BACK TO ORIGINS? ECONOMIC SANCTIONS AND SHIFTS IN PRIMARY ENERGY CONSUMPTION OF THE TARGETED STATES

by

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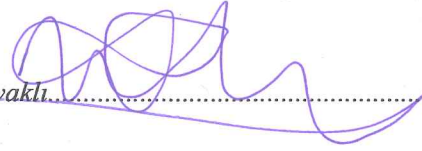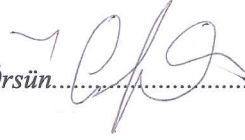
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ABSTRACT

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Keywords: economic sanctions, total primary energy consumption, energy mix, renewable energy, fossil fuels

This paper explores the relationship between economic sanctions and total primary energy consumption of the targeted states. Iran and Panama serve as illustrative cases to depict the mechanisms by which this association exists. This study utilizes the interrupted time series across the individual cases of Iran and Panama over the period from 1975 till 2004. Since targeted countries tend to hide the real effects of economic sanctions, the total primary energy consumption trends comprise an accessible indicator that sender countries and policy makers may evaluate. While sanctioned states are faced with economic constraints and limited investments at hand, they are compelled to shift the investments to more cost-effective options. Study finds the long-term increasing trends in the share of fossil fuels within Iranian energy mix, largely endowed with hydrocarbons. While for Panama, rich with renewable energy, results indicate a reversal of the trends followed by a long-term shift towards non-renewable path of consumption. It seems that existing inland renewable endowments do not play a primary role for a targeted state when faced with economic sanctions. On the other hand, high initial capital expenses required for installing renewable energy plants comprise a factor that divert energy preferences towards expanding usage of hydrocarbons at times of economic sanctions.

ÖZET

KÖKLERE DÖNÜŞ? EKONOMİK YAPTIRIMLAR VE HEDEF ÜLKELERDE TEMEL ENERJİ TÜKETİMİNDEKİ DEĞİŞİM

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Anahtar Kelimeler: ekonomik yaptırımlar, temel enerji tüketimi, enerji karışımı, yenilenebilen enerji, fosil yakıt

Bu çalışma ekonomik yaptırımlar ve hedef devletin toplam enerji tüketimi arasındaki ilişkiyi inceler. Iran ve Panama, bu ilişkinin işleyişini açıklayan örnekler olarak ele alınmıştır. Bu araştırma, kesikli zaman serileri kullanarak, 1975'ten 2004'e kadar olan süreçte Iran ve Panama örneklerine yer verir. Hedef ülkeler yaptırımların gerçek etkilerini saklamaya meyilli olduklarından, toplam temel enerji tüketimi eğilimleri ulaşılabilir bir gösterge olarak yaptırım uygulayan ülkeler ve politika oluşturanlar tarafından değerlendirilebilir. Yaptırım uygulanan ülkeler ekonomik kısıtlamalarla ve sınırlı yatırımlarla karşı karşıya kalırken, yatırımlarını daha uygun maliyetli seçeneklere yöneltmeye zorlanırlar. Sonuçlar, uzun vadede geniş hidrokarbonla donatılmış İran'ın, enerji karışımındaki fosil yakıtların payının artmaya meyilli olduğunu gösterir. Bununla birlikte, yenilenebilen enerji bakımından zengin olan Panama'da uzun vadede yenilenemeyen enerji tüketiminde artış gözlemlenir. Görünen o ki, var olan yenilenebilir enerji kaynakları, ekonomik yaptırımlar söz konusu olduğunda ikinci plana atılabilmektedir. Diğer bir taraftan, yenilenebilir enerji teknolojisinin inşaasının yüksek maliyetli oluşu, ekonomik yaptırım zamanlarında enerji tercihlerini hidrokarbon kullanımına yönelten önemli bir faktör olarak karşımıza çıkar.

To my Father

ACKNOWLEDGEMENTS

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LIST OF SYMBOLS AND ABBREVIATIONS:

FF: Fossil Fuels

GDP: Gross Domestic Product

KTOE: thousand tonnes of oil equivalent

MTOE: million tonnes of oil equivalent

Non-RE: Non-renewable

Non-RET: Non-renewable technologies

RE: Renewable energy

RET: Renewable energy technologies

Sasol: South African Coal, Oil and Gas Corporation

TPES: Total Primary Energy Supply

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INTRODUCTION

Most of us know the ancient Greek legend about Prometheus who was entitled to spread Zeus' numerous gifts to various creatures living in the world. Prometheus distributed all these splendid endowments among the creatures, but when man's turn came, none was left. The end of the story may be more familiar to a reader. Due to his deep love for humanity, Prometheus decided to bring the most valuable piece, the part of the Sun, i.e. fire to mankind. Zeus was so angry to Prometheus that he sanctioned him to the greatest punishment. Zeus chained him to a rock and every day eagles ate the liver of the titan.

Inventing such a narrative ancient Greeks were in some measure right, as every story has a true part in it. It was the fact that fire brought by Prometheus to the Earth as an energy releasing process, was a part of the Sun. Be it muscle power that people primarily used in preindustrial times, be it coal, or oil masses suppressed in million years under the Earth. Be it McDonalds' burger or delicious kebab, - all these are the products of photosynthesis, the process with an inevitable presence of the Sun.

Even though ancient Greeks mistakenly conceptualized fire as a piece of Sun itself, and since we know that fire constitutes an energy release process from burning hydrocarbons, perhaps what Prometheus brought to the Earth was nothing much but a simple piece of burning animal waste or biological waste from Earth.

The ancient Greek narrative brings us to the notion of the light and energy, which have been not only at the center of human activities and progress of humanity for centuries, but also at the heart of numerous conflicts. Conflicts over vital energy sources are one of the most frequent conflicts and disputes between and within states. Not only scarcity or abundance of energy sources have instigated more domestic and international conflicts known today such as those in South Sudan, Nigeria, and Iraq, it seems that advantages of possessing larger volumes of resource endowments have been likely to fuel the warring capabilities of state and non-state actors, granting an upper hand in disputes (Colgan, 2011; Van de Graaf & Colgan, 2017). Moreover, tremendous reliance of economies on the fossil fuels and the lack of domestic reserves shaped interstate relations and foreign policy of many states (Klare, 2014; Maugeri, 2006). In the resource-conflict literature we see that state-sponsored repression, severity and duration of the violent conflicts, and propensity to political instability are highly associated with the large presence or absence of hydrocarbons.

While many scholars have focused on the role of energy in the onset and unfolding of conflict (Colgan, 2011; Le Billon, 2001; Lujala, 2008; Ross, 2004), few look, in turn, the effect of interstate conflict on the use of energy in its aftermath. Given that interstate conflicts bring wide spectrum of immediate and long-term economic and political repercussions, the use of energy in the aftermath of conflict may tell a lot about direct impacts on the human well-being. Meeting the basic needs of people such as healthcare, education, or even simply an access to heating and cooking, - are contingent on the availability and effective distribution of energy which is affected by conflicts.

However, not only energy sources have been a focal point in many conflicts, their presence and particularly their usage have been at the center of the climate change debate. The climate change, which is mainly caused by increasing volumes in the global carbon-dioxide emissions from burning of hydrocarbons, increase of the Earth temperatures, as recent research suggests, would bring many complexities and challenges to almost all aspects of human existence (Stocker et al., 2013). Economic growth in many regions of the world has already been impaired by the increase of natural disasters like hurricanes and increase in droughts and rainfalls. Even at the end of 20th century the anthropogenic impact on the environment has been already observed in many regions of the world. For instance, due to the increased number of droughts and water shortages the problems with the access to sanitation and safe water supplies have exacerbated the underdeveloped and

the most vulnerable groups living in Africa in 1990s (GEO, 1999). Ten years later, as we entered the 21th century, the overall damages that were brought by "climatological disasters" increased more than 50 % in volume, according to the Centre for Research on the Epidemiology of Disasters (Guha-Sapir, Vos, Below, & Ponserre, 2012). Moreover, the rise in the sea levels as prognosed will lead to catastrophic massive human displacements. Therefore, the negative impact of rising concentration of greenhouse gases, if follows the same trend, would drastically change many aspects of humans' lives and would pose even more challenges to states.

Among the many spheres to be affected most strikingly by the global climatic changes is the security realm. By threatening the physical livelihoods that result in land degradation, deforestation, resource scarcity, increase in number of rainfall and droughts across different geographies climate change brings essential dangers that comprise increasing propensity of violent conflict, protracting the existing social conflicts, and putting individuals' security under the numerous risks (Barnett, 2003; Barnett & Adger, 2007; Podesta & Ogden, 2008; Salehyan, 2008; Trombetta, 2008). Moreover, the heavier competition over the resources, provision of the access to resources, mitigation of negative impacts on the livelihoods, and management of mass human movements will soon comprise usual challenges for international and national authorities. Therefore, calls for reductions of carbon dioxide and other anthropogenic gases to the atmosphere that is accounted as the major cause of the climate change, are becoming more and more frequent guests on the international agenda.

Creation of the international institutions and national plans concerned with the global warming seem to be insufficient mechanisms for the mitigation of the climate change. Taking into consideration that deleterious consequences of climate change are not immediately visible, and the fact that many states, especially emerging economies, have been reluctant to compromise developmental needs by cutting the use of fossil fuels for their expanding economies, it seems that regardless of many attempts, yet there is no an effective mechanism to force states to decrease their fossil fuels consumption and depart from the carbon-heavy paths of development.

Within the threats that excessive CO_2 emissions pose to the sustainability and endurance of global peace, it is essential to understand how conflicts change the energy consumption patterns and the way energy is used prior and in the aftermath of conflicts. Although considered as a more effective alternative to war, economic sanctions, is one of

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the forms of contemporary conflict-waging, which have complex consequences on the many aspects critical to political, economic, social and environmental realities.

All in all, it is important to notice the relationship that energy has on three dimensions. First, energy as a strategic source has been central to many conflicts and wars. Second, in the long-term the way energy is used by states is crucial to climate change (carbonization of economies). In turn, the climate change seems to pose additional security threats to the human existence globally. Therefore, to make more accurate and relevant predictions about the future, we have to look at the trends in the energy usage in the aftermath of the conflicts.

The chapters are organized as follows. First chapter present the main literature debates and maps out the relationship studied. Then a theoretical framework of the mechanisms by which economic sanctions have on the energy consumptions of the targeted states is developed. Finally, the relationship is examined in-depth through mini-case studies and statistical analysis, followed by concluding remarks and policy implications.

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LITERATURE REVIEW

Economic sanctions have been used as an often-used foreign policy tool, especially since the end of the Cold War, the time when the world entered a new era characterized by increased political instability. Collapse of a bipolar world brought many regimes to fall and fostered a democratic transition in many parts of the world. Despite great optimism, many countries could not succeed and faced with a major backlash of the regimes frantically repudiating the supposed changes. The democratic transition did not proceed peacefully. Rising number of intrastate and interstate conflicts and disputes needed to be regulated. In the attempts to coerce states to alter their unwanted activities or to assure their compliance with norms of a newly emerged world jubilant by liberal and democratic ideas, sanctions became a favorite foreign policy tool of decision makers, since it was considered to be a less costly substitute to a warfare (Hufbauer, Schott, Elliott, & Oegg, 2007). Indeed, lacking a panacea to arising conflicts and disputes, the 90s, which were distinguished by extensive usage of economic power, were called "the sanctions decade" (Cortright & Lopez, 2000).

What are economic sanctions? Conventional scholarship suggests that economic sanctions comprise trade and financial measures imposed by different types of senders, such as international or regional organization, but most commonly by sovereign states towards another in attempts of policy change (Hufbauer et al., 2007). The sanctioning

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party (sender state), following its foreign policy goals, may try to threaten, penalize the other state or correct target's policies by restricting imports or exports, financial flows or movement of citizens (Hufbauer et al., 2007).

Exerting to such an instrument also, as conventional literature entails, signalize a resolve of a sender party being ready to pay the price for ensuring compliance of the other and not tolerating morally inappropriate behavior to the parties not involved in sanctions (Galtung, 1967; Hufbauer, Schott, & Elliott, 1990; Lindsay, 1986; Tsebelis, 1990). Sanctions may vary by the length and by scope, whereby a sanctioning party wields more embracing comprehensive sanctions or target's narrow circle of key individuals or entities through the "smart" sanctions (Drezner, 2011).

Early studies on economic sanctions such as seminal works by Galtung (1967) and Wallensteen (1968) were more of an exploratory character. In spite of being based on the limited number of case-studies, research of the pioneers in the economic sanctions' literature postulated essential questions on the definition and goals of economic sanctions, raised concerns over the mechanisms by which economic sanctions translate into political change, and opened the one of the most important ongoing debates related to the definition of success and efficacy of economic coercion in its achievements over the pursued goals.

Initially, policy makers thought that the economic difficulties, trade and/or financial restrictions imposed on the target polity would immediately translate into political pressure against the targeted government. Galtung (1967) criticized this "naïve" logic. He suggested that imposition of a material cost to the state, which violated the material or normative interests of the other state, would not necessarily result in political concessions, and compliance by the target state. Rather, sanctions may have a reverse effect that stems from the ability of a state to adapt, and counteract the sanctions effect, resulting in a political consolidation, rather than a disintegration (Galtung, 1967). Therefore, economic sanctions have often been accounted as ineffective measures for pursuing political goals (Drury, 1998; Hart, 2000; Lindsay, 1986; Pape, 1998; Tsebelis, 1990).

Over time, an extensive literature has developed concerning the effectiveness of economic sanctions, at the center of which we find a debate on the definition of the success. Sanctions episodes being dissimilar, context-specific, each of which with unique circumstances, led to various approaches for measuring success. The ambiguity over the definition of success created conceptual discrepancies among the scholars. The efficacy

of economic measures was argued to depend on the goal pursued by the sender states. Sender may target not only compliance of the target through impairing an economic pain, but also may pursue deposition of the regime, refrain other nations from unwanted actions, signal the resoluteness or merely meet internal political demands (Lindsay, 1986). Conflicting conceptualization of the sanctions' success largely pawed the way to the question whether economic sanctions are an effective policy worthwhile to undertake.

Whereas for some scholars an effective economic coercion should result in the change of the undesirable policy of the target state (Cortright & Lopez, 2000; Drezner, 1999; Hufbauer et al., 2007; Pape, 1997), others contend that the mere suffering of economic costs is an enough fact to account for the successful implementation of the policy (Baldwin & Pape, 1998; Dashti-Gibson, Davis, & Radcliff, 1997; Nossal, 1989).

Standing on the optimistic side within economic sanctions literature, Hufbauer et al. (1990), in their first large scale data set on economic sanctions concluded that over 30 percent of the sanctions imposed between 1914 to 1990 were successful in accordance with the measure they introduced. The proposed scale to measure efficacy, whereby the "achievement of the policy objective" and "contribution that sanctions made toward achieving the objective" are multiplied, were highly criticized by the opposite camp of scholars (Baldwin & Pape, 1998; Hufbauer et al., 2007).

HSE conceptualization were found highly flawed since authors did not differentiate possible alternative explanations that would have complementary effect along with sanctions, such as use of force (Pape, 1998). As the main criticism holds, prior to assessment of the policy, one should distinguish economic sanctions from trade wars, economic warfare, whereby sanctions are wielded to weaken military capabilities of a target. Failure to account for the sanctions impaired to pursue pure political goals by HSE seems to undermine the evaluations made, and as a result makes all causal inferences made on the behalf of economic coercion in achievement of policy objectives as highly problematic. More specifically, no concession in policy change by a target state, even if state suffers significant cost, which is considered to be a success story in HSE, should be actually counted as a failure. This more rigid stance on evaluating economic sanctions and "the causal logic of the theory of economic sanctions", was in turn criticized, since there exists a variety of causal relations and structures in the social world, which is often hard to distinguish and quantify. All these factors are essential parts and by their own

logic pave a way for the development of different theories of economic sanctions to be accounted for (Baldwin & Pape, 1998).

We see that even though large part of scholarly thought expresses a great pessimism over the effectiveness of economic coercion, it is puzzling then, why, being generally unproductive foreign policy tool, economic sanctions earned such a popularity in recent decades among states and international organizations. Nevertheless, a long debate on sanctions success has accrued with little if any resolution, and economic sanctions continue to be one of the most popular foreign policy tools.

Later studies have started looking at the onset (Cox & Drury, 2006; Drury, 2001; Hafner-Burton & Montgomery, 2008; Lektzian & Souva, 2007) and the duration of economic sanctions (Bolks & Al-Sowayel, 2000; Dorussen & Mo, 2001; Hatipoglu, 2014). Furthermore, an extensive literature has developed concerning the consequences of economic sanctions in their aftermath.

For a long time, conventional literature regarded sender and target states as unitary and homogenous actors. However, to master an understanding of the mechanisms by which economic measures work, it is not only necessary to depart from this logic, but also important to move further from the long-debated questions on when and whether sanctions work. Significant part of the economic sanctions literature is covered by the research that disaggregates states and examines the consequences on different structures and actors within states.

One strand of scholarship has driven the further research of the factors that condition efficacy of economic sanctions in pursuance of their intended goals. Among these we observe that the scope (Brooks, 2002; Kaempfer & Lowenberg, 1999; Martin, 1993), regime characteristics (Brooks, 2002; Cox & Drury, 2006; Hart, 2000; Lektzian & Souva, 2007), the importance of the issue at the stake and risk calculations (Ang & Peksen, 2007; Golikova & Kuznetsov, 2017; Peksen & Peterson, 2016) mediate the impact of sanctions.

Having examined the determinants of sanctions' onset and duration in depth, a distinct strand of literature emerged looking at the longer term, "unintended" consequences of sanctions, much of which proved to have negative effects on the targeted state. These studies have mainly focused on political, economic, and humanitarian consequences.

The extent to which welfare of the citizens in the target states is influenced by economic coercion was one of the topics that were usually underscored by policy makers, who highly prioritize policy achievements in their calculations. Scholarly analyses, on

the other hand, reveal that economic sanctions detrimentally affect human rights, women rights, increase ethnic violence and deteriorates health.

As the main source of criticism, economic sanctions owe to the adverse effects the coercion has on the human rights of the civilians in the targeted states. It seems that economic distress does not only lead to expanding imparities in wealth distribution across populace, but also contributes to increased state repressions (Escribà-Folch, 2012; Wood, 2008). Leaders in the regimes lacking check and balances tend to raise physical repression against civilians for preventing retreats, suppress opposition and control constrained resources around own small circle at times of economic distress (Escribà-Folch, 2012; Wood, 2008). The harsher the nature of imposed sanctions, the sterner the level of repression (Wood, 2008). Paradoxically, it was found that a tendency of increased human rights violations elevates even in the case when sanctions themselves aimed at protection and promotion of human rights in sanctioned states (Peksen, 2009). Unfortunately, sender states willing to alleviate continuous civilian atrocities in the target states, do not reach intended reduction in the number of civilian suffering (Krain, 2017).

After the disastrous societal suffering was brought by comprehensive sanctions in Iraq and Iran, policy makers start to prefer "smart" sanctions to comprehensive embargoes, targeted at the narrower circles of responsible governments and elites. Substantially diminishing the scope of civilian suffering, "smart" sanctions targeting the authoritarian leaders still end up with gross human rights violations. Regardless of the scope of the sanctions, the most vulnerable groups which are often women and children, as well as marginalized ethnic groups, are exposed to more sufferings (Drury & Peksen, 2014; Lv & Xu, 2017; Peksen, 2016). Furthermore, among the basic rights unintendedly transgressed by the economic sanctions, the public health is one of the spheres affected the most. Examples from Haiti and Iraq have been one of the most vivid and tragic ones to capture the extent of sanctions' influence to human suffering. Among numerous spheres, the ones which have been the most affected in accessibility and quality are health care, education, and employment. Acute deficits of medicine and health care supplies and services exacerbated the increasing trends of child mortality, malnourishment and spread of infectious diseases at the pace unimaginable before (Gibbons & Garfield, 1999; Lopez & Cortright, 1997; Peksen, 2011).

Economic coercion and the concomitant hardships can also pave a way to unintended political consequences. The shrunk pool of freedoms and liberties that leads to destabilization of the democratic principles as well as consolidation of the authoritarian

rule are the results of impairing economic sanctions (Marinov, 2005; Peksen & Drury, 2010). So-called "the rally-round-the flag effect" is one of the by-products of economic sanctions whereby citizens of the targeted state exhibit a stronger support for the leader and the national policies as the result of the tailored and propagated convictions of the sanctioning "enemy" (Galtung, 1967; Lektzian & Souva, 2007; Peksen, 2009; Wood, 2008).

Intermingled with political and social adversities, economic sanctions have often intended macroeconomic outcomes, not only to trade flows (Caruso, 2003), but also to the foreign aid, FDI flux, and the health of banking system.

Sanctions deprive target state from the access to the foreign capital markets and major investors. Lack of external capital markets to maintain the functioning of the national financial system puts economies under the threat of ensuing instabilities. Foreign investors pool out from the sanctioned state, since economic distress may forfeit their assets. There is a significant reductive effect of sanctions on the foreign direct investment from the U.S. firms, which are one of the main global investors (Biglaiser & Lektzian, 2011). The outflow of the investments futher incites economic losses to the target through elevating uncertainties and risks over investment returns and the health of the economy in general. Thus, distabilization of economy not only magnifies the likelihood of banking crises, but also instigates the occurence of currency crises in the sanctioned states (Hatipoglu & Peksen, 2016; Peksen & Son, 2015). Moreover, international donors become more cautious over the sanctioned states, considered as "wrongdoers", increasing target's dubiety as a potential beneficiary (Early & Jadoon, 2016).

Although a lot have been said about effectiveness and indirect consequences of economic sanctions, the extant research did not take into consideration the association between economic sanctions and energy consumption. So far, the relationship between energy and sanctions has been only touched upon in the analysis of the trade and financial sanctions that curtailed the access to energy markets their effect on their effect on targets' Gross Domestic Production (Canes, 2000). While many case studies focused on the political and economic effects of economic trade and investment restrictions on energy commodities, the variable of interest rarely was an energy sector per se. Iran, Iraq and South Africa are among often studied cases analyzed in that direction (Borszik, 2016; Crawford, 1999; Kaempfer, Lehman, & Lowenberg, 1987). Energy sectors and technologies were a part of bans and restrictions, however, there was not to a date, an

extensive study regarding the effects of sanctions on targets' overall energy consumption trends.

The purpose of this study is to explore and depict the mechanisms by which economic sanctions are associated with changes in energy mix of targeted states, for instance, reversal of the trends, increasing growth or break in the increase rates of hydrocarbons and renewables within the energy profiles.

3

SANCTIONS AND THEIR EFFECT ON THE TOTAL PRIMARY ENERGY SUPPLY OF TARGETS: A THEORETICAL FRAMEWORK

3.1 Importance and immediate relevance of energy

Fossil fuels and renewable energy sources have own specificities that significantly distinguish them from other extracted and traded commodities. Energy is an essential factor relevant for all areas of the human existence. Unlike other traded commodities, deficits of energy resources have the most precarious and tangible implications. While disruption of the food supplies as for the other essential commodities at the times of shortages may be substituted or relieved by humanitarian aid, in the case of energy, even temporary energy disruption can severely undermine almost all aspects of communities' and states' existence. Recent example of humanitarian crisis brought by Hurricane Maria in Puerto Rico draws our attention to the scope of the calamitous effects that energy shortage may bring. More than 3 million people were not only left short of the access to electricity for crucial residential and commercial use but also suffered from the lack of basic services and goods contingent on the electricity supplies such as water flux pumped to the households and health care services (Punta, 2018). Restoring the grid infrastructure and mitigating all the precarious impacts are complex tasks that require enormous financial and administrative costs to be borne by the insolvent government of Puerto Rico

in many months after the hurricane took place. Apart from long-lasting energy shortages, even short-term energy disruptions may lead to a havoc and may cost to the economies millions of dollars. For instance, a nine-hour blackout of electricity in Turkey in March 2015 cost the national economy approximately 700 million USD, hitting the country heavily with "the traffic lights ceasing to work, hospitals sounding the alarm, factories halting production, mobile phone connections suffering from disruptions and people becoming stranded in elevators and traffic jams" (Sezer, 2015). Considering these facts, the immediate and long-term importance of uninterrupted energy supply cannot be underestimated.

Apart of meeting the ever-expanding energy demand in times of emergencies, availability and accessibility of energy sources is not only directly related to the quality of life, economic development, environment, but also directs the foreign policy, relations and security consideration of states. Given the centrality of energy in everyday politics and functioning of society, we need to understand how interstate relations affect energy supply and security of countries.

Ensuring access to reliable and affordable energy that able to meet internal demand has been one of the main concerns of states since energy sources are not only economically crucial as a final product but also as a means of production in many strategic industries such as military complex. It was traditionally perceived as important indicator of military capability states can project onto others (Singer, Bremer, & Stuckey, 1972). For instance, the Fall Blau operation during the second World War by the Nazi Germany targeted specifically the abundant oil reserves in Caucasus, since energy supplies from the South were critical to the USSR economy and its national power.

In 1990 Soviet Union cut the gas and oil supplies to Lithuania as a reaction to its independence declaration in 1990s (Hufbauer et al., 1990). The leadership of the USSR and personally Mikhail Gorbachev sharply rejected the declaration of independence by the Baltic republics. The USSR declared the documents adopted by the Supreme Council of Lithuania unconstitutional, and thus, invalid as. Gorbachev suggested Supreme Council of Lithuania to abolish this decision. Facing a defiant Lithuanian leadership Moscow, in April 1990, imposed an embargo on energy supplies to Lithuania (Rich, 1992). Serious contractions in Soviet's gas and 10 weeks contraction of the oil supply affected more than half million of Lithuanians, who, at the time, were heavily reliant on Soviet energy supplies for household heating and other everyday uses of energy. This

proves again that provision of reliable, secure and diversified energy supplies should be the main strategic national concern for the states (Teslova, n.d.).

Moreover, since economic growth is ubiquitously related with the availability of the inexpensive energy sources, open trade in energy sources, and availability of the hydrocarbons in particular, energy politics were an important shaper of interstate relations for decades (Colgan, 2011; Yergin, 2011). For a long time, the scarcity of domestic energy resources needed to meet the ever-growing internal demand, was one of the main reasons for the U.S. military presence in the Middle East and Persian Gulf. Concern of Washington over the possible blocking of Strait of Hormuz by Iran stemmed from the security threat of the cut of the domestic and international hydrocarbons' supply. Making alliances and offering military protection to the oil-rich countries in the region were laying behind the foreign policy of the U.S. for not letting a disruption of the global flow of oil (Klare, 2014).

In the attempts to safeguard the uninterrupted international flow of energy, suddenly initiated after first OPEC crisis, states fostered cooperation in different forms from formation of various international organizations such as International Energy Agency, to provision of numerous foreign aid and low-cost loans in order to augment the energy production and transmission capabilities in different regions in the world. Trading electricity across the borders is becoming another locus of interstate relations which in addition to general energy trade flows raises the interdependencies that make any cuts in energy supplies more precarious and unwanted (Pineau, Hira, & Froschauer, 2004).

3.2 Impact of economic sanctions on the supplies of energy

The application of economic sanctions has been yet another foreign policy tool with important implications to the energy dependent interstate relations. Being one of the most often used coercive tools in a foreign policy toolkit, states often use sanctions to constrain or alter unwanted behaviors by other states. Such coercive measures, in turn, can affect energy supply in the targeted states in several ways. Some of these effects are instantaneous, such as direct embargoes on energy trade. Economic sanctions also hinder

energy provisions through preventing the access to international finance either specifically targeting energy sectors, or by preventing the flow of international capital to targeted state. For the former case, depending on its design, sanctions can lead to an immediate halt of primary energy resources through a total embargo. Anti-apartheid sanctions imposed to South Africa in the second half of the 20th century may serve as an illustration of comprehensive economic constraints on the oil importing country.

Oil was an imported commodity to South Africa and had been a subject to a growing demand from industries and transportation (Crawford, 1999). Evaluating the burden that oil embargo may bring to the South Africa, policy makers in the U.S., UK and other countries that joined the sanctions halted the exports of oil to the South Africa in pursuance of changing the apartheid regime. Oil embargo, disinvestment movement, arms embargo, and widely held boycotts were placed within the framework of multilateral (US, UK, Japan) economic and social attempts to change the South African apartheid policies that had been for a long time politically and economically excluding the black strata of population. As the result of deficit of regular imported oil, many related industrial activities substantially contracted. For instance, previously developed refinery industry activities were considerably shrunk, and had to use significantly smaller amount of more expensive oil products imported from few countries that were overriding sanctions regime at the time in order to maintain the workability of these refineries (Crawford, 1999). Between 1973 and 1984 South African government had to spend extra 2 billion dollars annually to afford imported petroleum products (Davis, 1993).

Another example is a case of Iran which has been one of the leading world oil producers. Tehran's illicit enrichment of uranium that stood against global nuclear nonproliferation doctrine, and instigated a fear to Western democracies, led to imposition of extensive trade, financial, banking, and arms sanctions that lasted for the decades. The U.S.-tailored Executive Orders 12613 and 12959 on Iranian sanctions has not only restricted sale of gasoline to Iran by putting export embargoes on crude oil, they also prohibited provision of equipment for oil production, and have averted the general access to international investments which were the key for the energy industry (Katzman, 2016). Furthermore, foreign financial institutions were restricted to have oil-related as well as non-oil related deals and transfers with the Central Bank of Iran in accordance to the tightening sanction regime by U.S.

Apart of the negative effect on Iranian GDP, multilateral sanctions led to a loss over the energy refinery capacity of Iran. Restrictions over the energy technologies and financial transactions with oil companies led to deprivation of many Iranian refineries, which lacking finances for the maintenance and upgrade, produced highly contaminating and low quality refined petroleum products. Moreover, in the attempts to maintain a weakening refinery industry Iran had to buy up to 800 million dollars' worth oil equipment from Russia (Lelyveld, 1996).

Cutbacks of primary energy supply in cases such as one observed in the Southeastern Europe from Russia further support the fact that the immediate relevance of energy supply and instantaneous effects of the energy shortages cannot be underestimated at the times of sanctions.

Russo-Ukrainian dispute over the gas supply in 2008-2009 illustrates how energy supply disruption to Southeastern Europe promptly impacts the economies of the entire region. The crisis of 2008-2009 started in the end of 2008 because of the lack of communication and negotiation attempts over the gas supply and gas transit contracts for the new fiscal 2009 year between Russia and Ukraine. From 2008 on Russia has been warning Europe for the reductions of its gas supply via Ukrainian Corridor as a result of accumulated unpaid gas debts by Kyiv, and the lack of new transit contract. After several threats, Gazprom halted the gas supply not only to Ukraine, but also cut supply to 16 member-states of the EU for entire two weeks (Vahtra, 2009). High dependency of Ukraine and the EU on the imported energy and a need for uninterrupted gas supply for residential and industrial consumption in the middle of the winter caused a great deal of socio-economic disturbances within the EU and instigated political tensions between Kremlin and Kyiv at the time of "blue fuel" crisis. The shock was especially felt by the Southeastern European countries, which exclusively relied on Russian natural gas for meeting own daily energy needs (Kovacevic, 2009). Gas supply disruptions affected most prominently countries like Slovakia and Croatia which announced the state of emergency, and Bulgaria, where industrial manufacturing was temporarily halted.

It seems that apart of halting energy supply directly, increasingly targeted sanctions can prevent the trade of certain energy sources (e.g. nuclear fuel or oil), forcing a re-equilibration of the targeted state's energy mix. Certain types of smart sanctions focus rather on disrupting the flow of technologies rather on commodities themselves. For instance, energy giant ExxonMobil decided to withdraw from the joint project in Russia.

The transfer of technology needed to drill for the unconventional energy sources that lack in the host country was halted (Crowley, 2018). Usually these technologies relate to nuclear energy and oil refinery capacity. We see that a recent U.S.-led freeze of financial transactions with the local oil company, Petroleos de Venezuela, made leadership of a country to try to negotiate with the U.S. since sanctions halted the work of the refinery in Venezuela ("Imposing Additional Sanctions with Respect to the situation in Venezuela.," 2017).

Finally, from a more general perspective, economic sanctions create financial hardships in the targeted state's national accounts, often restricting access to international capital or raising the costs finding investments (Hatipoglu & Peksen, 2016; Peksen & Son, 2015). Since energy investments are often capital intensive, and often require financing consortia (McCrone, Usher, Sonntag-O'Brien, Moslener, & Grüning, 2012), sanctions may hurt domestic investment decisions of targeted states. More specifically, contracted international finance and deprivation of funding opportunities that come along with an economic distress is likely to shift decision-making of investing actors within targeted states in a way that triggers the search and usage of the most available and cheapest sources of energy.

The "survival" mode that targeted states enter exacerbates an existing issue of bridging the imparities between demand and supply of energy and make states to opt for more self-sufficient options. The volatility of and lack of capital investments which are reduced at times of sanctions may encourage states to invest to the energy systems which face less technical and market barriers and require less amount of capital expenses.

Having said that, even prior to sanctions' imposition the decision whether to use particular energy source depends on numerous factors such as availability of energy resources and necessary energy technologies available in a country, existing domestic and international pricing mechanisms, trade openness, as well as presence of regulatory and institutional structures (Painuly, 2001).

Although these factors may influence the amount of capital needed for construction of energy system, all of these will not have decisive importance if there is no access to capital markets necessary for energy technology to be deployed and maintain energy supply. Therefore, a targeted state would tend to switch to the available energy endowments in a country. To illustrate, as a response for the energy challenges borne out of anti-apartheid sanctions in 1970s and 1980s, the South African Coal, Oil and Gas

Corporation (Sasol) adjusted its energy mix with installment of the coal-to-oil production. Prior to sanctions imposition, Sasol 1 that was established in 1950s has developed and set the production of liquid fuels and synthetic chemical materials from the abundant coal reserves. These synthetic fuels were produced as a substitute to oil. Corporation expanded production by investing to the construction of additional facilities. Sasol 2 and 3 that became operationalizable in the beginning of 1980s at the time the comprehensive sanctions were enacted. Despite being economically burdensome and hazardously polluting coal-to-oil production played to the hand of the apartheid regime at the time of sanctions, since the fuel outputs substituted partial amounts of the embargoed foreign oil. As we observe in the case of South Africa, supply of energy is extremely important for stability and development of any country, and in times of external shocks, as a main guarantor for the energy supply, state is responsible to find ways to provide energy for industries and populace without delays. Considering this argument, we suggest that state would prefer to utilize sources of energy depending on which source is the most accessible and cheapest at the time of economic sanctions which is usually domestic endowments or cheap imports in former's absence.

3.3 Variation in energy profiles of states

Various factors that account for the change in energy consumption patterns have been the focus of many studies. Scholars have categorized determinants of energy consumption, such as ones related to economic growth and per capita income, demographic variables such as population, and external factors. Many studies probed into the effects that fluctuating energy prices (Asafu-Adjaye, 2000), levels of investment and trade (Copeland & Taylor, 2004), economic crises (Commoner, 2015), political and financial instability (Yuan, Liu, & Xie, 2010), urbanization rates (Keho, 2016; Parikh & Shukla, 1995), and technological developments (Popp, 2001) may have on energy consumption.

Numerous research examined causal relationship between energy use and economic development (Asafu-Adjaye, 2000; Cheng, 1995; Chontanawat, Hunt, & Pierse, 2008;

Mehrara, 2007; Stern & Cleveland, 2004). This studies largely agree on that while every state needs a sufficient supply of energy for enhancement of economic, social, and other essential aspects of development, level of energy demand and total energy consumption patterns vary across countries in quantity and by fuel types. Although every state has a unique bouquet of features differentiating its socio-political and economic profile from the others, we need to categorize the countries for the aims of our inquiry.

One can categorize countries by various criteria, however, differences in energy profiles are especially visible between the high income and low-income economies. Structural organization of the economy and level of development impact energy use. What we observe in the developed economies, with high incomes, is that the more advanced country economically, the more likely country develops and promotes energy efficiency and that a lion's share of it consists of services sector, which is less energy-intensive (Keho, 2016; Mehrara, 2007). Therefore, as income increases energy intensive consumption tends to decrease. In comparison to developed and advanced economies, growing economies require more energy dense sources (Copeland & Taylor, 2004). It is not surprising then that developing, low and middle-income states require more energy supply to follow a path of faster development that is usually carbon-based and energy-intensive. Their economic development highly relies on the availability of the hydrocarbons for elevating economic growth, manufactured goods, services, and boosting the living standards of citizens.

Energy supply mix primarily depends on factors that include the availability of abundant and utilizable energy reserves, trade relations and available cheap energy technologies. Therefore, it is important to differentiate between nations which are fossil fuel producers and fossil fuel consumers, as well as establish the costs for bringing an energy system online.

One would expect different effects of sanctions on total primary energy consumption if a country is largely endowed with fossil fuels. Unlike renewables-rich nations, which have to import large amounts of hydrocarbons, the producer country will more easily maintain domestic energy consumption under the sanctions by increasing FF supply. Since externally imposed sanctions would not constrain delivery of energy from internal resources to the industry and households within a target country. Therefore, hydrocarbon rich countries would experience a growth in the rates of fossil fuels' share in the overall consumption.

On the other hand, states, which may have small scale indigenous production of fossil fuels and most importantly are largely endowed with renewable sources, and economically constrained to maintain energy intensive supply, should experience a decreasing trend in inland primary fossil fuel consumption. Energy intensive sectors in those countries may be affected by the economic distress, and state decision will be to hunt for cheaper indigenous sources. Share of fossil fuels consumption may be already low, leading to consecutive reductions in trend. And since no cheap and quality energy substitute exists for the industries, industrialization process will be slowed down, and growth diminished, trapping these countries into the cycle of underdevelopment instead. On the other hand, share of renewables in overall consumption should increase, conditional on the existing indigenous endowments and capital costs required to bring and keep energy system online. However, before setting the hypotheses, we have to establish another important factor, which is the initial installation costs for renewable energy technologies.

In this section, we assume that there are common implications over the cost-benefit calculations that each country and other decision-makers go through as rational and utility maximizing actors. In times of economic sanctions states' calculations will be influenced by the reduction of the external finance, thus shifting their energy preferences towards more immediate solutions among available. Therefore, it is important to additionally establish the variation and sources of the costs for renewables and non-renewables.

Following the argument, investment decisions and, thus inland gross energy consumption will not only depend on the availability of domestic indigenous renewables endowments, but also on the costliness of energy technologies.

3.4 Capital costs for different types of energy systems

Fossil fuels and renewable energy have own advantages and disadvantages. Stemming from their nature, geographic distributions, and finiteness, energy choices made by any state are contingent on the cost-benefit calculations at the heart of which we see the energy-related capital investments. Continuous investments are needed to keep

energy production online. Any energy system requires a lifetime expenses to be met. These costs often comprise the initial capital costs necessary for construction and installation of a facility, or so-called "capex"; operational and maintenance costs once a plant is put online; and the cost of the energy source to be utilized in a plant (Breeze, 2010). In this section, we will focus on the initial capital costs required for bringing an energy facility onstream.

Since the Industrialization, the world has experienced the proliferation of the fossil fuels, and found itself highly dependent on combustible energy resources, which determined the economic, human development, and security considerations of states (Fanchi, 2005). Historically, renewable energy systems could not reach the same proliferation as fossil fuels' systems and become fully cost competitive in relation to the latter, although it is extracted from free, but sporadic and intermittent natural forces, such as wind power, solar energy, and hydro power.

In the contemporary world we find that fossil fuel consumption has accounted for approximately 80 percent of total world energy consumption during the decades since 1970s. Moreover, trends of the energy usage show that the major share of the fossil fuel usage and carbon emissions derives from developing countries, and given that this trend continues, the world will face larger deployment of hydrocarbons and higher amounts of atmospheric carbon dioxide emissions (Landon, 2002). This trend is not of a surprise, since modernization path followed by developing countries usually refers to the carbon-heavy industrialization.

Although energy profiles may significantly vary across countries, experts agree that departing from their historical energy consumption trajectories is difficult for these countries due to a high burden of the initial costs for building an infrastructure and lack of risk prone investors (Hughes & Lipscy, 2013). Therefore, absent costly governmental policies or extensive foreign funding aimed at promotion of particular energy usage, a state would continue the followed energy consumption path.

Prior to understanding how the investment decisions and production would shift in targeted states, it is essential to understand how the costs scattered in a life cycle of energy plant differ for renewables and fossil fuels. Renewable and non-renewable power plants' costs vary at distinct stages of their life cycle, especially at stages of installation and fuel costs purchase. These difference between RE and non-RE in the cost mechanisms are determined by the nature of energy resources (Bockris, 2009).

Combustible hydrocarbon sources are finite, unequally distributed among states, affect state security considerations, and have been a part of various pricing mechanisms. On the other hand, alternative renewable energy, apart of nuclear energy, is extracted from sporadic and intermittent natural forces, such as wind power, solar energy, hydro power, and biomasses. Renewable energy's advantage lays in the fact that the source is free, so there is no cost to be paid. However, alternative energy disadvantage is in being heavily dependent on the technology advancements that are in stage of development, facing more market and technical risks than traditional sources of energy. Furthermore, production is intermittent – hence, at least until very recent years, RE energy is deemed unreliable for base-load energy.

Oil, natural gas, and coal require less initial capital expenses in comparison to alternative energy systems. World fossil fuel reserves are enormous, though they are unequally distributed among states. Once you explore, drill and start to extract economically feasible fossil fuel reserve, it is exploitable for tens of years until the resource is completely depleted. The average lifespan of a typical fossil fuel plant may vary from 25 years and more. Distributing infrastructure such as pipelines that transport oil and gas, once being constructed are utilizable for decades. Therefore, we see a wide usage of existing supply routes, since the construction cost has been borne and recovered (by the fuel costs paid by importing countries or consumers) and observe construction of new economically viable ones since there are less uncertainties and risks. Non-RE sources, however, require a purchasing price, which is up to fluctuations and may especially impact the producer nations. The resource is less costly to be obtained, technologies for extracting and distributing (excavating, pipelines) are well developed throughout past two centuries, and can be promptly utilized, given the economic viability of the reserve. Moreover, fossil fuels can be stored and transported, thus making them a more attractive option compared with yet non-storable alternative sources of energy.

Substantial additional costs necessary for renewable energy facilities make the energy output more expensive compared to hydrocarbon systems. The extra expenditures stem from the fact that RE by definition is more decentralized source of energy, which requires extra capital expenditures for 'siting' (land, contracts, permits) and transmission infrastructure (power lines, etc.) ("Barriers to Renewable Energy Technologies.," 2017).

Having lower output, the majority of RET become relatively unattractive for investors. RE plants cannot produce energy produce a "base-load" power. In the other

words, the supply of renewable energy on continuous basis (or) and should be located in close proximity to the location rich of wind, sun, hydro or geothermal energy. Few types of RE facilities, such as large hydro and nuclear plants, can provide utility scale and massive energy supply as opposed to conventional energy. They host more risks behind its economic viability, many institutional and technical barriers that decision makers as rational actors would consider (recovering their investments and future profits) prior to investing in any energy facility.

On the other hand, decentralization of RET may reach far corners in the developing world, especially essential for development and residential needs of rural communities. However, proliferation of that kind of projects require large external funds and too costly for a targeted state and citizens themselves.

Due to the lack of country-specific and comprehensive data on required capital expenditures for bringing different energy technologies online, this study focuses on the existing reports, which are mainly available for more developed countries and for more recent years from U.S. Energy Information Agency (EIA), International Energy Agency, and World Energy Council information, as well as from reports of private organizations, think tanks, and scholars. The reports lend support to the fact that establishing a RE facility require high initial investments. While this data holds for the more advanced economies, I will assume that "relative costs of investment in per KW of energy" will hold in other countries as well.

The World Energy Council and Bloomberg New Energy Finance Report presents the costs for energy technologies globally and by region (Salvatore, 2013). There is a wide variation of RE costs across different renewable types as well as a variation of the capital costs across the regions. Report emphasizes that mature and older hydro, solar and wind technologies are currently more competitive than in the past, whereas new RE technologies are more expensive in terms of capital requirements (Salvatore, 2013). The report additionally highlights that capital expenditures especially for nuclear energy technology are remarkably higher.

Likewise, in the report by Lazard, it is suggested that on average alternative generation technologies are costlier than conventional ones (Lazard, 2016). Moreover, even though the trend in expenditures for the technical equipment of renewable energy decreases over time, renewable energy becomes costlier (Keay, 2013).

Non-market factors such as need for Research and Development, and state regulations favoring fossil fuels make RE economically unattractive. Rising expenditures for transmission and installation due to variation in geography, resource availability, transmission system locations, and accessibility should be additionally covered in capex. Author stresses that in addition to these factors, we should count for escalating incremental costs of renewable energy, which states that with every additional RE unit introduced, the costs of renewable energy will get costlier in accordance with 'Rising resource cost curve' (Keay, 2013).

We should bear in mind that different criteria may exist when a state evaluates RE or FF power plants. In their analysis, Afgan and Carvalho (2002) include economic and environmental parameters as sustainability indicators. The assessment of different types energy systems is based on the systemized parameters and indicators. Authors, in fact, put an emphasis on the parameters such as efficiency of energy plant and installation costs in USD/kW. They have determined weighing coefficients for linear functions calculated for a study. By keeping all weighing coefficients ceteris paribus, when comparing plants by one single criterion such as installation cost indicator, we see that even though gas and coal power plants are cost-competitive with wind and hydro plants, in efficiency criterion renewable energy power plants lay behind traditional energy power plants that offer more energy output per USD (Afgan & Carvalho, 2002). Consequently, the cost-benefit calculation over the necessary capex and efficiency of energy output of relevant renewable or fossil fuels, may affect the decision of risk averse states and investors to opt for constructing and maintaining more cost-efficient non-RE plants rather than building RE facilities that will bring less unit of energy per money spent on it once operationalized.

Large scale solar photovoltaic facilities and wind renewable energy power plants have only recently reached the cost parity with non-renewable generation technologies and start to establish broader niche in power sector globally. Some of RE technologies are getting lower in cost, but others continue their historical trajectory as carrying more risks and being more expensive especially on initial phases of development, thus requiring strong financial support. Though such cost reduction may provide an opportunity for developing countries to harvest, for instance, more wind energy through deployment the RET technologies, yet, if we disaggregate costs for wind facilities, we can observe that it consists of many additional costs to be met. U.S. Department of Energy has been a leading institution which produces up to date information and reports on renewable energy. Since

there is no global time series data, we take wind technologies as a proxy to illustrate the costs for renewable energy technologies over time. A lion's share of wind power technologies' capital expenses comprises expenditures on wind turbines, site preparations, employment, construction of distribution networks, and other extra costs for construction of necessary additional infrastructure. In the Figure 1., we see that wind installation cost fluctuated since 1983 and remained above 1000 USD per kilowatt of energy (Wiser & Bolinger, 2014). The fluctuation may be explained by the changing price of cooper and steel which are necessary for wind technologies. The offshore wind power plants' expenses are almost as twice as the onshore ones, due to the complexities of constructions in the sea and components additionally required to overcome difficulties of installation of an offshore facility. However, if the decreasing trend of installation costs will continue it may become an attractive option for targeted states rich with wind energy. However, from what we observe so far, is the costs of installation could not be met by many governments today. If during 80s we observe the costs of installation reached on average nearly 3 000 USD/kW, at the time of economic sanctions it was a costly and luxurious enterprise to build a RE plant. In comparison to RET, the costs for FF technologies during 80s were on average three times less capital-expensive, which made it an attractive option for states at the time (Salvatore, 2013).
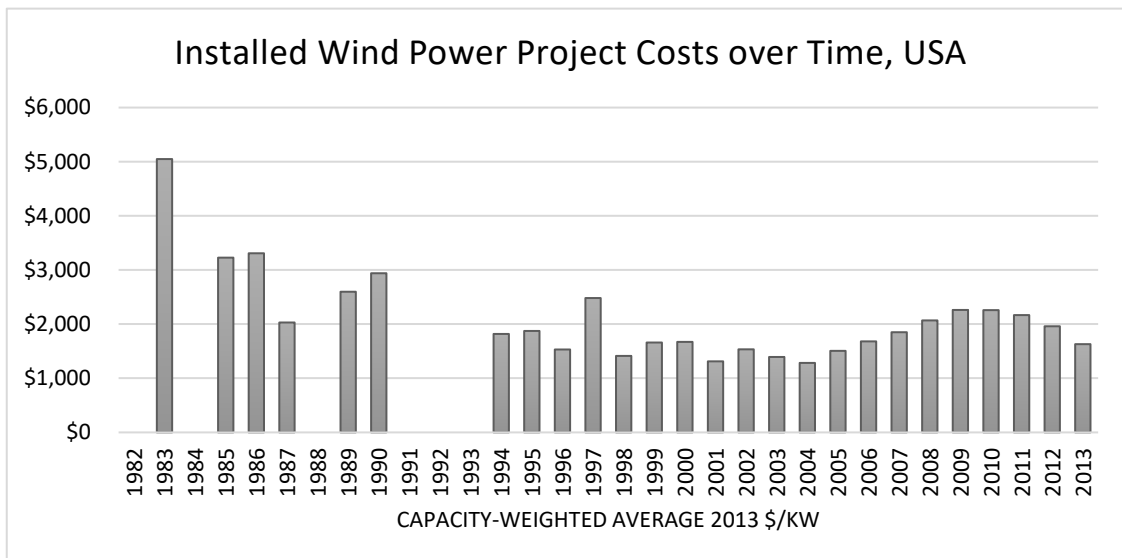

Figure 1. Installed Wind Power Project Costs over Time
(Wiser & Bolinger, 2014)

All in all, the realm of RET and non-RE industries are dynamic and exposed to many factors that may alter cost calculations significantly. That makes us alert of these factors and of the need to information updates. Technologic advances, policy and regulation uncertainties, country-specific characteristics, geotechnical features of sites, as well as availability of resources. Across the reports, we notice that constructing a conventional generation plant require less upfront capital expenses along with larger amount of energy output per dollar invested. Moreover, since non-renewable are more predictable and incur less risks over the future employment and returns from investments, investors usually prefer not to enter the realm of RET unless there are incentives and assurances provided by state, or regulations that make non-RET unattractive. Given that states targeted by economic sanctions tend to suffer financial difficulties, financing such RET projects become a more challenging task in a sanctions' environment.

3.5 Hypotheses

The argument we have been establishing until that point is that imposition of economic sanctions may encourage states to use energy sources with a higher energy density value in order to meet final energy consumption by industries, transport, households, agriculture, and service sectors.

Satisfying energy needs and keeping energy intensive industries remain one of the top priorities for a state when subjected to an external shock. Economic stability is strongly correlated with energy-intensive activities and outputs (such as steel, automotive or other forms of heavy industry production) in a country. Furthermore, the energy needs of country's population would be another primary concern for a state, since energy supply disruptions, extreme fluctuations, and declines in energy supply are the events that governments would try to avoid or mitigate in order to contain the dissent and backlash from its citizens. For example, amid the electricity interruptions massive civilian protests took place in Pakistan in 2012 ended up with violent suppression and killings ("Civil society stages demonstration against power outages," 2012). Moreover, in 1987, acute electricity shortages sparked major riots in Romania, with thousands of people taking to

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the streets, and causing a major unrest across the country ("Romanians riot against shortages," 1987).

Economic sanctions restrict access to foreign capital and, thus, leave governments with constrained pool of finances left to sponsor building and maintaining of domestic energy systems. The economic distress caused by sanctions then is likely to push state for more immediate energy solutions by utilizing and investing to less costly energy source. Hence, when a state has to decide over meeting the strategically essential energy needs, we expect to see the change in the patterns within their overall inland energy consumption. We argue that within carbon-intensive modes of production, a country's initial endowments will decide how that country will choose to compensate for energy when targeted with sanctions, while longer term, initially more capital extensive, and technologically advanced energy investments will take a back seat.

Based on discussed literature and theoretical expectations, I presume magnifying effect of sanctions on share of fossil fuels in the total primary energy supply (TPES) regardless of whether a country is having a significant level of inland production of fossil fuels, or it is a nation, which is largely endowed with renewable energy. We do not exclude the possibility that RE rich states usually import a significant share of hydrocarbons from abroad to meet their domestic demand. Although, the attractive point for these states may be no price to be paid for utilizing the energy capacity of natural forces rather than paying a price for imported fuel, the heavy initial capital needed to build a RE facility will make it an unattractive option.

Since bringing and maintaining carbon-heavy energy production is cheaper, less technology intensive, and more efficient in energy terms for states rich in hydrocarbons, we expect that when the state and domestic companies face a choice between cheaper and faster to operationalize conventional energy sources such as coal, natural gas, and oil, or environmentally friendly and more capital-intensive renewable technologies they would prefer the most beneficial option, that maximizes their utility. Thus, we anticipate that targeted states will opt for more carbon-intensive fossil fuels' energy if endowed with rich reserves of hydrocarbons, as they may find economically unattractive to build RET in order to harness free energy from natural powers.

Therefore, I expect increase in level and growth in trends of fossil fuel share in gross inland consumption of energy in hydrocarbon-rich countries, such as Iran.

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Hypothesis 1: Economic sanctions are associated with an increase the share of fossil fuels in total primary energy consumption of targeted states in the aftermath of the sanctions, if the targeted state is endowed with rich hydrocarbon sources.

The capital expenditures for technologies that transform geographical advantages and abundant raw natural resources, especially renewable ones, into ready-to-use energy supply are not as available and cheap as the following operating and maintenance costs once a plant is constructed. Therefore, the countries with a high level of indigenous renewable energy production may face a choice towards carbon-heavy options.

Although a consumer nation can have a high capacity for renewable energy rather than conventional one, in economic and technological terms importing fossil fuels may be cheaper, faster, and less risky than developing and operationalizing the renewable capacity in a country. Due to a dependency of RE supply on intermittent natural forces and lack of storage technologies, and small energy output when compared to more stable and more energy dense supply of fossil fuels, RE becomes a less attractive option in the eyes of developing countries that aspire for a heavier industrialization and faster economic recoveries. As common wisdom suggests industrialization is an energy intensive endeavor often possible with the presence of fossil fuels. Taking into account that cultivating new and large-scale RET is expensive and less energy efficient, targeted state should opt for cheaper to use FF imports, thus increasing the share of FF in its gross inland energy consumption. Therefore, RE rich states tend to opt for burning imported hydrocarbons, rather than bear high initial capital costs for constructing RET. Therefore, with the states endowed with renewable energy I expect that:

Hypothesis 2: Economic sanctions are associated with an upward trend in fossil fuels' share in total primary energy consumption of targeted states largely endowed with renewable energy as the instigated economic distress will constrain economies to invest into operationalization of indigenous renewable energy sources.

4

EMPIRICAL ANALYSIS

4.1 Research design

The hypotheses developed above concern energy consumption trends. Trend analysis helps to establish a better outlook of the existing patterns within countries. Common knowledge says that the best predictor for tomorrow's data is yesterday's data, unless there are shocks that may disrupt the patterns. Furthermore, the longer-term trends tend to be stable absent such important shocks. Technological breakthroughs, wars or the discovery of new resources could be such shocks. Accordingly, this thesis asks whether sanctions imposition constitutes another type of an external shock, and if so, how this shock affects energy consumption trends within the targeted country.

4.2 Data Description

I will examine whether sanctions have different impact on the share of hydrocarbons and renewables in total primary energy supply for the two chosen cases, namely Iran and Panama. They were chosen from the pool of targeted states with available data both on

the energy indicators and sanctions imposition. The rationale for choosing these two cases are elaborated below.

The analyses are based on mainly on two datasets: The original data of Gokce and Hatipoglu on energy consumption figures includes 143 countries (1971-2015) (Gokce & Hatipoglu, 2018). The most recent version of the HSE dataset embraces the 174 cases of sanctions imposition (1950-2004) (Hufbauer et al., 2007). Unit of analysis in this study is a country-year. I have observations for of the two countries, from 1975 to 2004. I set a start of the analysis as of 1975, thus eliminating a spurious effect of the 1973 OPEC crisis.

4.3 Dependent Variable

In this paper our dependent variable is disaggregated indicator Total Primary Energy Supply, TPES, which stands for total consumption of primary energy sources within a country. TPES is calculated in the way where all exports and energy storage are extracted from the production and imports taken together (IEA, n.a.). Conceptually, total primary energy supply is often interchangeably used with the total primary energy consumption or gross inland energy consumption that exhibits the energy volumes consumed domestically.

We are looking specifically at the primary energy sources, namely crude oil, natural gas, coal, and renewable energy, such as hydro, solar and wind energy. Worth noting that we do not disaggregate fossil fuels and renewables in TPES in our statistical analysis. We also do not take secondary sources into account, such as imported electricity or refined energy products which are being processed for the final consumption to the end users with a certain amount of energy lost during processing.

Moreover, since target countries tend to hide the real effects of sanctions, the total primary energy consumption trends comprise an accessible indicator that sender countries and policy makers may use for evaluations. More specifically, we will look particularly at the distributions of the shares of fossil fuels and renewables in TPES, which we take as an indicator for detecting the changes in total inland consumption patterns of a particular type of energy source. Since the populations and sizes of target states vary, as

well as the volumes of fuels consumed, examination of the shares of conventional and alternative energy helps to assess energy preferences of states in a more comparable manner.

Worth mentioning is that while natural gas, crude oil, and coal are included in the list of fossil fuels, solar, wind, hydro and nuclear energy are regarded as renewable sources of energy. When categorizing the energy sources, we count nuclear energy along with a renewable type of energy although there are many debates around accepting nuclear energy as a renewables type of energy. First of all, usage of uranium in the plant has a very low carbon emission output, what speaks to the RE definition of being less polluting source of energy. Moreover, despite the fact that uranium as a basic nuclear energy source is extractable and finite, available methods to "breed" nuclear fuels and its large deposits that will not be depleted in million years gives nuclear energy a sustainable and long-lasting role in fueling the world along with other replenishable sources (Cohen, 1983). Finally, nuclear energy requires very high levels of capex, similar to other renewable energy investments.

4.4 Illustrative cases

Within the scope of the study, I will assess cases of Iran and Panama in order to empirically examine and illustrate whether economic sanctions induce a change in the usage of hydrocarbons or renewables within the energy mix of the sanctioned states.

Moreover, evaluation of total primary energy consumption trends in two cases of upper middle income developing countries carries high importance since energy choices made by these countries have consequences for economic growth and global climate change. Exploration of how contextual factors alter the rate of changes serves only a preliminary evidence for the association between economic sanctions and energy shifts. The aim of the illustrative cases is to bring the reader and researchers one step closer to the existing sanctions and energy nexus.

Countries are selected due to a variance they exhibit in relation to the energy mix and the similarity over extensiveness of the sanctions imposed (See: Table 1). Whereas Iran

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represents a country with the rich hydrocarbon production, Panama refers to a case with large indigenous renewable energy output. All the countries are in trade relations for the primary energy sources and energy products. Since within the scope of this study we cannot trace all dynamism of exports and imports in energy sector across the cases, inspecting total primary energy supply allows us to observe types of primary energy the sanctioned state ends up with in the aftermath of economic sanctions. More specifically, after subtracting energy exports and storages from the imports and production of energy, we can observe the volumes of primary energy consumed inland. This information, in turn, gives a clearer picture and provides the real depiction of the hydrocarbons and renewable energy shifts within the state's overall consumption before energy is processed and reached the final consumers.

Although the goals of sanctions vary, HSE allows us to translate the joint impact of sanctions on the target economies and policy outcomes into the scale of the sanctions' overall impact that ranges from limited and moderate effects to extensive ones (Hufbauer et al., 2007). For the impact of sanctions across the cases, we observe extensive financial and trade sanctions imposed on Iran and Panama.

Moreover, in Hufbauer et al. (2007) we find details about economic sanctions on the given cases. Suspected to fund the terrorist groups and develop the weapons of the mass destruction, Iran, that was sanctioned by the USA earlier in 1979, was further blamed and hit with a new set of extensive sanctions in 1984, whereby Washington "targeted primarily at limiting development of the Iranian oil industry and thus Tehran's capability to fund terrorist groups" (Hufbauer et al., 2007).

Manuel Noriega's regime in Panama was targeted by the USA in 1987 after the ex-ally of the Washington went uncontrollable putting a main threat to the safe access to the Panama Canal and overall national interests of the U.S. in the Central America. Panama and Iranian cases in fact are the ones where the United States implicitly pursued the regime change, whereby only in Panama case sanctions were followed by the military involvement in 1989. That confounding variable, or more precisely, inability to disaggregate the effects of military and economic action makes us cautious about the interpretation of the statistical results. Extensive financial and trade sanctions lasted for three years and were extensively enforced before the military operation. Additionally, since there is no evidence on the major damages to the major energy facilities, and mainly the Trans-Isthmian oil pipeline being one of the large suppliers of hydrocarbons to the

country, I prioritize sanction utility over the military intervention, since the evidence suggests of massive direct pain inflicted to the economy that I am interested in.

Table 1. Profiles of targeted states and of economic sanctions imposed by sender countries, goals, and time of implementation. Data extracted from UNCTAD, the World Bank, Hufbauer et al. (2007), Gokce and Hatipoglu (2018).

Target country	Iran	Panama
Imposed Sanctions[1]	1979-1981[2] 1984-2004[3]	1987-1990
Goal of sanctions	Nuclear proliferation, terrorism	Destabilize Noriega
Sender country	USA, International cooperation	USA, Unilateral
Effect	Extensive	Extensive
Type of sanctions	Financial, Export and Import	Financial and Import
Indigenous production	Fossil Fuels: Oil, Natural Gas, Coal, small hydro-energy	Renewables
Economic development	Upper middle income	Upper middle income

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[1] For the interrupted time series analysis, intervention year accounts to the first year of sanctions' episode.

[2] I have to note that Iran had been sanctioned more than once, however, since multiple interventions reduce the number of observations in pre- and post-sanctions periods. Therefore, I will limit the intervention to one sanction episode.

[3] In HSE data in 2004, the last year available in the data, Iranian sanctions were still at work.

Table 2. Descriptive statistics of Fossil Fuels and Renewables Shares in Total Primary Energy Supply (Gokce & Hatipoglu, 2018).

	Iran	Panama
Fossil Share		
Mean (SD)	0.99 (0.00)	0.67 (0.05)
Renewable Share		
Mean (SD)	0.01 (0.00)	0.32 (0.05)
Total Primary Energy Supply per capita		
Mean (SD)	1.38 (0.42)	0.78 (0.10)
Min, Max	0.8, 2.2	0.6, 1.0
Total Primary Energy Supply, mtoe		
Mean (SD)	77.33 (38.60)	1.93 (0.44)
Min, Max	26.6, 155.6	1.4, 2.9

Although for the purposes of the study I use illustrative cases for the effect of sanctions on the share of fossil fuels and the share of renewables in the TPES, the larger sample will be more beneficial for the power of the model and for being closer to the true relationship between economic sanctions and share of fossil fuels and renewables controlling for confounding variables.

4.5 Interrupted Time Series Analysis

I will use interrupted time series (ITS) design to evaluate how economic sanctions affect the trends in targets' energy distributions in total primary energy supply.

Interrupted time series analysis has been widely used in different spheres such as in community intervention research, assessment of policy changes and reform. ITS has also been useful design for studying interventions in the public health sphere, and pharmacology (Biglan, Metzler, & Ary, 1994; Lopez Bernal, Gasparrini, Artundo, & McKee, 2013; Öge, 2016; Ramsay, Matowe, Grilli, Grimshaw, & Thomas, 2003; Wagner, Soumerai, Zhang, & Ross-Degnan, 2002). ITS can help to track the break in the time series trend affected by various types of interventions, therefore, this method can be used in the research where economic sanctions, similarly to policy changes and other interventions, are perceived as an external intervention or 'interruption' at a certain point of time, having a capacity to alter the existing trends that fossil fuels follow in TPES of the target states.

The model runs segmented regressions for the pre-intervention and post- intervention years, based on which I will determine the level and trend changes in the share of non-renewable fuels in TPES in each case. To analyze a change in levels and trends of my dependent variable before and after the intervention, I will observe whether an intercept, and slopes of my regression equation have changed respectively, and whether this change is significant in statistical terms.

The regression equations are:

$$\textbf{FossilFuelsShareTPESti} = b_0 + b_1\textbf{presanctions} + b_2\textbf{sanctions} + b_3\textbf{presanctions*sanctions} + e_t \tag{4.5.1}$$

$$\textbf{RenewablesShareTPESti} = b_0 + b_1\textbf{presanctions} + b_2\textbf{sanctions} + b_3\textbf{presanction*sanctions} + e_t \tag{4.5.2}$$

My dependent variable in the equation is the Share of Fossil Fuels in Total Primary Energy Supply at time t (in years), in a country i. TPES is measured in million tonnes of oil equivalent, and since I examine the share of non-renewable energy in TPES, observations are values that range between 0 and 1 and stand for the proportion of the energy type. The same regression is run for the Share of Renewables in TPES, where coefficients are interpreted analogously.

$$Y_t = \beta_0 + \beta_1 T_t + \beta_2 X_t + \beta_3 X_t T_t + e_t \quad (1) \qquad (4.5.3)$$

Y_t is the aggregated outcome variable measured at each equally-spaced time-point t, T_t is the time since the start of the study, X_t is a dummy (indicator) variable representing the intervention (pre-intervention periods 0, otherwise 1), and $X_t T_t$ is an interaction term. These terms are displayed in the lower half of Table 1. In the case of a single group study, β_0 represents the intercept, or starting level of the outcome variable. β_1 is the slope, or trajectory of the outcome variable until the introduction of the intervention. β_2 represents the change in the level of the outcome that occurs in the period immediately following the introduction of the intervention (compared to the counterfactual). β_3 represents the difference between pre- and post-intervention slopes of the outcome. Thus, we look for significant P-values in β_2 to indicate an immediate treatment effect, or in β_3 to indicate a treatment effect over time (Linden & Adams, 2011).

The main underlying assumption that allows to make analysis is that the trend and level of fossil fuels'/renewables' share in TPES would have follow its own trajectory if the external shock, such as sanctions, were not imposed. Another assumption is that although sanctions were lifted after some time, since no substantial aid or other countermeasures, proportional to the loss from sanctions, were implemented to outweigh the damage on economy, and since no reliable method is there to detect the exact dispersion of the interruptions' temporal effect, the influence of sanctions is regarded to continue even after sanctions were lifted. Therefore, post-intervention period comprises years from the imposition of sanctions up until the last time point in the HSE dataset, which is 2004.

5

EMPIRICAL FINDINGS

Table 3 presents the regression coefficients rendered by the Newey-West estimator with lag one. Findings suggest that the imposition of economic sanctions is associated with immediate and long-term shifts of renewable and non-renewable energy within the total primary energy consumption, accompanied with varied rates of increase.

Regression coefficients indicate in the aftermath of sanctions, Panama's energy consumption shifted towards using more hydrocarbons as the share of fossil fuels in TPES significantly increases. Likewise, for Iran we observe significant increase in the hydrocarbons' share over time. Interaction term, which allows for a comparison between the pre-sanction and the post-sanction trends, exhibits a significant growth, suggesting that both renewable-rich and fossil fuel-rich countries experienced a boost of non-renewables in their energy mix.

5.1 Panama

In 1987, United States imposed extensive financial sanctions on Panama, which was the result of the worsening relations with the local dictator, Manuel Noriega (Moreno-Villalaz, 1998). Although infamous military leader was caught and trialed by the U.S. in

1990, what he left behind was a stagnating economy and deteriorating inequalities within the country. U.S.-originated economic aid, financial transfers and credits were cancelled toppled with 50 million dollars cut of the loan from the World Bank (Harding, 2006). Moreover, earnings from the Panama Canal, one of the main income sources for country's economy was denied by the U.S., which was worth tens of million dollars (Harding, 2006). Shrinking pool of funds left government in a precarious situation with its GDP dropping over the 15 percent in two years and unemployment doubling (Harding, 2006; Moreno-Villalaz, 1998; Witt, 1990). At the time, economy experienced major shock with banks closing their functioning for several months (Witt, 1990). Economic health and budgetary strength has been irreversibly affected, which, in turn, had a precarious impact on entire country. Development of capital intensive renewable capacity available in Panama was perhaps one of the last issues on the agenda at the time. Within such devastating episode, the factors that played to the country's advantage was the Panama Canal through which international fuel tankers were passing through, ensuring accessibility to the imported fuels, as well as the presence of Trans-Isthmian Oil Pipeline, constructed in 1982, that carried around 800 million of barrels of oil per day (LaFeber, 1990).

As we see from the statistical analysis there is a major reversal of the energy preferences within total primary energy consumption of Panama (See: Table 3). Moreover, there is a large upward fossil fuel relocation the trend reverses. Despite a great solar and hydro-power potential in the country, government highly favored the imported fossil fuels for meeting internal demand ("Panama: Policy and Regulatory Overview," 2012). Neighboring fossil-rich countries played to the advantage to the growing demands within the country. Panama for decades has been importing fuels from Colombia, Chile, the United States, and Venezuela ("Panama: Policy and Regulatory Overview," 2012). Although being further thrown apart the U.S. military operation to oust Noriega and the mass civilian killings, it seems that for some time, energy consumption fell for the short period in the aftermath of sanctions and military invasion (See: Level change in Table 3).

Over few years hydrocarbons' share has been recovered (See: Figure 2). Restoration of the relations with the U.S. and the return of its capital to the country in 1990s may account for such a rapid increase (Harding, 2006). When we additionally look at the TPES per capita over time, it further supports the argument of the fast recovery of energy consumption in the aftermath of economic sanctions.

Figure 2. Depiction of the trends: Interrupted time-series regression with Newey-West estimator, lag(1), Panama.

Shares of different types of energy in Total Primary Energy Supply
Panama, 1975-2004
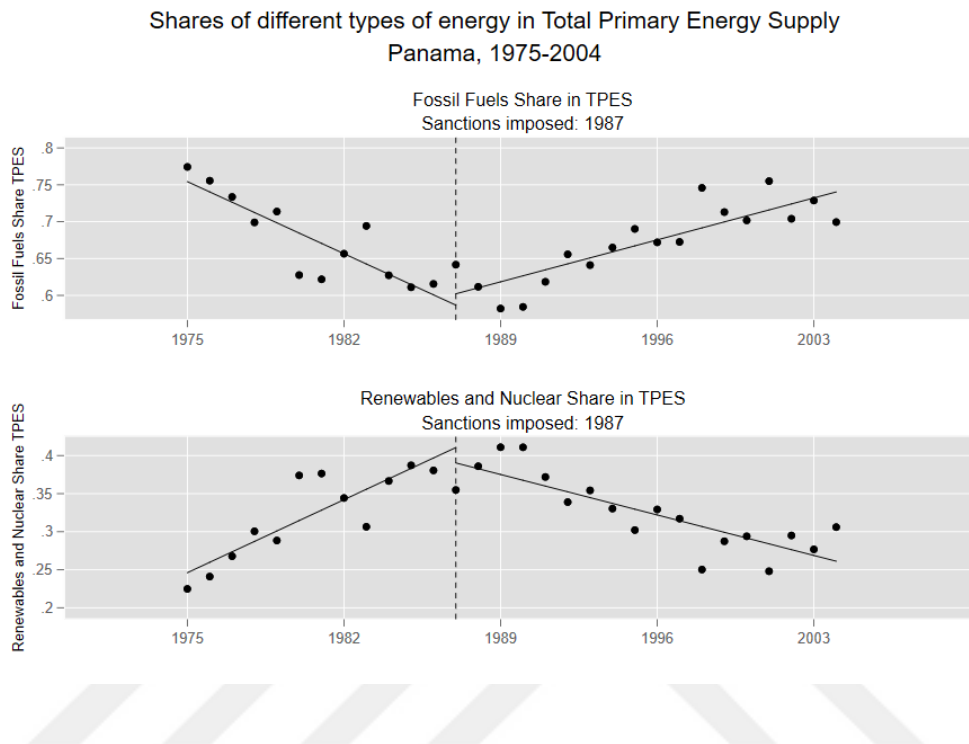
5.2 Iran

Iran possesses considerable reserves of fossil fuels and has been one of the top producers of hydrocarbons in the region among the OPEC members. Despite isolation from the West and continuously updated packages of sanctions, Iran for some time enjoyed cooperation with the EU which were willing to invest to resource extraction industries until pressured by the USA (Hufbauer et al., 2007; Torbat, 2005). Regardless of the presence of renewable sources of energy, such as hydro, wind and geothermal and solar energy, very small part of energy supply is covered by hydroelectricity (Atabi, 2004). For years hydrocarbons such as crude oil and natural gas were used to meet the internal demand. The oil embargoes, which constrained the external markets for crude, left Iran's budget tight and hardly capable to afford large investments necessary to fully

rebuild the oil refineries, which were thrown apart by Iraqi-Iranian war (Lippman, 1991). Iran largely used Singapore's and Yemen's refineries, which processed and returned the crude in the form of demanded petroleum products, since national capacity allowed to meet only the half of the internal demand in the mid-1980s ("Iran forced to import oil products," 1986). Although, Iran found buyers for its crude, such as in Nicaragua, the markets of countries overriding embargo are not large to compensate for the large loss due to sanctions ("Nicaragua to get oil," 1985).

Regardless of the loss over refineries outputs and embargo on the exports, we observe an incremental expansion in the fossil fuel stake in the total primary consumption. The essential take-away point being worth of further investigation is the observable shift within different types of fossil fuels. Expansion of the indigenous natural gas role in the domestic energy consumption seems to take place after the sanctions' imposition (See: Figure 5).

Moreover, although renewables are rising, when assessed within TPES, it loses to the hydrocarbons which follows its historic path. Indeed, our regression results support that economic sanctions encouraged state to utilize large fossil fuels endowments and reduce renewables' usage within its energy mix, following the need for faster recovery from the war and for the economic losses.

Table 3. Segmented regression coefficients representing level change due to economic sanctions and post-sanctions trend change in the Share of Fossil Fuels and Renewables in TPES for each country.[4]

Country	Groups	Year of sanctions	Intercept[5]	Pre-sanctions trend	Level change	Trend change	Linear post-sanctions trend[6]
Iran	FF	1984	98.2	0.000173	-0.000287	**0.000409****	0.000582
	RE		1.77	-0.000191	0.000393	-0.000382**	**-0.000573**
Panama	FF	1987-	76.8	-0.0140***	-0.00672	**0.0233***	0.0093
	RE		23.2	0.0137***	0.00108	-0.0213***	**-0.0076**

p-values * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure 3. Depiction of the trends: Interrupted time-series regression with Newey-West estimator, lag(1), Iran.

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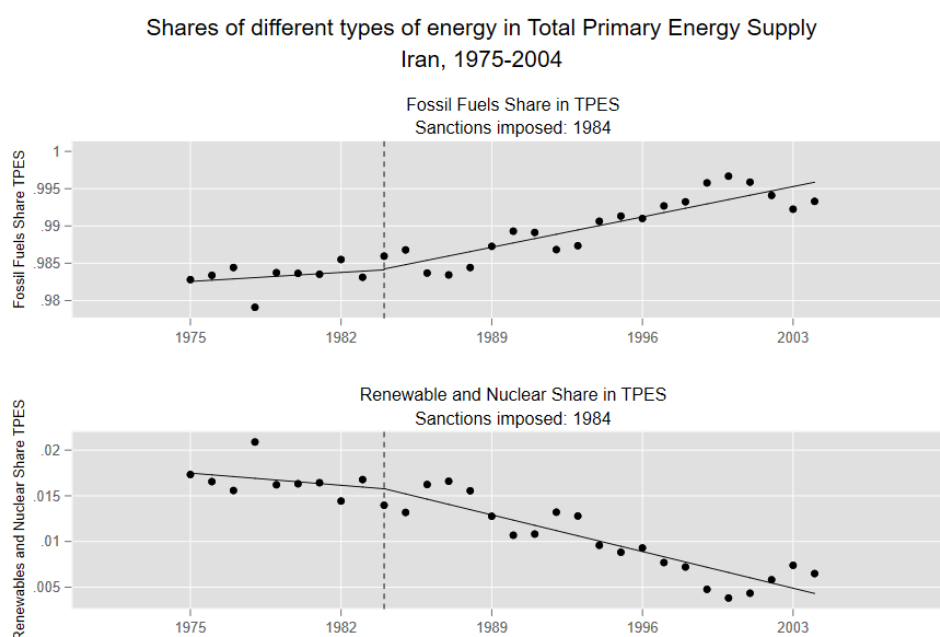
[4] There are 30 observations for each energy group. Regression with Newey-West standard errors with a lag (1) (Linden, 2015).

[5] Intercept coefficient refers to the share in the TPES at the beginning of time series.

[6] Linear post-sanctions trend is not a part of statistical output. Despite being calculated manually, it is still important to have these numbers for the purposes of inquiry. Linear Post-sanctions trend = pre-intervention trend + trend change.

5.3 Methodological issues

The researcher that decided to use the interrupted times series analysis should be prepared for the road full of limitations and validity threats that require and often have an available remedy.

The most striking methodological issues of this work are a causal inference problem and low external validity. Moreover, it is hard to infer the causal relationship with a small and not representative sample of countries. Therefore, there is no possible way to generalize my findings. What my aim was, on the contrary, is to use illustrative cases for depicting the association that have not been studied before. I regard country specific case studies to be a plausible first step in order to make it easier for a reader and scholars to grasp the existing associations and open the way to further research.

Another limitation in my analysis is an autocorrelation problem that is very common in time series regressions. Moreover, since in the segmented regression the first observation is included to the analysis, it can pave the way to another essential problem such as heteroskedasticity of the disturbance terms. Heteroskedasticity is the problem. Dougherty points out that in cases 'where heteroskedasticity is suspected, but there is not enough information to identify its nature', it is possible to deal with biased standard errors by using robust standard errors (Dougherty, 2016), whereby the variance of the residual is not constant, and it may have various sources.

To detect autocorrelation and heteroskedasticity in segmented regression I have plotted residuals, run pac-test and correlogram. In order to test whether data have the abovementioned problems, I also run the Durbin-Watson test (Dougherty, 2016). For all countries, we observe d-statistic to be less than 2, which implies the presence of autocorrelation.

After testing individual cases for autocorrelation and heteroskedasticity, I corrected models in accordance with the present problems utilizing Newey-West regression. First of all, since the value for share of fossil fuels in particular year is affected by the value in the previous year for cases I run regression at the lag 1. The results are presented at Table 3.

I must acknowledge the difficulties for clearing out the relationship between economic sanctions and total primary energy supply for few reasons. There are possible drawbacks of the model threatening the internal validity such as other alternative explanations that may account for the change in the share of fossil fuels and renewables in TPES.

My assumption that no confounding variables are there to explain sharp changes in the patterns that would coincide with the same timing of the sanctions imposition may not reflect reality. I acknowledge that there may be possible forces to project a slow and gradual effect on my dependent variable, such as policy changes, more environmentally friendly regulations that may change share of non-renewables in TPES. In order to deal with this particular threat to internal validity, it is suggested to list possible events that may affect my dependent variable and try to make sure that these alternative factors indeed could influence the energy consumption patterns in the country (Shadish, Cook, & Campbell, 2002). Even for the limited number of countries in the sample, it is still a very complex task to detect all possible alternative macro- and micro-factors that may have different effect on each country, for instance, the oil shocks in 70s, domestic policy changes, intra-state or international conflict, economic recession, and many others. However, as the next step in my research, I can diminish the non-systematic and systematic differences that the target states possess to the certain extent by using a large-N sample. Nevertheless, additional analysis, such as multivariate regression, or introducing a control group to ensure that sanctions were the cause for the level and trend changes, are required, even in the case if the model included a larger sample of countries.

This quasi-experimental design allows to examine the levels of change in values in time series data and the following trends. As Campbell and Ross (1968) states, when using ITS analysis, an event that occurred in a specific time is analyzed as a 'causal' variable, which will let to infer the change that this event assumingly 'caused' the shift in trends after it occurred. However, ITS design cannot allow us to make a robust claim over the reasons for the observable shifts, thus reducing the validity, since the suggested ITS analysis uses only one outcome measure, and it cannot account for all possible confounding factors on the outcome variable as was previously mentioned (Shadish et al., 2002).

Additionally, there may be more precise and valid measure for studying the changes in the dynamics of different types of fuels in states' economies, and their energy

preferences. The dependent variable is the share of the FF and RE in TPES that oscillates between 0 and 1, and it is not a continuous value that shows the volumes of gross inland energy consumed. We could look at the values of each fuel type TPES in each country throughout the time. However, since states are different by size and population having different rates of indigenous production of energy as well as exports, and pricing formulas, we took shares of hydrocarbons and renewables in TPES as a measure that may help us to track the changes within TPES of each country.

Last major limitation is availability of short time series of 30 years, which are segmented by the sanctions in non-equivalent pre- and post-sanctions periods that differ within and across the countries.

All in all, the scope of this study should be broadened further and examine other factors affecting energy consumption in depth.

6

CONCLUSION AND POLICY IMPLICATIONS

This paper aimed to uncover how economic sanctions being external shocks affect the trends in fossil fuels and renewables share in total primary energy supply of targeted states in the aftermath of extensive economic sanctions.

Findings partly support the hypothesis, for Iran we indeed perceive the growth in the share of fossil fuels. However, results also indicate that sanctions lead to long-term increase in fossil fuels' share in consumption patterns of renewables-rich Panama that do not possess indigenous hydrocarbon reserves. Availability of indigenous resources seem to have play only a partial role for mechanisms in the energy trends.

ITS results for Panama and Iran further confirm our hypotheses. Panama, experiencing a short-lasting decline of fossil fuels in its energy mix, exhibits a reversal in the trend directions. Within carbon-heavy modes of development, countries rich with RE then are likely to exhibit prominence of the fossil fuels in their energy mix after the imposition of economic constraints. At the times of economic sanctions, Panama seems to possess high incentives to maintain energy demand through hydrocarbons. That is what we observe in upward trend in Panama.

We observe that developmental and recovery needs as well as necessity for immediate solutions at times of extensive economic sanctions may hinder sustainable energy choices. And given large initial investments needed at initial stage of RE

development, there are limited number of options left in the targets' hands, making fossil fuels as a cheaper alternative.

Although sanctions against Panama and Iran are considered as unsuccessful to render behavioral changes in the regimes, as the statistical result supports, sanctions may instigate unintended consequences to the long-lasting trends within the total primary energy consumption We observe that it is likely that economic sanctions may reverse historical paths of energy use boosting fossil fuels' usage, as well as perceive a major growth of hydrocarbons' stake within the fossil abundant Iran.

Considering the popularity of economic sanctions as a foreign policy tool, there is an increasing importance of understanding how these policy choices may affect energy choices of the targeted states in the future. There was no comprehensive research conducted before that concerns the adverse effects of sanctions on the total energy consumption of a target country. Therefore, the research studying the relationship between foreign policy tools and the energy realm across states is increasingly important within new security and environmental challenges.

The findings have considerable implications to the development and climate nexus. Among many effects of economic sanctions, this instrument may bring unintended environmental consequences. Considering the developmental needs of sanctioned states, energy policies and energy consumption patterns of both RE and FF rich targeted states are critical for the global climate change framework. Since most of the sanctioned states are middle income developing states, even though some of their energy demand is met by less polluting renewables, they do not disdain from the usage of hydrocarbons. Fossil fuels seem to maintain a successful and attractive position of the cheapest, easiest, and the most polluting option for many states.

The observed trends in this study imply that economic sanctions slowing down financial and economic growth give target states strong incentives to keep using cheaper and more energy dense energy sources. Not only higher capital investments constrain switch to renewables, but also the ever-presence of industrial and population energy demands encourage states to recover and compensate by burning fossil fuels. Growth of hydrocarbons in the energy mix of targeted states, given an increasing popularity of this foreign policy tool, may further carbonizing world economy and exacerbate climate change in the long term.

Additionally, economic sanctions may displace the incentives of states and firms to implement and join the market schemes aimed at reducing carbon dioxide emissions. Future carbon trading schemes and permit systems, in which polluting allowances are traded, can be distorted in a way that extra burden for using hydrocarbons will not serve anymore reductive role, being offset by immediate and rapid events where state will prefer the instantaneous self-sufficient measures.

Lastly, there are many other impacts carried on with sanctions-energy nexus, especially in realm of fossil fuel rich and "rouge" states. Given that the increasing trend of hydrocarbon usage is additionally instigated by economic sanctions may in turn affect the forecasts of future energy supply and demands as well as change the course of the energy policies tailored based on the national security and self-sufficiency expectations.

This research is a first step for clearing out the relationship between economic sanctions and share of fossil fuels and renewables in total primary energy supply in sanctioned countries. The mechanisms are partially supported by statistical model often used in studying the effects of various interventions in public policy, pharmacology and health reforms. The preliminary results can contribute to a better understanding and more effective design, implementation, and evaluation of sanctions by the sender countries. Advanced large-N study may account for possible confounding factors that will bring a better insight to the economic sanction effect on the total primary energy consumption.

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Descriptive statistics

Table 4. Descriptive statistics for indigenous energy production in countries of interest.[7]

Indigenous Production, ktoe, thousand tonnes of oil equivalent	PANAMA	IRAN
COAL		
Mean (SD)	0.00 (0.00)	668.78 (88.46)
Min, Max	0.0, 0.0	452.5, 815.3
CRUDE OIL		
Mean (SD)	0.00 (0.00)	178211.55 (58938.67)
Min, Max	0.0, 0.0	74162.9, 301086.0
NATURAL GAS		
Mean (SD)	0.00 (0.00)	24962.48 (20980.66)
Min, Max	0.0, 0.0	3658.3, 76168.2
NUCLEAR		
Mean (SD)	0.00 (0.00)	0.00 (0.00)
Min, Max	0.0, 0.0	0.0, 0.0
RENEWABLES		
Mean (SD)	612.25 (104.70)	770.65 (178.42)
Min, Max	380.0, 798.8	461.4, 1114.2

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[7] Mean, median, standard deviation, and range of the data is presented for all types of energy in TPES, ktoe.

APPENDIX B

Share of Fossil Fuels and Renewables in TPES in Panama and Iran, 1975-2004

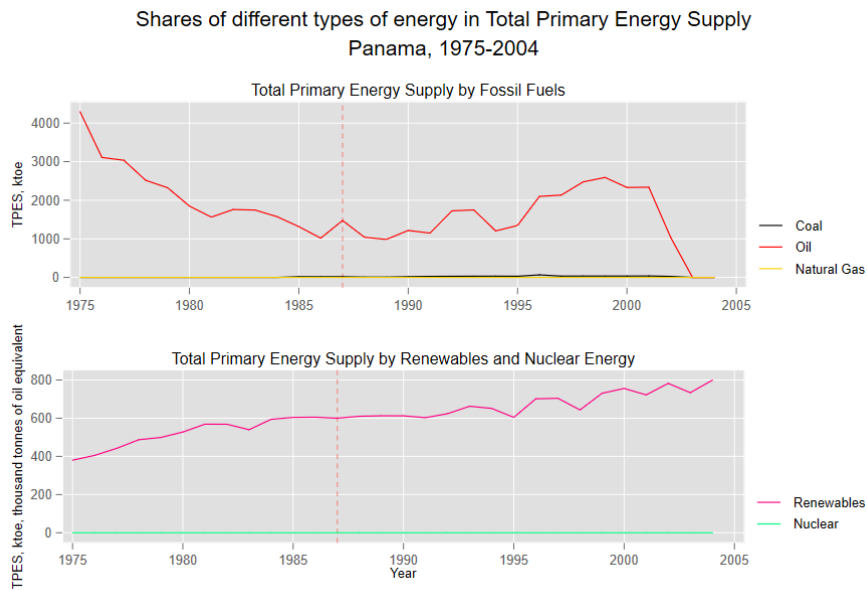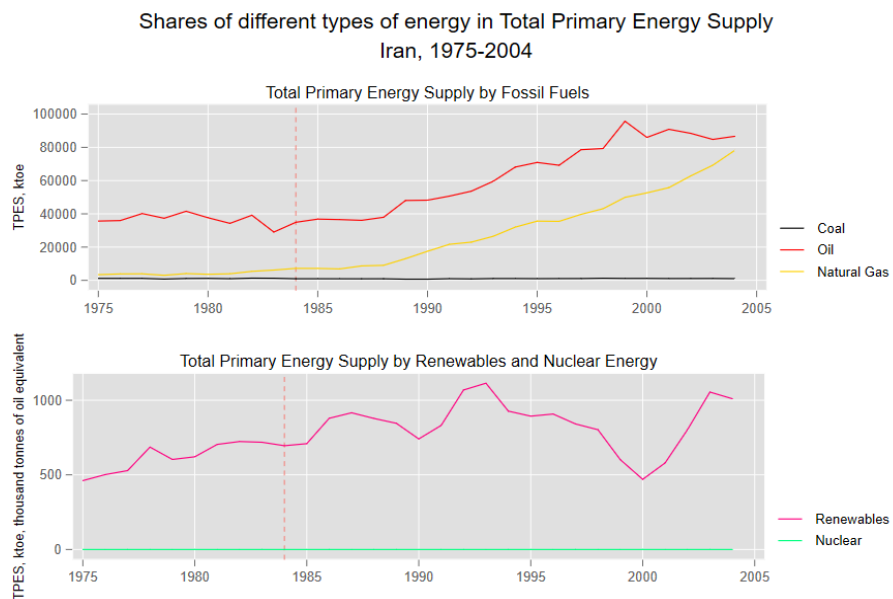**Figure 4.** Shares of Fossil Fuels and Renewables in TPES, Panama, 1975-2004

Figure 5. Shares of Fossil Fuels and Renewables in TPES, Iran, 1975-2004

Total Primary Energy Supply per capita in Panama and Iran, 1975-2004

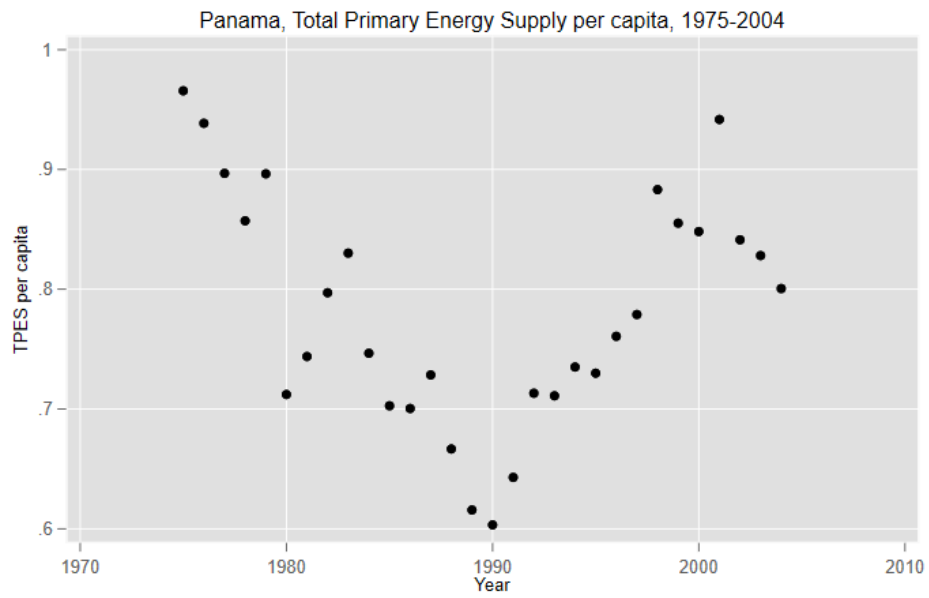**Figure 6.** Panama, Total Primary Energy Supply per capita, 1975-2004

Figure 7. Iran, Total Primary Energy Supply per capita, 1975-2004