/$2011 PPP GDP), WDI*
- *EXPORT – export of goods and services (% GPD), WDI*
- *IMPORT – import of goods and services (% GPD), WDI*
- *FDI – foreign direct investment, net inflows (% of GDP), WDI*
- *Agriculture – agriculture, value added (% of GDP), WDI*
- *Services – services, value added (% of GDP), WDI*
- *URBAN – share of urban population, WDI*
- *EU – dummy variable for EU members*

Our results are based on national-level data for 15 countries of the FSU, collected over the period 1990-2013. Table 1 provides descriptive statistics for 2012.

Variable	Obs	Mean	Std. Dev.	Min	Max
CO2pc	15	5.55	4.59	0.35 (Tajikistan)	13.93 (Kazakhstan)
GDPpc	15	6493.13	5169.90	821.37 (Tajikistan)	16677.99 (Estonia)
RENTS	15	9.89	14.58	0 (Armenia, Latvia, Moldova)	40.29 (Azerbaijan))
EI	15	8.43	3.98	3.88 (Azerbaijan)	16.61 (Turkmenistan)
EXPORT	15	50.57	21.72	21.54 (Tajikistan)	86.58 (Estonia)
IMPORT	15	58.15	24.05	20.60 (Russian Federation)	95.27 (Kyrgyz Republic)
FDI	15	4.32	2.42	1.10 (Ukraine)	8.90 (Turkmenistan)
Agriculture	14	10.83	7.56	3.67 (Latvia)	26.60 (Tajikistan)
Services	14	57.47	11.27	31.46 (Azerbaijan)	72.28 (Tajikistan) (Latvia)
URBAN	15	55.73	15.07	26.57 (Tajikistan)	75.47 (Belarus)

Table 1. Descriptive statistics, 2012

29 Deaton, A. and Heston, A., 2010. Understanding PPPs and PPP-based national accounts. American Economic Journal: Macroeconomics, 2(4), pp.1–35.

30 Ibid.

31 World Development Indicators | DataBank, 2019. Available at: https://databank.worldbank.org/data/source/world-development-indicators; IEA, 2015. CO2 Emissions From Fuel Combustion. Highlights 2015.

Now then the equation takes the following form:

$$\ln CO2pc_{it} = \alpha_i + \delta_t + \beta_1 \ln GDPpc_{it} + \beta_2 \ln^2 GDPpc_{it} + \beta_3 \ln^2 GDPpc_{it} + \gamma_1 \ln EI_{it} + \gamma_2 RENTS_{it} + \gamma_3 \ln URB_{it} + \gamma_4 \ln FDI_{it} + \gamma_5 \ln \text{Agriculture}_{it} + \gamma_6 \text{Services}_{it} + \gamma_7 open_{it} + \gamma_8 EU_{it} + \varepsilon_{it}. \quad (2)$$

To allow for the regions' heterogeneity, we use a fixed effects model (individual intercepts α_i can be treated as fixed parameters) and a random effects model (individual intercepts α_i can be treated as drawings from distribution with the mean α). We allow for both country-effects to capture country specific factors, and time-effects (to capture global impacts, such as energy prices).

EMPIRICAL RESULTS

The estimation results for Group 1 are given in Table 2.

VARIABLES	Model 1 lnCO2pc	Model 2 lnCO2pc
lnGDPpc	16.63***	19.69***
	(2.918)	(2.695)
$lnGDPpc^2$	−1.911***	−2.252***
	(0.361)	(0.324)
$lnGDPpc^3$	0.0758***	0.0892***
	(0.0148)	(0.0128)
lnEI	0.464***	0.584***
	(0.116)	(0.131)
lnRENTS	0.00501***	0.00525***
	(0.00111)	(0.000906)
lnURBAN	−0.157	
	(0.425)	
lnFDI	0.00185	
	(0.00535)	
lnAgriculture	0.00484**	0.00572**
	(0.00187)	(0.00212)
lnServices	−0.00510***	−0.00327*
	(0.00148)	(0.00179)
open	−0.000121	
	(0.000182)	
EU	0.00277	
	(0.0173)	
Observations	140	149
Number of groups	7	7

Standard errors in parentheses
****** p<0.01, ** p<0.05, * p<0.1***

Starting with Model 1, which is more general, we found that urbanization, FDI, EU membership and trade openness have insignificant coefficients. Likely, urbanization insignificance is due to its high level (66% in average, minimum 44, maximum 75). EU membership also has no effect on pollution, which is interesting but possiblly explained by the following reasons: Firstly, Estonia satisfies almost all of its energy needs from shale oil, one of the most emissions intensive fossil energy sources (Europe's largest deposits of shale oil are located on Estonian territory). Besides, in 2009 Latvia closed the Ignalina Nuclear Power Plant under pressure from the EU, whereupon it has increased consumption of fossil fuel and, consequently, CO2 emissions from its combustion.32 As for the insignificance of FDI, this is a little disappointing on the one hand, as it means that FDI does not improve technology. On the other hand, however, it assures that these FSU countries have not become pollution havens. The negative coefficient of value-added services is very encouraging, reflecting the fact that reducing the industry share leads to a reduction of emission.

Estimation results for Group 2, which are given in Table 3, are slightly different, and speak in favor of the countries' differentiation:

VARIABLES	(1) lnCO2pc	(2) lnCO2pc
lnGDPpc	1.292	2.087***
	(2.918)	(0.345)
$lnGDPpc^2$	−0.0195	−0.0647***
	(0.382)	(0.0157)
$lnGDPpc^3$	−0.000681	
	(0.0167)	
lnEI	1.133***	1.254***
	(0.0364)	(0.0620)
RENTS	0.00215***	0.00299***
	(0.000714)	(0.000912)
lnURBAN	1.378***	1.618***
	(0.428)	(0.457)
lnFDI	0.00785	
	(0.00860)	
Agriculture	−0.00145	
	(0.00181)	
Services	−0.00164	
	(0.00237)	
open	−0.000902	
	(0.000611)	
Observations	146	176
Number of groups	8	8

Standard errors in parentheses
****** p<0.01, ** p<0.05, * p<0.1***

Table 3. Estimation results for Group 2.

32 *Brizga, J., Feng, K. and Hubacek, K., 2014. Drivers of greenhouse gas emissions in the Baltic States: A structural decomposition analysis. Ecological Economics, 98, pp. 22-28.*

Here, we observe not an N-shaped but an inverted U-shaped form ($b_2 < 0, b_3 = 0$) with a turning point at 16.13. However, the sample log of GDPpc varies from 5.8 to 9.2. Thus, the observations lie on the increasing branch of the parabola. As highlighted above, we detect positive dependence of carbon dioxide emissions on fossil fuel rents. Value added in agriculture and services sectors have an insignificant impact and, as opposed to group 1, the share of urban population has a significant positive effect. FDI again seems to be insignificant, likely for the reasons elaborated on above. In conclusion, we can state that despite the fact that both groups exhibit positive effects of fossil fuel rent on carbon dioxide emissions, there is a significant difference in their EKC shapes, as well as in the value and significance of other factors.

After verifying the joint insignificance (the corresponding probability is 0.78), we proceeded to Model 2. As expected, the N-shape hypothesis is confirmed. To verify this, it is enough to look at the signs of the estimated coefficients of model (1) in the table 2: indeed, $b_3 > 0, b_2^2 - 3b_3 b_1 > 0$

In other words, GDP per capita growth leads to an increase of CO2 emissions. It is worth to note that our sample log of GDPpc varies from 6.85 to 9.77, and within these limits the curve is almost horizontal. Moreover, we revealed significant positive dependence of the carbon dioxide emissions on fossil fuel rents.

As noted above, the division of the Group 1/Group 2 also corresponds to the division of the North/South or urban/traditional cultures. The difference in the relationship between economic growth and environmental degradation between the Group 1 and the Group 2 can be reflection of the global North-South Divide into the post-Soviet space.[33] The more agrarian south of the post-Soviet space may differ significantly from the more industrialized north.

CONCLUSION

This paper adds some empirical evidence to the debate on the relationship between an abundance of fossil fuel resources, economic growth and the environmental situation in developing countries. Herein lies the confirmation that fossil fuel rent and urbanization have had a positive effect on carbon dioxide emissions in the FSU countries from 1990 to 2013. The insignificance of EU membership is a rather unexpected result, but explicable when considering the increase of shale gas and decrease of nuclear power in group 1's overall energy mix.

In addition, the model revealed that the inflow of foreign direct investment does not affect air pollution. One would expect that in case of the pollution haven hypothesis, not only exports from the FSU but also FDI into polluting sectors might shift the Kuznets curve to the right. It is very likely that country level data can veil the effect at the industry level. However, due to the lack of data, the total flow of investment in all sectors was examined. This requires further analysis.

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33 *Reuveny, R. X., and. Thompson W. R., 2007. The North–South divide and international studies: A symposium. International Studies Review, 9.4 pp. 556-564.*

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