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The Italian Energetic Security: Development of a Geopolitical Risk Index for the Gas Diversification Strategies

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ACADEMIC YEAR 2021/2022

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INTRODUCTION

Energy security is a source of major concern between policymakers and business leaders because the security of flows is a determinant of social stability and economic growth. The issue of energy security has emerged more strongly in the current public debate due to the current situation in Ukraine. The Russian Federation declared war on the Ukrainian nation on 24 February 2022, which has a disruptive effect on the global political and economic balance. The Russian Federation uses its enormous market power in the field of raw materials and fossil fuels as an inexhaustible source of financial resources to support its Federal budget and at the same time as geopolitical leverage over European countries. A rigid application of the market mechanism brought Europe and Italy to develop a strong dependence on the cheap natural gas supplied via pipeline from Russia. Within this framework, Italian policymakers and international institutions have raised major concerns about this unacceptable and unbalanced dependence on Russian fossils. As a result, a wide-ranging look is needed to start finding possible solutions that lay the foundations for a sustainable long-term strategy of diversification of natural gas supplies.

The first chapter of this work illustrates the ongoing dynamics that shape the Italian natural gas market and it provides an overview of a portion of the existing literature that deals with the quantitative aspects of energy security, i.e. which are the underlying factors that shape the risk profile of countries. Over the last two decades, the debate experienced rapid development of the literature concerning the security aspect of energy supply, because of the growing importance of fossil fuels for modern and globalized societies. As a matter of fact, the globalized world is characterized by fierce competition between multiple national actors who want to gain access to a finite and excludable amount of subsurface resources at an affordable cost. This pattern has been catalysed because of the growing involvement of a major portion of people in the global markets expressing high demand for fossil fuels. A globalized world connects multiple nodes in a single system, so disturbances at one node may catalyse unforeseen or otherwise undesirable phenomena at other nodes. Therefore, any event of an economic, political, or military nature can negatively affect the availability of energy commodities.

Because of this context, many scholars developed a number of indexes able to express quantitatively complex and multidimensional phenomena with the aim to measure the intensity and scoring of the ongoing processes. Hence, quantitative indicators permit us to convert into the same scale the several facets of reality. Some commentators argue that the energetic pillar is not enough to assess the reliability of the energy sources, i.e. multiple factors can alter or mitigate the risk profile

of exporting countries. Indeed, a number of studies suggest creating composite indicators with the aim to assess stability through economic, socio-political, and international factors.

There is a number of underlying and root causes that can destabilize the security of energy supply, i.e. this thesis aims to integrate multiple dimensions for assessing the geopolitical stability of gas suppliers and the structural benchmarks of the evolution of this stability. A wide range of literature deals with the issue of energy dependence, market concentration, and risk of supply, however, many indexes seem to be narrow or too general because they do not assess the specificity of countries according to policy-oriented results. Composite indicators can express multidimensional phenomena and they play an important role in driving the development of public policies, hence the indexes are deemed to provide assessment for the resolutions of policy issues.

Moreover, the literature develops a number of indexes that do not detect structural problems because there is no involvement of mutually-correlated factors that changes together through similar patterns. Therefore, this thesis aims to construct a composite indicator that scores and assesses the geopolitical stability of gas suppliers to Italy. The index has been named Geopolitical Energy Security Index (GESI), and it can be argued that this composite product is tailor-made and policy-oriented because it includes only a certain category of countries and it introduces a country-specific component in the fourth pillar of the theoretical framework. The GESI is measured for representing the evolution of factors that influence the geopolitical stability of gas suppliers in the last decade, namely 2010, 2015, and 2020. The sample includes countries with natural gas exporting capacity, and economic and political relations with Italy, i.e. the thesis includes Algeria, Azerbaijan, Libya, Egypt, Nigeria, and Qatar.

The second chapter illustrates the theoretical framework and the methodology followed for developing the GESI. The theoretical framework explains how the variables are mutually related and they represent proxy measures for intangible phenomena that are not directly observable because geopolitics is not a statistical or economic aspect of reality, but it is reality itself with its several connections. The index aims to explain the correlation among multiple variables that seem to be disentangled but they are pieces of a broader puzzle. The GESI is composed of four pillars, namely economy, energy, socio-political, and relation with Italy. Each pillar is the result of the aggregation of different sub-pillars and, by analogy, each sub-pillar is the expression of one or more correlated variables. With particular concern with the fourth pillar, foreign policy has been introduced as a factor that influences energy relations and the possible long-term commitment in terms of energy supply. The thesis introduced two proxy measures in a sub-pillar named “external actors involvement” with the purpose to measure the influence of malign actors on the Italian national interests in the MENA

region and Sub-Saharan Africa. The second chapter provides a theoretical justification of the framework and it assesses benchmark countries (e.g. Azerbaijan and Algeria) for clarifying the points to assess in the analysis.

Following the methodological part, the third chapter shows the quantitative realization of the index and each step for dealing with the statistical aspects. The outcome of this chapter includes the comment on the results of the GESI prepared for 2010, 2015, and 2020. This comparison helps to clarify the dynamism of the socio-political landscape of sample counties. The chapter discusses the main takeaways and the main hypothesis of the thesis. Hence, GESI suggested that an exporter must deal with the domestic demand for energy sources because of its internal economic and social development that can prevent the capacity to fulfill long-term energetic obligations with other countries (e.g. with Italy). In addition, the chapter verifies if the internal socio-political dimension can disrupt the level of political commitment to long-term energy supply deals. Another outcome to detect is the effect of economic development on geopolitical stability, i.e. it mitigates shocks and helps to ensure the long-term commitment of the country. Finally, the GESI would like to assess external actors' involvement and verify if this claim is mutually excludable from the Italian energy policy because it can aliment entropic dynamics because of the friction between opposing spheres of influence. It would be asked the following question: Can Italian influence mitigate the political risk and increase the level of political commitment for long-term energetic partnerships? Therefore, It can be argued that building energy relations can increase the geopolitical security of both countries and at the same time it represents a self-fulfilling mechanism (but not a causal relation) for enforcing good bilateral relations because energy investments are capital intensive and the energy sector is long-term oriented.

The last section of the thesis highlights a possible bridge between the current work and new theoretical outcomes. This section aims to build a bridge between this thesis and future research in the area of improving the descriptive capacity of GESI.

CHAPTER I: ITALIAN GAS SECURITY AND THE EUROPEAN NEED FOR REDUCING THE POLITICAL RISK

1.1.1 EUROPEAN GAS MARKET: A PATH TOWARDS DEPENDENCE

The following thesis aims to untangle the intricate relationships between factors that can influence multidimensional concepts such as energy security. We intend to construct a composite index aimed at aggregating multiple variables from different pillars that can influence the energy security of countries. The subject of our study is Italy's energy security, particularly in the gas sector. However, there are phenomena, such as the geopolitical situation, which are not directly observable and cannot simply be represented by a pile of a few untwined variables. Therefore, in the context of high inflation due to supply shortages, as well as an exponential increase in conflict in certain areas of the world, the issue of supply diversification has resurfaced more forcefully in the public debate in recent months. In order to be properly studied, complex phenomena must be represented in their components and then examined as to how these interact and how they can be effectively adjusted. Moreover, since the issue of energy security is fundamental to the public debate, as well as to a country's national security, it is essential to build tools that can monitor the evolution of phenomena over time (to adapt them to sudden changes in circumstances) and that can be easily communicated to the general public. The following work aims to develop a tool to monitor the dimensions that lead to the emergence of political risk in countries exporting gas to Italy. Therefore, it is first necessary to analyse the framework within which Italy operates to build its national diversification strategy. The following chapter intends to introduce the European gas market in terms of volumes, dependence, and the functioning of general mechanisms. Therefore, an assessment of these mechanisms, which create a dependency between countries, is crucial to understanding the fragilities of Italian manufacturing and our economic system as a whole.

Before the 2000s, the majority of natural gas prices in the EU were controlled by long-term contracts that were tied to the price of oil, a system known as oil indexation. Gas prices tracked the patterns in oil prices, with volatility smoothed down, hence this provided a constant reference price that supported large-scale investments in upstream projects, transportation pipelines, and LNG terminals (Zeniewski, 2021). It is important to highlight that energy policy choices fall within the scope of the choice of strategic infrastructures to physically transfer gas volumes. Within the pipeline infrastructure network, countries decide to tie themselves to a less flexible and resilient system but it ensures lower costs and more efficient logistics. Furthermore, pipeline construction involves a

political commitment among several countries that agree to pass the infrastructure through their territories and bear the costs of maintaining and building the facilities, in exchange for a portion of the transported gas. In contrast, LNG shipped to regasification facilities is more expensive but the resilience of supply lines is higher because the importer can switch suppliers and find new dealers. It can be argued that cheaper gas prices via pipeline deeply shaped the energetic agenda of European countries because its economic convenience is regarded as the trade-off between resilience and economic affordability. Within the current international landscape, decisions are influenced not only by governments but also by international environmental groups and, more crucially, multinational corporations. Furthermore, in order to properly grasp international relations, we must first understand the internal context that rules a certain state. Domestic configuration of interests, domestic power distribution, and institutional conditions are at least three characteristics that govern a government's foreign policy. Indeed, the economic profitability of the Russian gas influenced the preference of European utility operators because of the economic profitability. In addition, lower energy prices can boost economic development and make the cost of goods traded with international customers more competitive. Otherwise, if certain European countries can ensure cheaper gas prices, they would develop a competitive advantage with respect to the countries developing more expensive energy prices because of the LNG costs or other factors. As a consequence, there is the incentive to rely on the same cheap supplier in order to mitigate the effects of different costs of production in a given economic zone with a fixed exchange rate such as the Eurozone. In case of relevant asymmetries between energy price and fixed exchange rate regime, countries can experience important trade imbalances, hence the best equilibrium is to exploit the cheapest supply.

Prior to the reforms, the gas prices did not reflect the supply-demand fundamentals of the gas market, and purchasers in the EU were unable to benefit from periods of lower-cost supply, especially after the US shale gas revolution. Gas prices in the EU have steadily shifted away from oil indexation and toward "gas-on-gas" (known also as supply and demand) competition, in which prices reflect many suppliers and purchasers of natural gas on spot markets. The Netherlands' Title Transfer Facility (TTF) has emerged as the most liquid hub and important pricing benchmark in the EU, providing trading and hedging options to an expanding pool of market players (Zeniewski, 2021). The TTF is a spot market Exchange that brings buyers and sellers of commodities, securities, futures, options, and other financial instruments together. The exchange gives the current price and volume available to traders with access to the exchange based on all orders given by participants. In the spot market, short-term contracts are the majority of the instruments issued by buyers and sellers. The spot price is the current quote for a commodity's immediate purchase, payment, and delivery. This is significant because pricing in derivatives markets, such as futures and options, will unavoidably be dependent

on these values. Because of this, spot markets are extremely liquid and dynamic. Commodity producers and consumers will participate in the spot market before hedging in the futures market. A negative aspect is the problem of speculation because some operators can buy gas or other products only for speculating on the increase of the price when the speculator does not have the real need for the specific product, otherwise, other operators may need it. Another disadvantage is that spot markets cannot be utilized to properly hedge against future production or consumption of products, which is where the derivatives market is better suited. The TTF_M index values are calculated as the arithmetic average of the daily quotes issued on the working days of the preceding month for the month of supply. The arithmetic average of each price provided by the operators is stated in €/MWh and translated to €/Smc by multiplying by 0.0107, resulting in a calorific value of 0.03852 GJ/Smc (ACER, 2021). Following the Covid-19 epidemic and its associated limitations, there was a reduction in demand for natural gas and energy in general in early 2020. As a result, TTF natural gas prices reached new lows, falling to a little over 3.5 €/MWh in May 2020 (ACER, 2021). Nonetheless, the period of inexpensive natural gas costs appears to have passed. Indeed, the rebound of economic activity has resulted in increased energy consumption, with natural gas prices returning to pre-pandemic levels by Q3/Q4 2020 (Nouicer & Piebalgs, 2021).

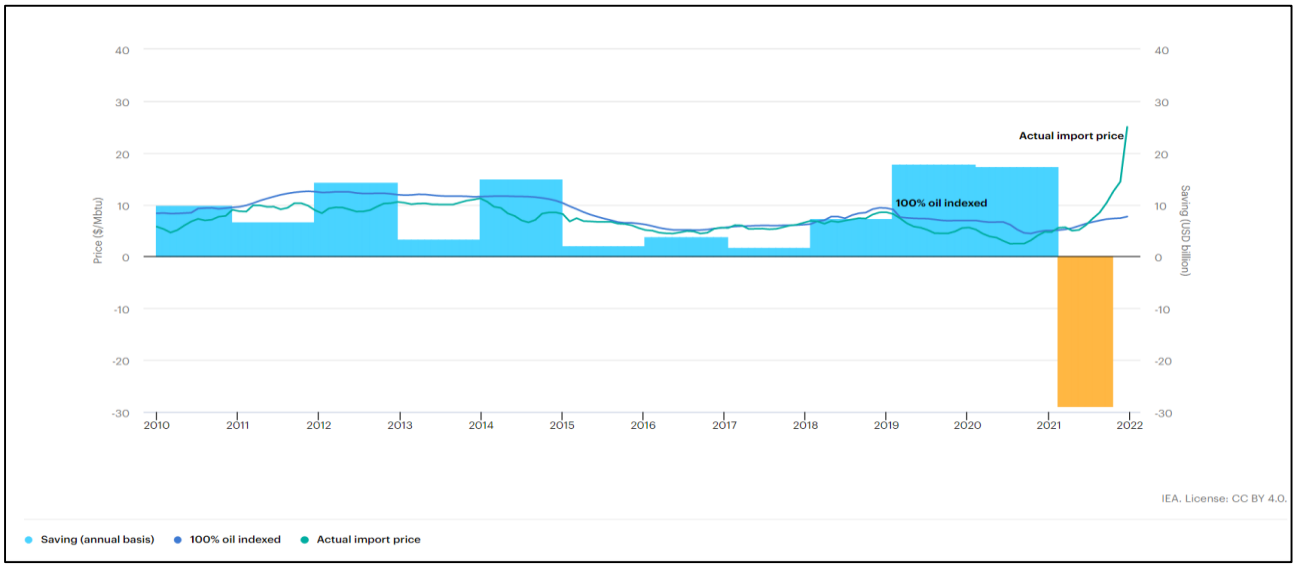

Fig 1. Difference in natural gas import costs in the European Union under actual import prices v. 100% oil-indexed prices, 2010-2021. Source: IEA, 2021

Looking at the figure elaborated by the IEA, it can be argued that the adoption of the spot market mechanism played a significant role in reducing the costs of energy transactions in Europe. European countries aim to ensure lower utility prices as much as possible because of international competition with Asian countries and the US. In fact, Europe needs to stay competitive with Asian hubs, and the

spot prices in Asia are quite similar to that of European so this mechanism can preserve European competitiveness. The spread between gas prices is even higher if we compare the European prices with the Henry hub in the US. Within this framework, the EU was forced to accept the Russian supplier because of its economic feasibility. The IEA shows that savings in terms of costs were significant for each year, hence if we rely only on the economic aspect for measuring the risk for the national interests, there is no possibility to evaluate the potential sources of alternative risks to the economic activities and the national interest (e.g. geopolitical unforeseen events). The spot market minimizes the costs during normal times (i.e. business as usual/daily operating activity) and provides the possibility to gain better prices because in case the market fluctuation is from the structural patterns of the energy sector such as the rotation of seasons. Therefore, the weaknesses of these European prices can be reported as follows:

i) Speculation of financial operators in the spot market can artificially increase the costs of energy because of the high degree of reactivity of short-term contracts;
ii) The spot market prices (i.e. short term) are less predictable rather than long-term contracts with fixed prices and mitigation of risks caused by skyrocketing gas prices - if there are outbreaks or other disruptions from the supply or the demand sides that were unforeseen by the market operators – cannot be easily handled;
iii) A gas infrastructure heavily reliant on a dense network of pipelines creates strong ties with the producer country, and consequently, unexpected disruption of the flows can dramatically harm the spot prices because financial operators tend to adjust their expectations to the belief that the gas would be a rare source compared to the demand, hence this makes the price skyrocketing because of the scarcity of the commodity.

As stated by IEA, in a normal scenario the spot price benefitted the EU because the comparing the prices. Considering price simulations, in the case of oil indexisation, the disbursements would have been higher. However, if we look at the time interval between 2021 and 2022, we can see that this pricing system was negative and deteriorating for European positions. With oil price benchmarking, the EU would have been cheaper. Indeed, market solutions such as the spot market reveal many weaknesses and fragilities when it comes to the so-called “weaponisation of gas” conducted by the Russian Federation to put pressure on European countries and induce them to indulge in the military choices recently made by the Russian leadership. Heavy reliance on Russian gas has provided incalculable leverage for Moscow. Therefore, policymakers will necessarily have

to include political risk factors in energy policy in order to mitigate future threats to national security and macroeconomic equilibrium. The next paragraph will illustrate the political influence on the EU caused by the over-reliance on the Russian Federation's natural gas.

1.1.2 EU GAS SUPPLIERS: WHAT'S WRONG WITH MOSCOW?

Natural gas and electricity prices, as for other commodities, are primarily a function of supply and demand in the market. A high natural gas supply over demand would result in lower prices and vice versa. The supply of the EU natural gas takes place via a network of pipelines, mainly from Russia, Norway, and Algeria, or it can be shipped as liquefied natural gas (LNG) to the EU LNG terminals. Natural gas is typically purchased and stored during periods of low prices and low or normal demand, i.e. in warm months, in order to be sold to consumers. The trading of natural gas (either OTC or via exchange) happens in two main distinct markets: the spot market and the futures market, where gas can be purchased one month before its delivery.

There is a strong tie between the political agenda and the European natural gas supply security. New gas pipeline and LNG projects received strong interest and investments, especially in light of the European Union's growing need for imports: its own production is declining; around 100 billion cubic meters (Bcm) of long-term contracts are set to expire by 2025, and there is some upside for gas consumption as coal and nuclear plants are retired. The IEA predicts that by 2025, the EU will need to seek extra imports to satisfy up to one-third of its projected demand (IEA, 2019).

However, According to the International Energy Agency, Russia has been lowering its piped gas supply to the EU market while failing to fill its storage facilities in the EU to appropriate levels. Gas piped from Russia fell by 25% year on year in Q4 2021 (ACER, 2021). This drop-in Russian pipeline supplies to the EU grew more evident in the first seven weeks of 2022, dropping by 37% year on year. The last pipeline exports to Germany via the YAMAL pipeline (through Belarus) occurred in December 2021 (ACER, 2021). During this time, Russian gas flows via Ukraine averaged 55 mcm/d, significantly below the contractually authorized capacity of roughly 109 mcm/d (ACER, 2021).

Other gas providers, like Algeria, Azerbaijan, and Norway, boosted their deliveries to the European market during the heating season compared to the previous year, using commercially accessible supply lines. In addition, it has been registered that the loss of Russian flows has been offset by greater liquefied natural gas (LNG) inflows, which have climbed by 63 percent year-on-year through October. However, gas prices experienced a deep increase and the expectations of

market operators enforced the self-fulfilling prevision of the price skyrocketing. It can be argued that the Russian government successfully leveraged the expectation effect and brought a significant climb in gas prices all over the European markets.

The depletion of volumes from Russia is not enough to completely explain the new interval of gas prices, i.e. the spot market enforced the bullish mechanism because operators adjusted their expectations to growing prices (expected less supply), hence the effective prices skyrocketed more than they expected and more than supposed to do. The Russian government aims to exploit economic and political advantages from the dominance in the European gas portfolio. The Russian invasion of Ukraine started on the 24th of February and involved several aspects of the hybrid warfare doctrine elaborated by the Russian military apparatus. The hybrid threat compounds many tools that traditionally overcome the military means (e.g. cyber, economic, cultural, and energetic advantages) that can be exploited in order to target enemies and incentivize certain political behaviours. Within this framework, it can be argued that Russia used energetic means in order to polarize the Western alliance and divide the stakeholders. This strategy can be particularly impactful for over-exposed countries such as Italy and Germany[1]. The degree of dependence on Russian fossil fuels has been exploited as an arm for political aims and aggressive international politics. It seems undeniable that European policymakers, especially the Italian politicians, underestimated the political risk when they decided to bind their economic and energetic security to Moscow. The next section will provide an overview of the Italian national energy study in order to explore the ongoing trends that erode the Italian sovereign and freedom of action in the international arena.

1.2.1 ITALIAN ENERGY SECURITY

Italy presents a high profile of risk because of the low diversification of its energy portfolio, especially in the gas sector. Complex relations of dependence on Russian gas can harm economic security and erode the political will of governments in complying with the Western's decision to increase geo-economic pressure on Moscow. In fact, decreasing energy imports from Russia can financially hit the Kremlin's ability to aliment its federal budget and consequently the military policy for confronting the Western block. In addition, economic sanctions are able to impact the Russian GDP and its military industry, hence the reduction of financial flows from fossil fuels can represent the most important erosion of the Russian power. As a matter of fact, Russia is an energy giant—the world's third-largest producer of oil and the second-largest producer of natural gas, hence

[1] Ungheria, Slovacchia, Chech Republic and the Baltic States can be mentioned as over dependent on Moscow.

by some estimates, fossil fuels account for 14% of the nation's economic output. Revenue from the sector is responsible for more than 40% of the federal budget (McBride, 2022). However, the dependence on Russian fossils cannot be reduced easily and rapidly without harming the Italian economy and creating a strong social discontent against policymakers. Social discontent can be turned into anti-NATO policies, low or negative economic growth, an increase in unemployment, and raising in inequalities. Within this framework, the Italia policymakers should try to develop a long-term strategy for decoupling the economy from Russia in order to avoid further disruptions. Indeed, it seems fundamental to analyse the evolution of the Italian national strategy in order to detect continuities between governments despite their political orientation. Given the frame, the next paragraph will tackle such changes and recurring patterns. The purpose of this section is to analyse the evolution of the liberalization of the natural gas sector to observe the results 12 years after the process began and to assess the potential arising from the opening of the Gas Exchange

1.2.2 DEVELOPMENT OF THE ITALIAN SPOT MARKET: WEAKNESSES UNDER SCRUTINY

Considering the geographical position of Italy, we realized that it is at the centre of the gas supply network from North Africa, Northern Europe, Russia and, Caucasus. Because of this strategic position, the Italian Peninsula can play a central role as a swing between different energy networks and become a central hub able to provide a strategic point for the stability and security of the gas supply for the entire European Union. Over the last decade, the supply of natural gas has changed since the liberalization of the sector led to the creation of a Virtual Trading Point (VTP) and later to the Gas Exchange to guarantee citizens the right to a secure and reasonably priced energy supply (Capece, 2014).

Since the beginning of the 2000s, Italy experienced an important increase in its energy consumption, hence the demand for fossil fuels brought the rapid growth of the gas import. The process of growth has led to a structural process of liberalization (through the European Union) that gave rise to the need for regulation to protect consumers and develop competition. Indeed, since the end of the last century, the natural gas sector was the subject of a considerable amount of legislation at both a national and a European level in order to liberalize the national market and create a single European market. The European liberalization process has affected many sectors of infrastructure services, with the aim to lower prices and improve consumer welfare and to reduce the competitive disadvantage for new entrants and smaller operators. By the end of the 90s, the EU Commission and the European Parliament approved the Directive 98/30/CE aimed to liberalize the energy sector of

member countries (Capece, 2014). Before this reform, the energy sector of Italy (and other European countries) was vertically integrated and characterized by monopoly, i.e. few companies got the direct ownership of various stages of the production process rather than relying on external contractors or suppliers. Therefore, the Directive forced an unbundling within the supply chain, hence production, transportation, and trading must be separated and divided into different companies with different owners.

Another important reform to highlight is the introduction of the Third Party Access (TPA) which states the possibility for potential network users to request and obtain access to gas facilities under transparent, objective, and non-discriminatory conditions. In addition, the EU law introduced the concept of "eligible customers", i.e. Italian consumers can choose their supplier and they can buy gas at a competitive price because on the market there are several suppliers able to provide the same service. The legislative Decree n.164/2000, known as the Letta Decree, transposed several guidelines concerning the definition of eligible customers, competition, and conditions of reciprocity (Capece, 2014). The ENI group experienced an important process of liberalization, especially for what concerns the gas sector. The Letta Decree imposed the unbundling of distribution companies from those in retail thus allowing the latter to operate in a more competitive market.

It can be argued that most of the liberalization reforms have benefited Italy's energy security by protecting consumers from the distorting effects that generally occur in monopoly situations. However, the creation of a single energy market has forced many energy players to find competitive suppliers compared to the supply prices of foreign companies. Indeed, the Russian gas was cheaper and more competitive, and abundant respecting the alternatives provided by other suppliers. It can be said that the market mechanism brought Russian dominance to emerge as a spontaneous equilibrium between competitive market forces. The competition between different actors does not only affect competition between different national champions, but it also concerns central aspects of competitiveness between country systems. Within the Eurozone, large disparities in competitiveness, often given by cost asymmetries due to different remuneration of production factors (i.e. capital, labor, and energy) between different national economic systems, generate problems caused by the accumulation of large trade deficits and excessive indebtedness of importers (less competitive countries). Large trade deficits generate the need to finance this consumption, which translates into private foreign debt that risks leading countries into the balance of payments crises that lead to the heavy economic crises of entire nations.

Italy does not host appreciable coal caves nor has nuclear national power was never implemented in the last decades, consequently, the only alternative source to coal was the introduction

of natural gas in the Italia energy mix. In addition, the economic and political incentives toward energy efficiency and the reduction of emissions incentivized Italian firms and households to adapt their plants to the gasification of electricity. As a result, over 50% of the electricity generated in Italy is derived from this gas consumption, accounting for over 70% of the annual energy bills of the average Italian family (Capece, 2014). The market mechanism reduced the incentive to exploit national resources because the number of investments compared to the real extraction capacity and the economic return worked as a disincentive for the national production of favor of foreign suppliers[2].

In 2006, the first spot market transaction was established in Italy and the Virtual Trading Point (VTP)[3]. VTP is a virtual hub to trade and sell gas injected into the Italian national natural gas transport system[4] managed by SNAM Rete Gas which is the leading natural gas transporter and dispatcher in Italy. VTP aims to provide the users with a platform where bilateral over-the-counter (OTC) transactions of natural gas take place on a daily basis, hence the platform can be considered as a *"gas and transmission capacities market with the objective of facilitating negotiations, reducing transaction costs, and hence improving the overall efficiency of the system and the balancing between supply and demand"* (Capece, 2014). It is a virtual hub where there is no interception between physical pipelines or other infrastructure, but within this platform, national or regional infrastructure system. The virtual hub is open to market competition and promotes natural gas negotiations between the various competitors including the numerous supporting services.

Almost all the gas consumed in Italy is imported from five countries: Algeria, Russia, Norway, Netherlands, Libya and Qatar[5]. By 2021, Italy consumed around 67.7 billion cubic meters as imported goods, and Russia was the major supplier with a total amount of 28.5 billion cubic meters (Statista, 2020). In 2022, it is expected to import from Russia around 29 billion metric cubics, and more than 40% of the total national import will come from Russia. According to the ECB (2022), the partial reduction or the imposition of tariffs on Russian gas would inevitably harm the economic security of target countries. The ECB stated that "*regarding supply disruptions, the direct and indirect impact of a hypothetical 10% gas rationing shock on the corporate sector is estimated to reduce euro area gross value added by about 0.7%*" (ECB, 2022). In order to assess the impact, the ECB estimated the quota of value-added for each economic sector provided by gas usage. The effects are computed by

[2] In addition, the local resistance to gas extraction from the offshore basin brought the Italian policymakers to capitalize the social aversion towards trivellation because of environmental concern.
[3] Even if the first transaction took place in 2010.
[4] Known as "Rete Nazionale di Gasdotti or RNG".
[5] Mainly via gas pipeline, although the amount transported by ship is rising considerably thanks to the introduction of the Adriatic LNG terminal near Rovigo, where the tankers from Qatar now offload.

comparing the value-added derived from an input-output structure with full coefficients and the value-added derived from a hypothetical input-output structure where the final and intermediate supply to the euro area of the electricity, gas, steam, and air conditioning supply sector are rationed by 10% (ECB, 2022). The accounting exercise suggests that gross value added in the euro area could be 0.7% lower in this rationing scenario, with losses being particularly significant for countries where production relies more heavily on gas and where the production of the electricity, gas, steam, and air conditioning supply industry itself represents a considerable share of value-added. Nevertheless, Italy is one of the most impacted countries, hence the ECB estimated that the economic output would -be 0.8% (ECB, 2022). However, it can be argued that many indirect side effects could occur in catalyzing the negative consequences of such a policy. Because of this dependence, Italy needs to develop a concrete and effective strategy of diversification that will ensure the long-term sustainability of supply in terms of the volume of natural gas.

1.3.1 LITERATURE REVIEW AND THEORETICAL FRAMEWORK

The following section aims to highlight the conceptual framework behind which this thesis constructs its meaning. The dissertation proposes a review of the existing literature that we considered most relevant to defining energy security concepts, and at the same time, we intend to enrich the paper with a description of energy security indexes. This thesis is set within the broad framework of energy security indexes and illustrates the applications and use of compound indexes in the field of energy security. First, it will be reviewed some contributions to the energy security concept and its implication for the national security strategy. Second, the section explains the benchmark literature on composite indicators in order to assign the specific field of this contribution.

1.3.2 TACKLING THE CONCEPT OF ENERGY SECURITY

The concept of energy security seems to be both ambiguous and general, however, scholars have developed a substantial body of literature on the subject that involves a multidisciplinary reflection of energy-related items. The concept of energy security is inherently slippery because it is polysemic in nature, and it is capable of holding multiple dimensions and taking on different specificities depending on the country. There is a consistent number of researches based on the micro-level of the energy security landscape and most of these publications deal with deregulation of local markets, effects of the electrification of energy in specific countries, or the assessment of the commodity trading mechanism (i.e. economic and financial aspects of the fossil fuel market as regard as price

generation, general equilibrium of the market and economic effects of contracts). Nevertheless, the thesis frames the multidimensional and structural patterns of the exporting capacity of a country that exports natural gas to other nations. In order to tackle the theoretical framework of the thesis, it is important to clarify the main concepts and the relevant limitations of some speculations. The section will explore certain epistemological limitations of a certain field of literature in order to provide a long-sighted view of energy security. The argument starts with a general definition of the concept and then it will shift from the general to the particular.

1.3.3 THE FREE-MARKET LITERATURE AND ITS CONCEPTUAL LIMITATIONS

The first issue to identify when talking about energy security is the continuity of the energy flows often described in terms of availability, reliability, relative shortage, or complete disruption across the total supply chain. There is a wide range of scholars that identifies energy security with the possible disruption that can occur within the market mechanism, hence there is a perfect analogy between the supply and demand mismatch and the interruption of the energy mechanism. Some scholars, provided a more extreme conceptualization of this statement, i.e. they define energy insecurity ‘‘*as the loss of economic welfare that may occur as a result of a change in the price or availability of energy’’* (Bohi &Toman, 1996). In order to provide an example, Scheepers et al. (2006) state that "*a security of supply risk refers to a shortage in energy supply, either a relative shortage, i.e. a mismatch in supply and demand inducing price increases, or a partial or complete disruption of energy supplies*" (Scheepers et al., 2006). According to Chester, the concept of energy security has experienced various step of theoretical examination even if in "*twentieth-first century access to energy sources depends on open global markets and a vast infrastructure network of offshore platforms, pipelines, tankers, refineries, storage, generation capacity, and transmission and distribution systems*" (Chester, 2010). However, there is no consistency within the extension of the market mechanism to energy security because the concept cannot be reduced to only the economic dimension. In fact, it can be argued that many dimensions are involved in determining an energy security assessment especially if the macro perspective is assumed (country-related perspective). This first perspective can be criticized because it covers through its reflection only the narrow operational part of the energy market functioning and not the structural patterns that overcome the economic aspect. In addition, they do not properly consider the long-term perspective which is the scope of this thesis.

Therefore, it seems fundamental to analyze more recent literature where the proper conditions of the globalized world are involved. These scholars overcome the narrow perspective of the first

"sight" on energy security, e.g. they expand their perspective on these authors by looking at the commodity supply chain and identifying the multiple origins of disruptions in the supply of fossil fuels. As consequence, they try to translate the short-term and operational nature of the concept of energy security with the aim to expand the interest toward the long-term sustainability of the supply. The IEA (2004, 2007a) has also proposed energy security measurement 'tools' of physical availability (geopolitical energy security and pipe-based import dependence) and the price component (power system reliability and market power). Chester (2010) provided one of the major contributions to the concept of energy security because he highlights the multiple facets of this theory. Chester illustrates four aspects of energy security. First and foremost, an inherent feature of energy security is the management of risk (e.g. assessment of interrupted and unavailable energy supplies or the risk of insufficient capacity to meet demand and the risk of unaffordable energy prices). Second, the energy security concept may be framed to reflect a country's energy use 'mix', the abundance of local resources, and reliance on imports. Within this framework, many international organizations have developed indexes about the diversification rate and grand dependence of a specific country on external suppliers. Most of these indexes are tailor-made for policymakers and international actors because they need a featured tool aimed to identify the specific risk of supply disruption. Third, Chester aims to challenge the traditional idea of energy security as a tool for governments or other authorities, i.e. the concept of energy security is independent of politics, hence politicians can develop public policy in order to strengthen energy security (and set certain achievements) and not vice versa. Forth, and most importantly for the thesis, Chester argues that the concept of energy security has a temporal dimension, hence threats to physical supply differ across short, medium, and long-term horizons. Short-term risks involve contingent casualties such as accidents, extreme weather conditions, terrorist activities, and other geopolitical disruptions (Chester, 2010). The main issue of concern is the reliability and continuity of current conditions (or the development favorable technological and political landscape) in order to avoid further fluctuation in the long run. As a matter of fact, long-term risks concern the adequacy of supply to meet demand and the adequacy of infrastructure to deliver supply to markets and fulfill contractual obligations. It can be argued that for building a comprehensive national energetic strategy, the policymaker should comply with long term and structural circumstances of the exporting countries.

More appropriately, it is important to clarify the difference between the conception of this thesis and the market paradigm drafted above. Looking at the literature, we can identify two competing market paradigms, i.e. the pure Walrasian market which optimally allocates products in a perfectly informed, atomistic world where prices are assumed to be regulators of the exchange of information flows among market actors. Energy markets should be allowed to operate without

political or state intervention because interference represents a distortion of the mechanism that leads to the worst social and economic outcomes. Within this framework, governments must align their efforts with the aim to ensure the competitiveness of the markets, avoiding economic incentives or engaging all the policies that can disturb and manipulate the price mechanism, i.e. the efficient balance between resources (given by an affective allocation of information) hence competitively determined prices must be the most relevant achievements. However, this conception seems to be disentangled from the geopolitical reality the energy markets are deeply influenced by political decisions and the energy flows can be reduced or interrupted as political means. In addition, the existence of trusts, monopolies, political involvement, and other aspects of the international area lead to contrast this perfect market approach. Hence, it can be argued that the market construction is embedded in a specific context and several dynamics can occur in influencing the outcome of the energy sector. In addition, long-term prices (especially in the short term) do not represent a relevant contribution to increasing energy security. In addition, political aspects are often expelled from the assessment of the process of energy security.

Otherwise, there is an alternative perspective to mention, in fact, the market can be considered a social, political, and historical construct. Each paradigm defines the interrelationship between market and state, and thus the role to be played by policy to deal with matters such as energy security. The dominant neo-liberal discourse on the role of the state should be overcome in order to propose an alternative approach that will allow to development of a more realistic perception of markets where information asymmetries, and social and geopolitical realities can affect the outcome of the price mechanism (Chang, 2002). Chang argues that the central problem with the neo-liberal framework lies in the modus operandi of the market, the state, institutions, and their interrelations. The author challenges the main assumption of neoliberal theories because they present some elements of criticalities in their foundational ground. First, neoliberal thinkers seem to have a naïve and unrealistic view of the state and its social weight. Second, many theories do not consider the market failures and the unrealistic economic framework of the energy sector. Indeed, the energy sector has very high sunk costs and high requirements of investments for the fixed capital, R&D, and security costs hence it is a sort of natural monopoly (or at least oligopoly). Third, market failures can occur with regard to negative externalities (environmental impact of the extraction process), and monopoly problems (e.g. investments are less incentivized because there is no incentive for improving productivity). Forth, the free-market model has been rooted in an anthropological model that is not existing in reality because each individual is influenced by the context, thus it is produced by its culture, country, and social ties that all combined create a new payoff and hierarchy of preferences that are very different respect the "rational maximization" framed by the theory. The narrower market-centric definition of energy

security clearly is based on the pure Walrasian market with its self-equilibrating properties. Markets are assumed to clear automatically via price adjustments i.e. prices respond to changes in demand or supply, finding equilibrium at the price at which the quantity supplied equals the quantity demanded. Otherwise, competing needs, when dealing with the international landscape cannot be satisfied because the actors are heterogeneous. Indeed, the self-equilibrating nature of the market rests on numerous assumptions such as identical consumers behaving rationally because they are perfectly informed about all the available alternatives, zero transaction costs, no trading at disequilibrium prices, and infinitely rapid velocities of prices and quantities.

For the sake of this thesis, it is important to argue the relevance of Chang's analysis should be found in questioning the existence of contexts where information asymmetries in markets are resolved or calmed by simple state intervention or non-intervention. The only empirical evidence is that energy markets, such as all the other markets, are incomplete, and external and political factors can influence their outcome. International competition and geopolitical rivalries can influence the functions of the market, i.e. many events cannot be predicted. However, theoretical work focusing on economic development, gas investments, and geopolitics can help to tackle further political risk analysis. These frameworks can boost the national security of countries because it provides some benchmark and phenomena to tackle with the aim to predict the structural tendencies of exporting countries that supply gas.

1.3.4 LITERATURE ON ENERGY SECURITY INDICATORS

Energy security concerns are a key driving force of energy policy. These concerns relate to robustness (sufficiency of resources, reliability of infrastructure, and stable and affordable prices). For most industrial countries, energy insecurity means import dependency and aging infrastructure. In addition, developed countries may be harmed by the ongoing dynamics in energy-exporting countries. As a consequence, developed economies need to monitor the evolution of crisis zones full of fossil reserves because the resources can help to fulfill their demand and at the same time increase the economic growth of many emerging economies. Nevertheless, developing economies have additional vulnerabilities such as insufficient capacity, high energy intensity, and rapid demand growth. In many low-income countries, multiple vulnerabilities overlap, making them especially insecure. In fact, emerging economies are often unstable and given to popular turmoil. In addition, the fast-growing economies require more energy for fulfilling the economic cycle and consequently, the amount of energy to export tends to be eroded by the domestic market. Modern economic and social systems are complex networks built on a division of functions. This means that the vulnerability

of social systems to unreliable electricity and gas supplies has been increasing over time. Supply interruptions can impose dramatic costs and damage to the industry, private consumers, and even the public order. For all these reasons, the last few decades have seen the exponential development of many quantitative methodologies to measure energy risk, the level of dependency, and inevitably the geopolitical risk associated with energy supplies. The following section illustrates the main index used by the expert for assessing the energy security dimension of countries.

Kruyt et al. (2009) provide an overview of available indicators for the long-term security of supply (SoS) and distinguished four dimensions of energy security that relate to the availability, accessibility, affordability, and acceptability of energy and classified indicators for energy security according to this taxonomy (Kruyt et al., 2009). This entails an element of absolute availability or physical existence (fossil resources are essentially finite). In addition, there is an element of accessibility due to the large spatial discrepancy between consumption and production of resources, hence the access to those natural resources often carries geopolitical implications. To sum up, it can be argued that there are four aspects to manage when dealing with SOS. First, the availability of resources plays a central role in defining energy security and it is related to the geological existence of reserves. The second element is the accessibility that is ensured by geopolitical constraints. Third, Affordability represents the economic aspect, i.e. the price affordability of the energy supplied. Last, Acceptability is one of the major issues to deal with in the current scenario because it frames the social and environmental sustainability of the energy policies. The authors distinguish between disaggregated or simple indicators and aggregated indicators. The analysis should carefully consider the role of SOS indicators especially when the aim is to capture SOS in some kind of objective quantitative metric, which could be used in policy making.

Looking at this thesis, it can be argued that the indicator we would like to produce is mainly based on the availability and accessibility pillars because we would like to develop an index that stresses the importance of structural forces that can influence the supply risk of gas for sample countries. However, the index can be also useful for monitoring changes in the interest theatres by overcoming the fog of the moment. Looking at structural benchmarks and leading forces behind the export capacity of a country helps to deal with the long-term orientation of the national strategy. The natural gas sector has been chosen because of its lower carbon emission intensity compared to oil and coal and because Italy presents strong criticalities in terms of gas dependence on Russia. A long-term strategy of diversification of suppliers plays a central role in terms of energy transition and national security because further disruption between the supply chains can occur within the supply chain.

As regards a national strategy, it can be mentioned the contribution of Mara et al. (2022), i.e. they develop relevant considerations about energy security as part of internationally recognized indices that are deemed to assess the temperature of world security. The authors provided a regression modeling approach to test the crucial factors of social-economic development that impact the energy security indicators (Mara et al., 2022). The link between energy security and national security is explored, hence the authors pushed the discussion on whether energy security is indeed so impactful a factor for geopolitics and geo-economy. However, the study highlights the absence of long-term cross-state indices to reflect energy, economic, and social security to allow for valuable modeling. Within this framework, an assessment of the energy aspect of national security has been developed for Norway, Ukraine, China, and the US. Finally, the computation shows that major drivers that affect energy security are KWh per capita, fuel imports, adjusted savings (i.e. energy depletion % of GNI), electric power transmission and distribution losses (% of output), alternative and nuclear energy (% of total energy use), renewable sources production share in total electricity production, excluding hydroelectric (% of total), adjusted net savings, access to electricity (% of the population), access to electricity in rural countryside's (% of rural population), urban population (% of the total population) (Mara et al., 2022).

Last but not least, it can be mentioned the appreciable contribution of Valdés (2016) aimed to discuss the controversial relation between weighting, energy security indicators and arbitrariness of the research. Energy security has emerged as an issue of great importance in recent years. Nevertheless, the applied concepts of energy security registered an important number of methodologies for developing composite indicators. As a matter of fact, composite indicators are very popular despite they can be affected by several methodological choices that often result in a lack of robustness of the rankings involved. The contribution of the author is to provide a critical discussion about the methodological choices taken for energy risk indicators. The findings highlight some useful methodological understanding for constructing such indicators. Hence, the methodology raised sourced various sources of disagreement among energy experts in terms of selection of indicators, prioritization of areas, weighting procedure, scoring, use of quantitative versus qualitative methods, timing, scaling, data quality, and availability. The author concludes that "*lack of a standardized methodology and consensus among scholars regarding the quantification of energy security in a broader definition may be due to the novelty of the research field, different characteristics of energy systems and data availability*" (Valdés, 2018). Indeed, each method has its own strengths and weaknesses and it is suited to specific contexts. Aggregation, weighting, and scoring are other methodological aspect that should be justified by a strong and rigorous theoretical framework that is different for each situation and group of countries. Different social, economic and geographical

contexts require their own frameworks and the concept of energy security is in constant evolution, as a result of the evolving reality of the political, economic, and energetic environment.

Moving on with the thesis, *the proposed index aims to assess the level of risk, presented in a given sample of countries, by tackling the structural patterns that can affect the reliability of those countries as gas suppliers. In addition, the risk assessment involves the geopolitical relation with a target country, in this case, Italy.* Structural indicators influence positively or negatively the exporting capacity of the countries, hence they represent a long-term issue to face for importer countries such as Italy.

1.3.5 HOW TO: GEOPOLITICAL ENERGY SUPPLY RISK INDEX (GESRI)

The following section explains the benchmark paper that inspired this thesis. Indeed, the thesis aims to collect indicators for developing a composite indicator based on multiple sub-pillars, i.e. it wants to measure the exporting capacity of gas suppliers from the structural point of view. The composite index will help to understand if a country is a "good" or a "bad" exporter of gas towards Italy. Energy risk and security are hot topics in energy policy and analysis. However, analysing energy risk quantitatively involves considerable methodological challenges, particularly when dealing with some of its more qualitative features. The goal of this research is to use a multivariate statistical approach called factor analysis to quantify the geopolitical risk of energy supply. Particularly relevant is the paper produced by Munoz at al. (2015) where they quantitatively estimate the multidimensional geopolitical risk of energy supply. Factor analysis was used to reveal energy risk, a variable not directly observable i.e. the geopolitical risk that is assumed as the dimension able to put in correlation multiple aspects of the countries involved in the analysis. The index proposed by the authors can be used for energy planning and energy management purposes. Despite increased natural gas extraction, supply issues persist. Natural gas importers around the world are increasingly impacted by factors such as "*increasing traded volume, mounting fragility due to economic, political, and legal conflicts in producing and transit countries, fluctuating prices, growing reliance on foreign imports, the increasing share of natural gas in final energy consumption, and a lack of diversification*" (EfeBiresselioglu et al., 2015). Various studies have proposed a wide range of energy security indexes, either to compare nation performance or to track changes in a country's performance over time. The authors identify four pillars for measuring the geopolitical risk related to the energy sector. They established a sample of more than 122 countries with several clusters of observed data. Particularly relevant is the methodology used by the author, i.e. they established multiple levels of aggregation for each variable and the highest general and deductive concepts.

Each geopolitical situation is hardly stationary, contrary to the prediction of future economic variables, the geopolitical aspect cannot be estimated with a certain degree of probability. As a matter of fact, the most experienced analysts are not able to foresee how the geopolitical situation will evolve in the near future without a certain considerable amount of probability of error. Because of this methodological limitation, the assessment of the geopolitical landscape (e.g. geopolitical risk index) in the future traditionally relies on the scenarios technique. As stated by the authors, "*scenarios are not forecasts but alternative narratives about what could happen in the future based on some critical parameters of the international energy system. They are useful as a tool for decision making in the presence of uncertainty but cannot avoid the use of subjective criteria to characterize the different scenarios*" (Munoz et al., 2015).

The appreciable contribution of the paper is the development of a single quantitative indicator able to represent the geopolitical risk, overcoming the qualitative description of these phenomena. Hence, analysis of energy security would greatly benefit in the case of the development of the energy security indicator that involved political and geopolitical aspects of reality. To sum up the methodological development of the GESRI, the following points can be mentioned:

i) Generally, geopolitical energy risks refer to three categories corresponding to the economic, political, and social aspects of human activity. The aim of the paper is to address the energy security aspect, hence it would seem advisable to add a fourth category of variables specifically related to the energy sector. Therefore, **the four energy risk vectors associated with the social, political, economic, and energy-related variables would determine the geopolitical reliability of the exporting** and transit countries that form the energy corridors toward a country. The authors argued that the four risk vectors can be said to be objective indicators in the sense that they are based on the country-level data compiled and released by reputed institutions or scholars;

ii) Because the European Union (EU) is an energy importer, an EU-relations dimension was added to capture how a country's level of geopolitical energy risk depends on the nature and intensity of its bilateral relations with the EU-27;

iii) No single variable can be used to estimate these risk components, a group or vector of highly correlated variables can be identified for each component that could be used in factor analysis to reveal the four underlying dimensions of the geopolitical energy risk or partial risk factors.

As can be seen in the figure below, the image shows the theoretical framework, i.e. pillars and sub pillars (here named as vectors and categories) used for the conceptual development of the index.

Vector	Categories	Number of variables
Economic	ECO1: Freedom and economic stability	6
	ECO2: Size of the economy and energy consumption	4
	ECO3: Fiscal policy on energy	2
Energy-specific	ENE1: Production and exporting capacity of oil and gas	3
	ENE2: Duration of oil and gas reserves	2
	ENE3: Net trade in oil and gas in relative terms	2
Socio-political	SPOL1: Socio-political stability and institutional quality	8
	SPOL2: Political and social violence	5
	SPOL3: Market power	2
	SPOL4: Social diversity and inequality	2
EU-relations	EU1: Level of political association with the EU	5
	EU2: FDI flows with the EU and the EU's energy imports	3
	EU3: Trade relations and treaties with the EU	3

Fig 2. Vectors of GESRI and Related Categories. Source: Munoz et al. (2015)

Dealing with the results, the average single commonality for the four dimensions was between 0.73 and 0.89 (Munoz et al., 2015). The interpretation of these values is quite straightforward. For instance, the average single commonality of the economic risk dimension is 0.77, which means that the three categories of variables included in that risk dimension jointly explain over 77% of the total variance in the economic risk vector. The four values of average single commonality are quite high, which confirms that the data variation was adequately explained in all four risk dimensions[6]. Moreover, in 94% of the cases, the commonality between the variables included in the factor analyses was higher than 0.6. Therefore, it can be concluded that the variables finally considered in each risk vector have a simple commonality that is reasonably high.

[6] The correlation between aggregation groups or levels represents how much the variation of a variable is explained by other indicators variation (Looking If they move together). Certain high correlation provides a certain number of information to the composite index or at the higher aggregation level.

1.3.6 DEFINING THE RESEARCH QUESTION OF THE INDEX

This conclusive section will sum up the theoretical scope of this thesis and it is going to describe the general characteristics of the index proposed by this thesis. This chapter reviews some of the extensive literature available on energy security and composite indicators. However, the real theoretical scope of this thesis does not stop at a simple emulation of the indices already on the market but seeks to characterize its theoretical offering by developing a customized index for the gas export sector, *with a particular interest in the geopolitical stability of natural gas exporting countries*.

Moreover, the index is tailor-made for the needs of Italy, a country that shows a strong dependence on Russian gas, thus exposing the Italian Republic to dangerous retaliations motivated by geopolitical conjunctures of instability and head-on confrontation between the complex internal relations (mainly EU and NATO) of Italy and the interests of the Russian Federation. The literature has provided a useful starting point for constructing our product and, at the same time, it showed the limitations of certain quantitative reductions of complex and multifaceted phenomena that often cannot be reduced to single observations. Dealing with the geopolitics of energy requires us to overcome such a narrow approach. The theoretical scope of the index is enriched by the insights taken from the literature, especially the one concerning the GESRI described in the previous section. We will define more precisely what is meant by the theoretical underpinning of the thesis. The theoretical nodes can be listed as follows:

i) Contingent and merely economic aspects are not the focus of this thesis. The index analyses long-term processes, so it does not merely reflect analyses of operational and contingent contexts, which are easily attributable to market dynamics such as adjustments between supply and demand. In fact, the thesis seeks to analyse elements that are not entirely attributable to the economic aspect and the implications for Italian energy security. According to this framework, demand and supply abstracted from the concrete network of social relations, turn out to be concepts that are not explanatory of the geopolitical faults to be analysed;

ii) Long-term orientation is the preferred range of analysis in the index of this thesis because only an assessment of long-term structural reasons can provide guidelines and cardinal points for Italian energy policy. In fact, it is not possible to focus Italy's efforts and resources on building relationships that do not have a long-term return for the stability of Italy's energy imports and future supply diversification strategies;

iii) Availability and Accessibility are the two main dimensions this index aims to investigate, with particular mention of security of supply. It can be argued that the geopolitical

dimension is the preponderant one in defining these two aspects that underpin the conceptual framework of the index;

iv) The index includes aspects of reality that can only be analysed and framed using measures used as proxies to identify fragments of a multivariable and multidimensional phenomenon. The geopolitical risk index attempts to trace and define the main nodes that structurally influence the energy behaviour of a country. Of particular interest is the tailor-made aspect of the index that seeks to define bilateral relations with Italy and its energy security policy.

v) If we want to predict the usefulness of such a product, we could refer to its uses in decision-making contexts by public decision-makers to analyse crisis contexts and sensitive areas for the Italian national interest. In fact, the construction of energy relationships entails the need to mitigate political risks that could emerge in exporting countries. Therefore, a specific assessment of each country is carried out to define the relationships it has specifically with Italy. While using a general methodology, the intentions are very specific, so it could be argued that the composite indicator of this thesis falls under the umbrella of policy tools to be employed over time and that can be refined by adding new outcomes and observations of local realities.

The thesis produces a composite index to measure the degree of stability of a country supplying natural gas to Italy and to verify how geopolitical and social crises can influence this stability over time. Are composite indicators able to provide a complete picture of the structural drivers of stability of a country that ensures energy flows to Italy? The next chapter will address the methodological paths for constructing a composite indicator.

CHAPTER II: METHODOLOGY AND PATTERNS FOR BUILDING THE COMPOSITE INDEX

2.1.1 COMPOSITE INDICATORS:

Composite indicators play a central role in comparing countries' performances and they combine several dimensions in order to measure complex phenomena through a given quantitative outcome. Such complex indicators can be used to illustrate and analyze complex and sometimes elusive issues from different fields. Because of this flexibility, the explanatory power of these statistical tools has experienced a rapid increase in terms of its implementation in both the national and international sphere as regards the development of instruments for comparing complex and intangible forces that shape the global landscape. As a matter of fact, these indicators can be used to identify common trends and establish a general grid for benchmarking country performance. A composite indicator is defined as "*a quantitative or a qualitative measure derived from a series of observed facts that can reveal relative positions (e.g. of a country) in a given area*" (OECD, 2008). Indicators monitor trends and draw attention to particular issues and they can also be useful in setting policy priorities for the process of monitoring, implementing, and evaluating public policy performance. In particular, composite indicators refer to multidimensional concepts with different vectors (or pillars) of variables

There are pros and cons to the implementation of composite indicators. Starting with the pros, positive aspects can be listed as follows (OECD, 2008):

i) They summarise complex, multi-dimensional realities to support decision-makers by providing an efficient, simple, and complete benchmark;

ii) they are easier to interpret than a plethora of many separate indicators;

iii) they can assess the progress of countries over time in order to monitor the efficiency, effectiveness, and consistency of public policies or other results given by collective decisions or structural processes;

iv) indicators can illustrate and show relations between complex phenomena without dropping the underlying information base coming from the variables utilized;

v) indicators enable users to compare complex dimensions effectively and establish a common ground for public discussion about policy issues.

Otherwise, some negative aspects must be borne in mind to critically address the real explanatory power of such composite indicators. The main cons are the following (OECD, 2008):

vi) composite indicators may send misleading policy messages if poorly constructed or misinterpreted. In fact, they can bring policy makers to suggest simplistic policy conclusions in order to shape the public opinion orientation without real causal effectiveness;

vii) Unclear and ideological items can be introduced in the construction process of the indicators, hence some voluntary or involuntary manipulation can occur. If the production process is not transparent, the policy suggestions inferred from that assumption can be misleading and ineffective because of the implementation of inappropriate solutions.

The following theoretical explanation will present some methodological tools for mitigating the negative aspects and developing the index of this thesis.

2.1.2 ENERGY SECURITY INDICATORS

Energy risk and security are hot topics in energy policy and analysis. However, analyzing energy risk quantitatively involves considerable methodological challenges, particularly when dealing with some of its more qualitative features. The goal of this research is to use a multivariate statistical approach to quantify the geopolitical risk of energy supply. Four partial energy risk factors were calculated for two case studies of the potential gas supplier to Italy and then averaged to generate the composite GESI (Geopolitical Energy Supply Index) for the gas sector. Despite increased natural gas extraction, supply issues persist. Some scholars define energy security exclusively in terms of supply security, such as energy availability and pricing, others argue for a more complete definition that includes downstream impacts such as the influence on economic and social welfare. The concept and characteristics of energy security appear to be dynamic and it is changing over time, hence various studies have been proposed in order to compare nations or to track changes in a country's performance

over time. The construction of this index permits to analyse of the macro-structural phenomena that can influence a country's ability to export to Italy and at the same time, it includes international policy variables to study a possible correlation between a supplier's foreign policy and its ability to export gas to the peninsula. From this point of view, the index can be defined as tailor-made because it studies correlations between Italy and the complex international relationships that could influence the country's alignment with various regional competitor

Composite indicators aim to measure complex dynamics, hence each indicator must show to be rooted in a solid conceptual web of logical relations. Indeed, indicators are useful for capturing complex dynamics that can not be reduced by flat formulas and non-dimensional measurements. The theoretical framework sets the basic assumption for the selection and the combination of the variables. Each dimension is supposed to fit with the purpose of the indicator and it should be relevant. In fact, a weak theoretical foundation would harm the solidity of the final outcome. The selection of the variables must present a pillar-based structure, hence it has been decided to divide the composite index representing the security of gas suppliers through the development of four strings of variables. As a matter of fact, each pillar focuses on one dimension to weigh in the equation of energy security. *The index aims to score the solidity and the goodness of gas suppliers to Italy, in terms of diversification of producers for reducing the energetic dependence on the Russian Federation.*

According to the definition of energy security, we can describe this concept as all the tools and dimensions to consider in order to avoid disruption in the physical flows of energy toward a consuming country or a significant increase in energy prices. The indicators are used to measure the energy vulnerability, however, these analyses are often formulated in qualitative form and hence cannot be rigorously integrated into quantitative models or assessments. The purpose of this thesis is to provide a rigorous quantitative explanation of the security of gas suppliers in Italy. However, several dimensions can harm the energy security of a country and it seems that geopolitical disruption, known as difficult to predict, can alter the stability of gas suppliers and consequently the Italian energy security. Because objective probabilities cannot be established from available data, most geopolitical risk variables cannot be evaluated as probabilities. This critical issue makes developing quantitative scenarios concerning the geopolitical backdrop or combining geopolitical data with quantitative scenarios challenging (Munoz, 2015). Because of this epistemological limitation, a causal typology of energy risks is chosen that will subsequently be utilized to estimate energy risks related to geopolitical circumstances, which we will refer to more quickly as geopolitical energy risks. Thus, quantifying geopolitical energy risk and its components presents various challenges (Munoz et a., 2015):

i) The geopolitical factor is not directly defined and there is no variable able to allow an effective representation. In order to examine the geopolitical condition of an exporting country, appropriate proxies must be used for the development of the index;

ii) The variables employed as proxies for geopolitical considerations (e.g., the extent of government corruption) are not directly connected to the possibility of energy supply disruption. Instead, a set of associated political, social, and economic factors usually give information about a country's relative position in relation to the risk factor.

Within this framework, the dimension of the composite index are parts of a broader puzzle that can not be reduced to a single dimension. The measurements are supposed to detect which variables are statistically correlated in the assessment of a supplier in the mid and long-run. For this reason, the object of the index and the measurement tools should be clarified as much as possible. The complex phenomena of Italian energy security are represented by some subgroups of variables and each dimension gets weighted according to the influence it seems to have on the broader picture. It can be argued that not all multi-dimensional concepts have such solid theoretical and empirical underpinnings, hence some complex concepts are difficult to define and measure precisely and they may emerge some controversy among stakeholders. In order to overcome this obstacle, we decided to clarify each dimension and its logical connection with the phenomena of this study by referring to groups of variables mutually related. Groups and subgroups of variables are supposed to be mutually dependent and coherent one each other. Variables (or indicators) that we can encounter are classified as quantitative as well as each variable represents a specific dimension to introduce in the computation. Qualitative data are measures of 'types' and may be represented by a name, symbol, or a number code and they are data about categorical variables (e.g. what type), in contrast, quantitative data are measures of values or counts and are expressed as numbers, i.e. quantitative data are data about numeric variables (e.g. how many; how much; or how often)[7].

Proxy measures can be used when the desired data are unavailable or when cross-country comparability is limited. For example, data on the number of employees that use computers might not be available. Instead, the number of employees who have access to computers could be used as a proxy. As in the case of soft data, caution must be taken in the utilization of proxy indicators. To the extent that data permits, the accuracy of proxy measures should be checked through correlation. In addition, qualitative values can assume different values according to the scale of evaluation provided

[7] For more details, see: https://www.abs.gov.au/websitedbs/D3310114.nsf/Home/Statistical+Language+-+quantitative+and+qualitative+data#:~:text=Quantitative%20data%20are%20data%20about,variables%20(e.g.%20what%20type) .

by the researcher. For example, the political relations between two countries can be scored through a scale of goodness as the value can be bad, normal, or excellent.

2.1.3 DEFINITION OF THE PILLARS:

The OECD stated that the composite indicator is above the sum of its parts and "*the strengths and weaknesses of composite indicators largely derive from the quality of the underlying variables. Ideally, variables should be selected on the basis of their relevance, analytical soundness, timeliness, accessibility*" (OECD, 2008: 23). The dimension selected are the following: economic, energetic, socio-political, and relations with Italy.

The economic pillar aims to detect the relationship between the creation of value and human development. The country's economic development shapes the capacity to demand energy resources *per se* or to supply for external consumers. In several fossil fuel exporting countries, there is a strong correlation between budget spending and the revenues generated by the economic sector, thus oscillation in the energy volumes or unforeseen decrease in the production capacity can negatively harm the balance of the public spending and erode the political ties. In addition, most of the fossil fuel exporter countries, also called *rentier states*, experienced in the last decade relevant processes of economic development that make it hard to predict the evolution in the private sector consumption. Indeed, the basket of goods and services, consequently energy, consumed by each household is subjected to rapid increases or fluctuations that can harm the resilience and reliability of the energy supply to foreign buyers. It can be argued that most of the economic changes within the exporting countries induce some positive or negative externalities about the capacity to supply energy outside its boundaries. Therefore, economic development can be correlated to the geopolitical stability of the country and higher energy production and consumption.

Let's move to the energetic vector, thus it represents the heart of the theoretical framework of the indicator. As a matter of fact, the energetic mix, and the dependence on gas for the electrification of the country can dramatically affect the capacity to export resources if combined with growing consumption and an improvement of the industrial production in the country. It can be said that this mechanism represents a trade-off between the domestic demand for energy and a given fixed production capacity with a small portion of the increase in the short run because important economic expenditures and investments are required. As a consequence, exporting countries are supposed to boost their energy efficiency with the aim to manage the domestic demand and to ensure, through additional investments, the export of natural gas. However, there is doubt that in case of fast growth

the governments would necessarily provide the number of resources needed for the internal development by reducing the energy flows with the rest of the world. Stable or expected production of fossil energy is put in correlation with the domestic market and the number of investments in the energy sector. In fact, the domestic aspect must be included in our computation in order to weigh the effective capacity of supplying gas for external clients. The emerging economies seem to be more unstable and they are often unable to fulfill external obligations, especially in the case when the internal component is asking for more resources.

The third pillar constitutes the socio-political aspect composite indicator is represented by the socio-political component of the country. There are local dynamics that shapes the internal landscape in several areas and destabilizes entire nations. Economic inequality can harm the social stability of countries and it can be argued that some empirical tests suggest the presence of a certain threshold level on the Gini scale, after crossing which one can expect a radical increase in levels of socio-political destabilization in general and the intensity of terrorist acts / guerrilla warfare and anti-government demonstrations in particular. As a result, some commentators argue that "*the most well-established environmental determinant of levels of violence is the scale of income differences between rich and poor. More unequal societies tend to be more violent*" (Wilkinson, 2004). In addition, the level of fractionalization of society in religious, cultural, and ethnic terms can bring to the creation of ineffective and weak institutions where the economic activities can not be developed without occurring in further problems and local institutions become less efficient and unable to provide the basic services to the population. Social conflicts can harm political stability and consequently, governmental commitment in terms of foreign policy and energy contracts can change easily without real justification. Indeed, political stability influences the propensity of foreign firms, even energy sector stakeholders, to invest in the country. The energy sector is characterized by high fixed costs of the capital for the initial investments, hence political instability can deteriorate the fundamental cash flow that must be yearly ensured in order to cover the initial expenditure. The stability enforces the commitment of local political authority with positive externalities with the foreign counterpart. Before moving to the diversification strategy in terms of potential volumes of gas supply, the Italian authorities should evaluate the political effectiveness of institutions in order to avoid unexpected disruptions.

The fourth pillar of the GESI aims to measure the political effectiveness of a potential gas supplier. Neither the capacity to produce more gas nor the domestic environment is enough to score the feasibility of a supplier. As a matter of fact, there is a political environment to deal with before building closer relationships. Indeed, some countries have conflicting interests to protect, hence the political alignment should be involved in the assessment process. Therefore, external actors can build

an alternative sphere of influence and share alternative interests in the country, especially in the energy sector. Close commercial, diplomatic, and cultural links between the gas supplier and the transit nations might be anticipated to lower the importing country's geopolitical risk of energy supply. As a result, we would need to incorporate in this study the extra dimension of bilateral interactions.[8] In order to measure this sort of dependence on hostile actors, it can be measured the trade flows and the level of interconnection and embeddedness between the economies. The same procedure can be applied for measuring the relations with Italy and other actors' influence can be weighted in order to reduce the willingness of the supplier for a long-term political commitment in terms of energy contracts.

Each of the vectors described plays a role in detecting the "goodness" of gas suppliers for Italy, thus the dimensions can catalyze or deteriorate the Italian energy security. It can be argued that most of the dimensions selected seem to be intertwined and they weigh in the political decisions of governments in terms of energy policies. Governments must deal with an impersonal factor that often can not be managed in the short run because the social and economic costs are prohibitive and the level of political risk seems to be overwhelming.

2.1.4 CRITERIA AND SELECTION OF BENCHMARK COUNTRIES

The index measures the political risk of alternative gas suppliers for the Italian energy policies. For this reason, the sample of countries included in the index is selected according to two criteria: the relevance in the Italian energetic portfolio and the developed natural gas industry.

With the acceleration of economic globalization since the end of the Cold War, nation-states are increasingly interdependent in terms of energy policies, while competition and coordination started to play a major importance in international relations. Consequently, all parties have devolved growing attention to international energy cooperation and its institutional construction. Energy security can be achieved through multilateral cooperation between countries or through the construction of special bilateral relationships between governments. In fact, ensuring the supply of energy plays a major role in the national security strategy and in terms of the economic competitiveness of the industrial systems of developed and developing countries. There is an unequal distribution of energy sources worldwide, hence this asymmetric scenario leads to a different power distribution among suppliers and buyers. Within this framework, the development of common

[8] See Chapter 1 for a deeper analysis of Munoz et al. (2015), source: https://www.sciencedirect.com/science/article/pii/S0360544215000821 .

energetic ties with other countries should be carefully analysed in order to avoid the "weaponization of energy". Geopolitics can affect the flows of energy, thus "*cooperation, competition, conflicts and even wars between different countries and regions in the issues of energy production and consumption will naturally occur. Therefore, geopolitics has become one of the important theoretical bases for governments and major oil companies to develop their energy policies*" (YU & DAI, 2012).

The diversification strategies are developed to manage unforeseen and unexpected disruption of the energy flows because of: loosing of good relations with the supplier, wars, internal outbreaks, raising tension and instability closed to the strategic chokepoints, and high price oscillation produced by terrorist attacks. In addition, there are multiple aspects to take into account before moving towards the development of new or stronger energy ties with supplier countries. In fact, the political commitment should be constant and must be ensured in the long term because:

i) Developing energy relationships requires long-term commitment in terms of high investment in fixed costs (high time for the return of capital). During the Cold War, there was a separation between supply and demand where technologies, knowing how and fixed capital are often located in buyer countries, and the reserves of energy resources are managed by suppliers. Indeed, the FDI in the foreign energy sector aims to combine the capital of the buyer with the resources of the seller;
ii) The company perspective shows the cost of capital as one of the main factors influencing companies' decisions in crediting the capital structure. The cost of capital is affected by the risk that owners and creditors bear. This risk level determines the rates of return that these groups of investors expect from their investments. The additional risk on the market should be compensated by the risk premium and risk-free interest rate and impact on the cost of capital. The level of the cost of capital depends on the method of its estimation.
iii) Stability of the internal institutions and positive relations with the buyer. Within this framework, history matters because energy relationships are long-term oriented ad the presence of critical infrastructure can mitigate the excessive costs of building from zero the energetic boundaries (path dependence);

In order to sum up, the criteria we used for selecting our sample of countries are the following: the presence of economic relations, energetic boundaries, the presence of infrastructure, and the presence of gas export. As a result, we selected the reported countries: Algeria, Azerbaijan, Libya, Egypt, Qatar and Nigeria. However, we used as benchmark countries two of them namely Algeria and Azerbaijan because they represent an emblematic example of the structural dynamics that GESI aims to tackle. The following paragraphs will analyse the economic, geopolitical, and, energetic

situations of these two suppliers. Particular attention is devolved towards an assessment of the energy sector and the geopolitical aspect, e.g. the influence of geopolitical dynamics in the countries that are parts of the sample.

2.2.1 ALGERIA

2.2.2 POLITICS OF ALGERIA

Algeria is a country located on the southern sternpost of Mediterranean Africa and it is part of the Middle East and North African countries (MENA). The population is around 43,851,043, of which 26 % used to live in the rural area. Algeria is located in North Africa and borders Tunisia and Libya in the east, Niger and Mali in the south, and Mauritania, Western Sahara, and Morocco in the west. In the north, Algeria's vast coast of over 1,200 km extends to the Mediterranean Sea. Algeria is by far the largest North African country. However, most of its national territory is occupied by the Sahara, which explains the arrangement of population density: 90% of the population is located in the north (Energypedia, 2022).

The country emerged victorious from the 1954-62 war for independence from France. Although numerous political parties do exist, power remains solidly in the hands of the military-civilian elite that came to power upon independence. Algeria was ruled by a single party from independence in 1962 until the approval of a new constitution in 1989, which introduced the basis for a multipolar political system with a sort of circulation of the ruling class, hence through this reform of multi-parties, the monopoly of the Front of National Liberation ended (Ottaway, 2021).

After Boumediene died in 1978, President Chadli Benjedid sought to overcome the institutional political model characterized by the activism of the military and security apparatus and the old leadership. The first of the changes was the formation of multiple political parties. Thirty-three parties were registered at the beginning of 1991 (Ottaway, 2021). The same phenomenon of the emergence of a pluralistic political life within the respective national communities developed simultaneously in similar regional contexts. There were too many nondescript secular parties, with little to differentiate them from each other beyond the ambitions of their founders; Islamist parties also emerged rapidly but the Islamic Salvation Front (FIS from its French name Front Islamique de Salut) quickly became dominant. In addition, organizations that had fought secretly for decades for the rights of the Berber population became part of the Algerian legal political spectrum. The most important of these was the Front des Forces Socialistes, which had existed since 1963, thus "*the rise of Islamist parties, again a common development in Arab countries, was the result not only of broader*

regional trends but also of the attempt – that began with independence – to revive part of the Algerian culture that the French had done their best to erase over 130 years of colonial domination" (Ottaway, 2021).

2.2.3 GAS SECTOR OF ALGERIA:

In order to achieve the energy transition, European countries are establishing deep economic and energetic interconnections with the Algerian governments. The main issue to manage is the development of a European Energy Security strategy with the aim to diversify the suppliers of fossil fuel and at the same time, the efforts of the European countries are meant to boost the energy transition. In fact, gas as the source of electrification represents the intermediate step for reducing carbon emissions in the atmosphere. The global electricity demand that comes from burning fossil fuels is rising despite the fact that renewable sources are expected to reduce this dependence on carbon-intensive energies. Indeed, renewable energy (solar and wind power stations) is not developed enough to satisfy this increasing demand, and natural gas can be the "bridge" between fossil fuels and lower emissions sources because its carbon footprint is lower than other fossil fuels. As a matter of fact, natural gas is 15-20% cleaner than gasoline when it is burned and coal prices are moving between 60 and 143 USD (megawatt-hour), while the price of natural gas is between 41 and 74 USD (METGroup, 2020).

In terms of market size, Algeria has the tenth largest proven natural gas reserves globally and is the world's sixth-largest gas exporter. In addition, Algeria can boast of the world's third-largest untapped shale gas resources (UK GOV, 2021). According to Algeria's national oil company, Sonatrach, "*about two-thirds of the Algerian territory remains underdeveloped or unexplored, with an estimated 100 undeveloped discoveries*" (UK GOV, 2021). Nevertheless, there are some critical issues to mention, in fact, the production of Algeria is steadily declining in terms of volumes, and domestic consumption are expected to grow in the next decades. As a consequence, the Algerian government has stressed the importance of further exploration in order to boost national productivity and achieve a better outcome for potential foreign buyers. As a matter of fact, future products may not be able to meet foreign demand without weakening the domestic sector. In contrast, the bulk of the government's fiscal revenues are generated by the selling of hydrocarbons, hence fossil fuel exports are an important item in the national accounts, and are a key source of valuable foreign currency used by local importers to pay local suppliers for goods that the domestic economy is unable to produce.

Because of the relatively limited size of the Algerian population, its economic structure, and average income, Algeria sell abroad about three-quarters of its oil output and three-fifths of its gas production. Traditional buyers of Algerian hydrocarbons are European countries, the United States, Turkey, and some Asia Pacific countries. Algeria developed a complex system of infrastructure in order to extract fossil fuel from the onshore fields and then there are three international gas pipelines in use: TransMed (also known as Enrico Mattei Pipeline), connecting Algeria to Italy through Tunisia, which came online in the 1980s, the Maghreb–Europe pipeline, connecting Algeria to Spain through Morocco, was commissioned in the 1990s, and MedGaz, connecting directly Algeria to Spain, started operations in 2011 (IEA, 2014). Besides this pipeline-based export capacity of 50 Bcm/y, new liquefaction facilities were developed and Algeria now has four plants between Arzew and Skikda with a total export capacity of 24 million tonnes per year (Rossetto, 2016). Through this infrastructural system, the country aims to diversify its client in order to achieve more flexibility and protection from unexpected changes from the demand side experienced in South-West European gas market. This rigidity is overcoming and the country can deliver gas also to Northern Europe, Turkey and even Asia Pacific countries.

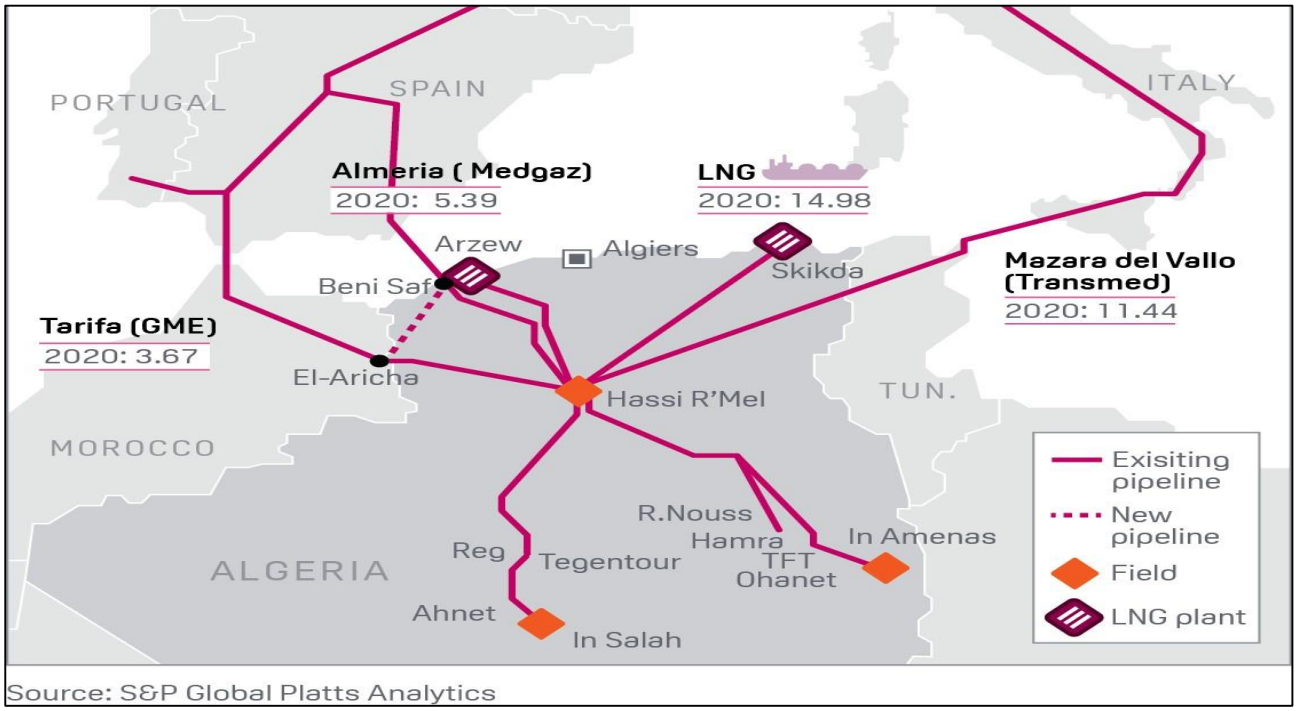

Figure 3. Algeria, Pipeline System of Natural Gas. Source: S&P

Algeria's rapidly rising demand and stagnating production presented a huge challenge for future export sales and Algerian authorities have come to realize the seriousness of the problems facing the country's gas sector, but clearly, political volatility continues to undermine energy sector

policy. As a result, the industry dynamics underpin the gas sector as well as there are some drivers of external instability that will determine whether the country can remain a major exporter of gas. A number of factors led to this decline, namely (OIES, 2019):

i) The maturing of old fields that have been in production for several decades, especially Algeria's largest gas field, Hassi R'Mel. Even some of the Berkine basin's fields which started producing in the early 1990s are presently beyond their plateau production stage. The early period of production, when the facility capacity is the bottleneck, is often referred to as the Plateau Stage of production because the facility capacity is relatively constant over time (PSU, 2020). It suggests that the production is expected to steadily decline;

ii) Lack of investments in secondary and tertiary recovery technologies to improve current low recovery rates from gas fields. The investment environment is fundamental for the recovery capacity of Algeria;

iii) Poor rate of new discoveries and proving up of new gas reserves due mainly to an unfavorable climate for international investments in upstream developments. A huge policy of exploration and production (P&E) must be established in order to improve the upstream sector and its implications on the production capacity;

iv) Bureaucratic problems brought to long delays in project development and implementation. The new hydrocarbons law, according to Sonatrach, envisions three types of contracts for investment in exploration and production activities: a production sharing contract (PSC), a participation contract, and a service contract. Sonatrach's upstream investment includes programs to prevent production declines in large mature gas fields such as Hassi R'Mel, as well as its own exploration efforts. Despite ongoing investments, the corporation has been unable to obtain adequate results.

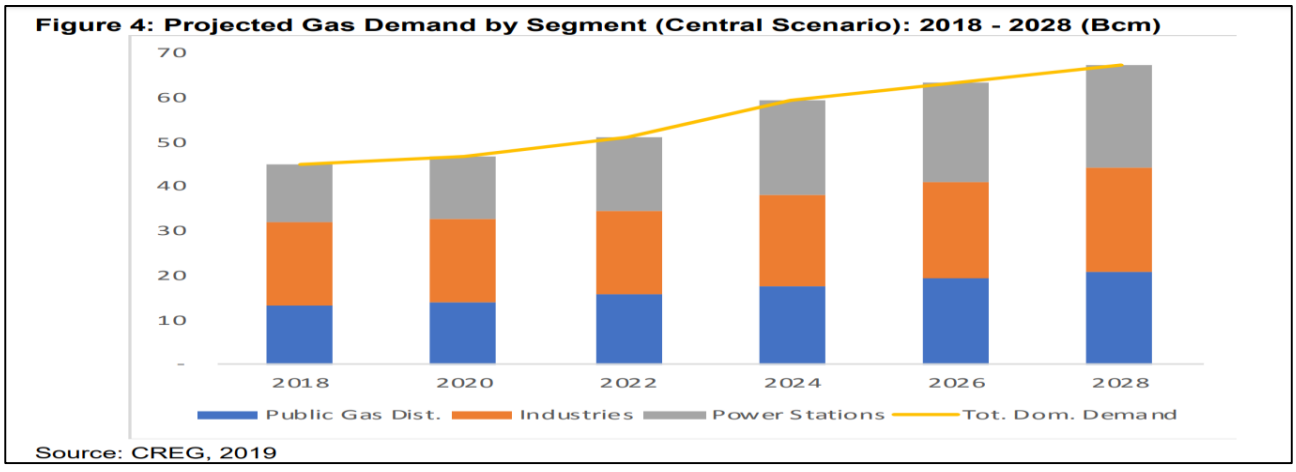

Figure 4. Projected Natural Gas Demand (Bcm). Source: CREG, 2019

According to the Oxford Institute for Energy Studies, the industrial sector is expected to have the fastest growth rate. Industrial gas demand is expected to grow at a six percent annual rate. It is immediately followed by the public gas distribution segment, which will continue to grow rapidly, albeit at half the rate achieved in the previous ten years. The power sector's use of gas is expected to slow by 2% per year but from a relatively high base (OIES, 2019). In addition, the policy of subsidies is distorting the gas internal price market, hence many households and industries are benefitting from artificially lower gas prices for electrification compared to the real cost of production. As a result, low energy prices incentivize low energy efficiencies, higher waste of energy, higher carbon emissions, and an unsustainable demand. The domestic demand absorbs the national production, e.g. the quota for the exports is expected to decrease without any policy intervention. The movement of domestic energy (electricity and natural gas) costs and subsidies will be determined by the future development of domestic natural gas consumption. Despite the fact that local authorities are aware of this reality, there are several social frictions and resistances to overcome, hence the political stability of the country is going to be affected.

2.2.4 RUSSIA-ALGERIA FOREIGN RELATIONS

Algeria aims to be a regional power and it intends to strengthen its international position in the region to exert influence on neighboring territories. Algeria's foreign policy strategy was founded on a set of long-standing ideals following its independence in 1962. Algiers sprang up as a voice of oppressed people, protector of national sovereignty, and opponent of foreign military incursions, inspired by its anti-colonial fight. It used self-determination and anti-colonial movements as diplomatic instruments to increase its geostrategic influence, particularly in Africa. Algerian authorities have consistently voiced solidarity with African liberation movements, the Palestinian people, and the Polisario Front, and have offered diplomatic, financial, and logistical support (Ghebouli, 2021). After ten years of terrorism and twenty years under former President Abdelaziz Bouteflika, Algeria's stance on anti-colonial and self-determination issues is questionable. However, under previous President Bouteflika, Algeria's diplomatic efforts were limited to counter-terrorism. Even amid regional chaos, Algeria remained neutral in Libya and Mali, preferring an intractable political solution. Nonetheless, President Tebboune's desire to play a larger regional role demonstrates a readiness to re-engage the diplomatic and military corps. Following the catastrophic civil war of the 1990s, Algeria used its military might to develop regionally. This ability may enable Algeria to impose constraints, as President Tebboune planned in Libya (Ghebouli, 2021). France's anticipated departure from the Sahel may potentially open the door for Algerian participation.

Furthermore, Moscow to discuss regional developments, indicating the possibility of increased Algerian-Russian collaboration (Ghebouli, 2021).

The relationship with Russia is crucial in terms of assessing the geopolitical risk of the Algerian gas supplier. According to the Congressional Research Service (CRS), Algeria has Africa's largest defense budget, and it is one of Russia's top arms export consumers, trailing only India and China (CRS, 2021). According to SIPRI, Algeria accounted for 15% of Russian weaponry shipments from 2016 to 2020, and Algeria's cordial connections with Russia date back to the Cold War era when Algeria fought a long war for independence from France and then established a socialist economic system (CRS, 2021). However, the foreign policies of the two countries may not always coincide and the same dossier can present contradictory resolution processes. Algeria's military is heavily reliant on Russian weapons, and the government has exploited its massive oil and natural gas exports to fund large arms acquisitions (CRS, 2021). Algeria imports a wide range of Russian weaponry, e.g. armament categories, including some of the most sophisticated systems on the market, such as Iskander-E short-range ballistic missiles and Project 636 submarines (SIPRI, 2021). Due to Algeria's high demand and capacity to pay for the latest Russian weaponry, Russia looks keen to maintain its market dominance in Algeria. Algeria's prominence as a Russian customer has grown after the toppling of Muammar al Gaddafi, who was formerly a prominent Russian armaments client. In 2006, Russia offered to forgive Algeria's current $4.6 billion debt in exchange for $7.5 billion in new military sales (SIPRI, 2022). As a result, according to SIPRI, Russia accounted for 80% of Algeria's weaponry purchases from 2006 to 2013 (SIPRI, 2021). The CRS has assessed the total value of the arms export of Russia to Algeria, thus it can be said that the pick has been reached in 2017 with a value of almost $1.6 billion (CRS, 2021).

From a historical standpoint, Algeria’s government refused to affiliate with any superpower during the Cold War, even as its military connections with the Soviet Union got stronger. Similar neutrality may be seen now in its failure to aggressively interfere in key crises and rivalries in the Middle East and Africa. Russian officials have attempted to frame this ambiguous position as a convergence with Moscow's regional goals, highlighting the two countries' previous backing for status-quo Arab authoritarians such as late Libyan leader Muammar Qadhafi and Syria's Assad (Wehrey & Weiss, 2021). Algiers has also taken moves that have irritated Moscow, such as the formation of an Algeria-Ukraine parliamentary friendship committee in 2019. Similarly, Russian news outlets have emphasized Algeria's persistent rejection to grant Moscow permission to construct a desired naval base in the Algerian port city of Oran(Avia.Pro, 2019).

Otherwise, Russia does not have enough economic resources to increase its influence with Algeria because the economic opportunity given by European countries are higher and the trade-off is completely unbalanced in favor of dealing with Europeans and Italy. The next paragraph will discuss the foreign relations between Italy and Algeria.

2.2.5 ITALY-ALGERIA FOREIGN RELATIONS

Thanks to a combination of actions and favorable conditions, the Algerian administration was able to restore the status quo before a complete Algerian Spring flowered. Different factors avoided the collapse of the social and institutional order of the country. The conditions can be listed as follows (OIES, 2019):

i) The administration has removed the state of emergency and formed a Reform Commission since the commencement of the demonstrations;

ii) Unlike in Tunisia and Egypt, there was a considerable amount of current assets and earnings from the energy industry available to calm the people;

iii) Revenues from the energy industry have been spent on massive infrastructure projects to modernize the country, and they have reduced the likelihood of internal revolts restoring social order by responding in part to the population's demands. As a matter of fact, a strong policy of subsidies to several economic sectors has been developed in order to reduce the social turmoil even if these policies can harm the price mechanism through which the open economies are supposed to work.

President Abdelaziz Bouteflika, head of the regime since 1999, managed to find a balance between the interests of the ruling class, the military élite, and the population. Indeed, It is unquestionable that the energy sector rents coming from European customers (e.g. Italy and Spain) were fundamental for the stabilization of the country. As a matter of fact, in 2013 3.75% of the national GDP and this number declined in 2019 when the export of gas used to account for 1.9% of the total GDP. At the same time, the energetic connection between Italy and Algeria is very strong because the Italian government developed a long-term strategy aimed to reduce the import dependency from Russia in terms of natural gas, hence the securitization of alternative gas suppliers plays a central role in the current energetic scenario and it represents one of the most important pillars of the Italian national security strategy. Within this framework, Italy planned to heavily reduce its

volume supplied by Russia, and in 2020 Algeria provided 15 billion cubic meters to Italy becoming the second gas exporter to the Italian peninsula (Statista, 2021). Because of the current geopolitical scenario, Russia showed to be an unreliable partner, hence the Italian authorities decided to reduce the dependence on Moscow in order to avoid further disruption of the energy flows as a retaliatory measure delivered by Russia as a sort of weaponization of commodities. By 2020, there is no doubt that Russia expressed its market power towards Italy, thus 29 billion cubic meters were supplied by Moscow accounting for more than 40% of the Italian energy import portfolio (Statista, 2021). However, Algeria's Sonatrach and Italy's Eni have agreed to provide an additional 9 billion cubic meters of gas to Italy by next year and in 2024 (Leali & Roberts, 2022). According to Italy's economic development ministry, the country bought around 29 billion cubic meters of gas from Russia and 22.5 billion cubic meters from Algeria. If the agreement is upheld, Algeria would overtake Russia as Italy's primary gas supplier by next year (Leali & Roberts, 2022).

Nevertheless, the Algerian decision was significant, if only because it immediately impacted the positions of two of the three northern Mediterranean nations that had formed marine zones opposing the Algerian EEZ (Bonafè & Pertile, 2022). Spain reacted quickly, questioning the bounds of Algeria's EEZ and demanding for dialogue to begin. Italy, historically one of the Mediterranean nations most opposed to the construction of EEZs, passed legislation on the subject and filed a formal complaint against Algeria's move. After some delay, the Italian government proposed at the highest diplomatic level the construction of an exclusive economic zone a few miles off the coast of Sardinia, in seas where bluefin tuna is fished. The new Algerian EEZ borders Sardinia and, at first glance, does not appear to take the principle of reciprocity into consideration in the partitioning of regions of interest. Italy has already experienced the first obstacles in setting the rules of the game for the observance of international law, with Saipem near Cyprus: everything has temporarily closed, with a "all at home" attitude (IILSS, 2021).

2.3.1 AZERBAIJAN:

2.3.2 POLITICAL LANDSCAPE:

Azerbaijan is limited on the north by Russia, on the east by the Caspian Sea, on the south by Iran, on the west by Armenia, and on the northwest by Georgia, and it occupies a territory that skirts the southern sides of the Caucasus Mountains. The Naxçvan exclave is located southwest of Azerbaijan, bordered by Armenia, Iran, and Turkey. Azerbaijan's boundaries contain the mostly Armenian enclave of Nagorno-Karabakh, which has been the site of a fierce war between Azerbaijan and

Armenia since 1988. Azerbaijan's capital is Baku. Azerbaijan was an autonomous country from 1918 to 1920 before being absorbed by the Soviet Union. In 1936, it became a component (union) republic. Azerbaijan proclaimed independence on August 30, 1991, and sovereignty on September 23, 1989 (Britannica, 2022).

Azerbaijan began its transition to a market economy in the early 1990s. The majority of items' prices were liberalized, while some state-owned firms were privatized. However, land privatization has been sluggish. Azerbaijan was the world's biggest petroleum producer at the turn of the twentieth century, and the oil-refining business flourished. Azerbaijan used to produce more oil than the United States at the turn of the century. For example, in 1901, Azerbaijan produced more than 11.4 million tons of oil, which was more than the net output of the United States. However, as the industry flourished in other parts of the USSR and across the world, Azerbaijan's position in oil production diminished. Exploration of the massive oil deposits beneath the Caspian Sea was hindered in the 1990s by political instability in Azerbaijan, ethnic unrest throughout the area, Russian claims on the Caspian fields, and disagreements over the site of new pipelines.

The 1991 Act of Independence distinguished the United States from the Soviet Union. A new constitution was decisively passed by referendum in 1995. The constitution calls for a unicameral legislature, with members elected directly for five-year terms. The president is the head of state, elected by direct universal suffrage, and a constitutional amendment eliminated the presidency's two-term restriction. The New Azerbaijan Party (founded by former President Heydar Aliyev), the pro-Turkish, nationalist Azerbaijan Popular Front, the Musavat New Equality Party, the Azerbaijan Social Democratic Party, the Azerbaijan National Independence Party, and the Azerbaijan United Communist Party, which was founded after its predecessor was banned in 1991, are among the political parties (Britannica, 2022).

As a small nation located at the crossroads of former major empires, civilizations and regional and global powerhouses, Azerbaijan realizes that its foreign policy objectives cannot be fulfilled without external commitment. The country shows strong ties with both Turkey and Russia because most of its strategic interests are mutually dependent on these two former empires.

At the same time, Azerbaijan heavily relies on the export of hydrocarbons, hence it has to manage different interests and find a balanced method for developing regional stability and economic development. Azerbaijan is a natural bridge between Europe and Asia, the Muslim and Christian cultures, and a gateway to the region's energy and transportation routes (Makili-Aliyev, 2013). As a result, Azerbaijan is one of the former Soviet Union's most strategically important states in terms of

regional and international security because of Azerbaijan's involvement in the transportation of hydrocarbons from the Caspian region must be considered (IEA, 2020).

2.3.3 GAS SECTOR

Oil and gas account for more than 90% of Azerbaijan's exports. Oil and gas production increased considerably in the 2000s, following the discovery of the Shah Deniz gas field, to reach record levels in 2010 (IEA, 2020). The government and international companies have invested substantially in the energy sector, and the construction of several new power plants as well as rehabilitation and modernization of the gas and electricity networks have improved reliability and security of supply. The Southern Gas Corridor expands and diversifies the European energy supply by bringing gas resources from the Caspian Sea to European markets. The Southern Gas Corridor is made up of four projects (SGC, 2022):

(i) the operation of the Shah Deniz natural gas-condensate field ("SD1" project) and its full-field development ("SD2" project);

(ii) the operation of the South Caucasus Pipeline ("SCP" project) and its expansion ("SCPX" project);

(iii) the construction and operation of the Trans-Anatolian Natural Gas Pipeline ("TANAP" project);

(iv) the construction and operation of the Trans Adriatic Pipeline ("TAP")

The Projects are expected to cost around $40 billion in investment. When completed, the SD2 project will contribute an additional 16 billion cubic meters of natural gas per year. The figure represents on a geographic map the energy flows coming from Azerbaijan towards Italy and the potential exporting capacity is reported as follows.

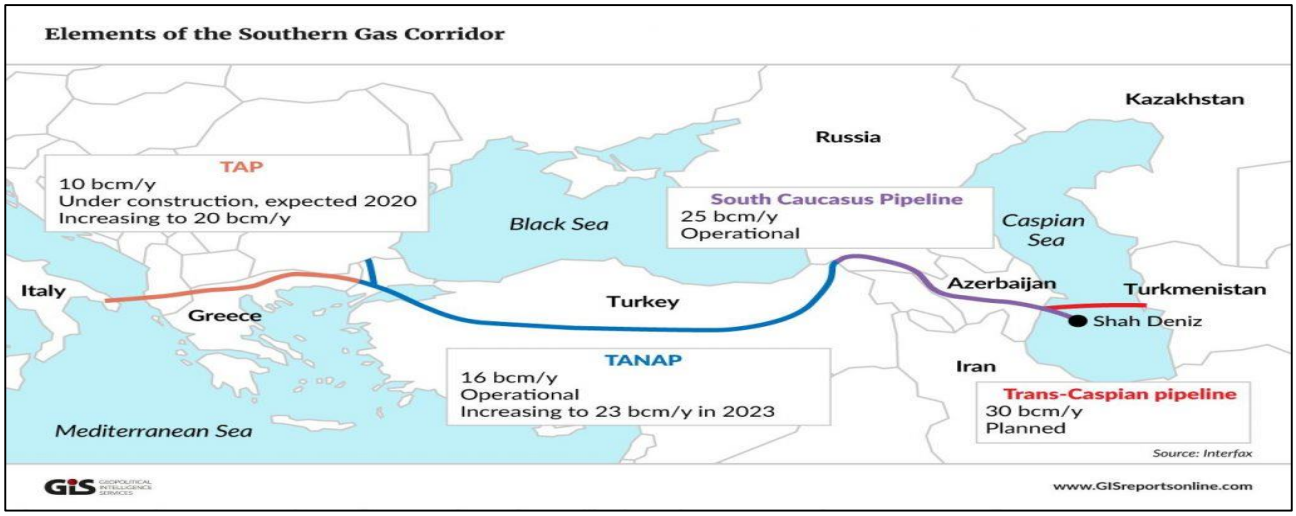

Figure 5. Gas Pipelines from Azerbaijan. Source: Caspian Barrel

This dependence on gas exporting assets heavily weakened the internal political landscape because the country is dependent on the global prices of fossil fuels, hence there is certainty about stability in case of economic or geopolitical disruption downsizing energy prices, or decreasing the capacity of supply towards foreign markets the energy. The case of Azerbaijan is emblematic because Baku has been particularly affected by the fall in oil prices in 2014-15. The Azerbaijan currency, the manat was devalued by 30% in February 2015 and by a further 50% in December 2015 (Pirani, 2016). Azerbaijan's trade surplus has been reduced almost to zero, and its banking sector weakened. In 2016, Azerbaijan entered an economic recession for the first time in 20 years. In the first four months of 2016, GDP fell 4.5% year on year and non-oil GDP fell 6.8% year on year (Pirani, 2016). A construction boom fuelled by high oil prices has ended suddenly; in the first four months of 2016, construction activity was 35.5% lower year-on-year. The return of economic recession has been accompanied by the resurgence in 2016 of the "frozen" military conflict with Armenia over Nagorno-Karabakh, the territory in western Azerbaijan that has been under Armenian military control since the war between the two states in 1992. These dynamic shows that the energetic issues can shape the foreign policy of the national government because the social disease and discontent must be directed toward an external enemy by fuelling nationalism and exploiting the historical sense of humiliation resulting from relatively recent defeats in the nation's history.

In addition, most of the energy sources, before the development of the new pipeline system, were forced to pass through Russia, thus the influence of the Kremlin on the economic system of Baku was completely overwhelming. Indeed, the authorities of Azerbaijan have found an alternative way to diversify the transit routes and decouple their infrastructure system from the Russian monopolistic influence developed during the Soviet Era. In particular, the window of opportunity was provided by the European Union (EU) which aims to diversify its import and reduce the reliance on Russia's fossil supplies. The EU has worked hard to diversify its supply sources, including acquiring natural gas from Azerbaijan via the Southern Gas Corridor (SGC) (Hasanov et al., 2020). In order to achieve this goal, the EU has granted financial assistance for portions of the Southern Gas Corridor. Despite the comparatively greater cost of delivering Azeri natural gas into the EU, the SGC was chosen as a supply source (Hasanov et al., 2020). The EU, Turkey and Georgia are considering the natural gas supplied by Azerbaijan as an alternative solution for diversifying energy resources from Russia. The following image shows the relevant potentiality presented by the former Soviet country.

Field Name	Estimated Reserves	Estimated Investment	Estimated Start Date of Production
Absheron	350 Bcm	$6.3 billion	2021–2022
Araz, Alov, Sharg	700 Bcm	$4 billion	–
ACG	280 Bcm	–	2027–2028
Umid	200 Bcm	$5 billion	2026–2027
Babek	400 Bcm	–	2026–2027
Shafag-Asiman	500 Bcm	–	–

Figure 6.Prospective new natural gas developments in Azerbaijan. Source: Hasanov et al. (2020)

In recent years, Azerbaijan's domestic market has been the primary source of increased demand for Azerbaijani gas. In the first half of this decade, consumption increased by more than 1.5 billion cubic meters (Pirani, 2016). Indeed, relevant investments are needed for improving the infrastructure network and increasing the ability of the country to supply to foreign clients, e.g. Italy.

2.3.4 FOREIGN POLICY WITH ITALY

Azerbaijan has grown in importance for Italy in recent years, becoming the focal point of Rome's Caucasus foreign policy. The two nations' connections are mostly centered on energy supplies. Azerbaijan, along with Iraq, has been Italy's principal oil source for many years. Furthermore, the Trans Adriatic Pipeline (TAP) commenced commercial operations in November. The TAP is part of the Southern Gas Corridor, a large gas transmission system that connects Azerbaijan to Southern Italy through Georgia, Turkey, Greece, and Albany. The pipeline provides a credible alternative to Russian gas, boosting the EU's overall energy security.

The ain of Azerbaijan, "*trade exchanges between the two countries have diversified, reaching a total value of €6 billion in 2020, an increase of 18%, as a consequence of economic reforms begun in 2018 by the Azerbaijani regime with the goal of converting the country into an international commercial hub, capitalizing on its strategic location at the crossroads of Europe, Russia, and Central Asia*" (Indiplomacy, 2021). As a result, Italy has become Baku's principal European partner, enhancing the importance of a connection that also boosts engagement with Turkey, Azerbaijan's biggest ally and a vital actor in the Mediterranean and the Middle East.

On February 2020, a true “qualitative leap” in the relations between the two countries, was completed by the signing of a “multidimensional strategic partnership” including a number of dimensions of political partnership to develop thanks to bilateral efforts between Italy and Azerbaijan (Indiplomacy, 2021). The parts of the agreement include several economic arrangements ranging from the energy sector to military cooperation, infrastructure, and investments. The strategic partnership brought Italy to abandon the position of equidistance it had always held with regard to the conflict between Azerbaijan and Armenia in Nagorno-Karabakh, adopting a more supportive stance of Azerbaijan’s sovereignty claims within the framework of international law. As a matter of fact, Italian national interests include a gradual but steady move away from the now politically unsustainable dependence on Russian hydrocarbons. Consequently, the military choices and territorial claims of other countries do not allow Italy to continue its line of condemnation towards Baku due to the violation of international law and the principles of sovereignty, territorial inviolability and prohibition of aggression. Italy could only intervene in the event of an escalation of conflicts on the kinetic side, which could damage or otherwise threaten the integrity of the pipelines transporting gas to southern Europe. In addition, the deterioration of the Caucasus security arrangements could turn into the reversal of retaliation practices against Azerbaijan, which would inevitably jeopardize Italy's energy security as well.

2.3.5 BAKU’S RELATIONS WITH ANKARA

Turkey aims to be a regional power as it was the Ottoman Empire in the previous centuries, i.e. It will establish an alternative sphere of influence where several countries are involved. Turkish imperial consciousness leads institutions to define privileged relations with all those geopolitical realities where Turks can claim a traditional cultural connection and a common economic and geostrategic interest. Geopolitical considerations have taken precedence over the reality that Turkey and Azerbaijan belong to two frequently hostile sects of Islam, Sunni, and Shiite, respectively. Turkey and Azerbaijan are linked by ethnic and linguistic links and are referred to as "Two States, One Nation", i.e. *ki Dövlt, Bir Millt* (Kuzio, 2020). The strong political ties between Turkey and Azerbaijan are rooted in historical backgrounds, energetic interests, and mutual military commitment in a recent war scenario.

The energy sector plays a central role in Turkish geopolitics because the country is a net importer of sources. In striking contrast to the European market, overall gas consumption in Turkey has been increasing since the beginning of the last decade and it may continue to rise for the remainder of the decade. Azerbaijani imports help Turkey reduce its reliance on Russia, its primary source.

Turkey committed to buying 6.6 billion cubic meters of Shah Deniz gas per year beginning in 2007 but was unable to do so for several years owing to infrastructural restrictions in the country's east (lack of compressor stations for transporting gas to areas of consumption) (OIES, 2016). These concerns were mostly resolved when Ankara's imports of gas increased by over 6 billion cubic meters per year in 2014-15, approaching the yearly contract quantity (OIES, 2016).

A further piece of news concerning the geopolitical rapprochement between Turkey and Azerbaijan is the development of new energy infrastructure corridors capable of bringing together the interests of the two countries at the expense of Russia. The development of the TAP increase the leverage owned by Ankara the European countries. The TAP is a transit connection between Greece's border with Turkey and it connects to Italy over an 878-kilometer stretch that also spans Albania and the Adriatic Sea. It may provide 10 billion cubic meters of natural gas per year from the Caspian offshore field of Shah Deniz to customers in the EU and the Western Balkans, diversifying supplies away from Russia and strengthening Azerbaijan's position on European markets (Bechev, 2020). TAP is also an important milestone for Turkey. This infrastructure, together with the Trans-Anatolian Pipeline (TANAP) and TurkStream, converts Turkey from a gas importer to a gas transit route. This energetic landscape helps Turkey to increase its influence on the region because it finds new sources for its domestic needs and at the same time it will eventually exploit the presence of critical infrastructure passing through its territory. In a hypothetical scenario of a direct or indirect clash of Turkish interests with Italian interests, the presence of these energy flows on Turkish territory could turn into a powerful lever in the hands of the Turkish government.

Finally, Turkey has deeply influenced the operations led by Azerbaijan against Armenia during the clash in Nagorno Karabakh. The RUSI analysed the conduct of the two parties during the operations and it stated that "without Turkish diplomatic and military assistance, Azerbaijan's victory on the battlefield against Armenia, as well as the recovery of seven occupied districts surrounding Nagorno-Karabakh and the southern part of this enclave centered on the important cultural center of Shusha (Shushi), would not have been possible. Turkey invested in training Azerbaijan's armed forces to NATO standards and provided drones and other military technologies" (Kuzio, 2020). It can be argued that Azerbaijan is central to building the new strategic axis of Turkey in order to reach new markets for its fossil fuels and avoid historical Russian patterns.

2.3.6 RELATIONS WITH RUSSIA

Since the end of the Soviet Era, Azerbaijan was under the sphere of influence of Moscow, thus the foreign policy of the country, after the offset of the Soviet Union, has become progressively independent. In order to achieve national sovereignty, Baku's authorities have diversified the transportation routes of their energy sources because the creation of new infrastructure can decrease the level of dependence on Russian networks. As a result, Azerbaijan aims to be more independent, hence it established several infrastructure projects to decrease the Russian influence.

Turkey is critical in the passage of hydrocarbons from the Caspian Sea to European markets. Energy cooperation ties are so deep that analysts say they are transitioning from "low politics" to "high politics." (Aliyev, 2013). Only military relations may threaten the primacy of energy cooperation in ties with Turkey. After the outbreak of the Nagorno-Karabakh conflict, Turkey closed its border with Armenia, assisting Azerbaijan in building a semi-blockade of Armenia. The security architecture of the Caucasian region was completely overwhelmed by the Russian military projection. However, after the end of the Soviet Union and the renaissance of terrorism and local turmoil, Turkey, Georgia, and Azerbaijan started a process of the capacity building aimed to develop military capabilities aimed to stabilize the protection of critical infrastructures and enhance the authority of the governments. Attacks (by PKK) and threats of attacks (by Russia and Armenia) against the energy infrastructure have already revealed the vulnerabilities of the pipelines and the tangibility of third-party attacks on them. In addition, Azerbaijan has refused to join the Russia-led Collective Security Treaty Organization (CSTO) and was one of the first former Soviet Union states to be free of Russian military personnel and bases (Ismailzade, 2020).

Azerbaijan-Russia relations have seen numerous ups and downs during their contemporary histories, ranging from border closures and accusations of backing separatism to warm statements of strategic importance (Valiyev, 2011). Both governments, though, have been wary about exceeding the point of no return. Nevertheless, Russia's ongoing backing for Armenia, as well as its delay in resolving the Karabakh war, have kept the two nations from becoming strategic allies. It can be argued that the process of emancipation from the Russian agenda has brought Baku to align its efforts towards the development of new infrastructural, economic, energetic, and geopolitical projects, hence the contribution given by Azerbaijan to the regional issues is often independent of the strategic posture of Russia about the same dossier. Within this framework, Baku will not cut its economic ties with Russia even though the creation of alternative partnerships is the main goal of the American ruling class. Looking at the historical trend, we can say that Russia has been declining as a regional ruler of the local dynamics due to the progressive cuts of the boundaries established during the Cold War.

The cases of Armenia and the development of regional gas hubs and alternative energy routes teach us that Baku has no intention to remain under Moscow's rule in the next future. According to some commentators, Russia continues to believe that if the Karabakh conflict gets solved at all, Baku would immediately rush into anti-Russian alliances or NATO (Valiyev, 2011). The unresolved Karabakh conflict remains the only leverage that Russia can use against Azerbaijan in order to keep the latter from unfriendly actions. For this reason, Baku has built more solid relations with Ankara with the aim to support its cause in the region.

2.4.1 SELECTION OF THE VARIABLES FOR ASSESSING THE GEOPOLITICAL STABILITY OF GAS SUPPLIERS

2.4.2 VARIABLE SELECTION AND GEOPOLITICA STABILITY

The selection of the variable is fundamental for moving from the concept to the measure of the phenomena. Indeed, there are several aspects and criteria that a variable must fulfill in order to show its solidity (OECD, 2008). First of all, the variables must be relevant, hence it has to answer the research question, be meaningful and it is supposed to add additional information to the indicator. The second aspect to consider is the soundness of a variable, thus it has to be reliable and validated even by the scientific literature. The third condition to fulfill is timeliness, i.e. the amount of time between the availability of the information and the occurrence or phenomena it depicts is referred to as "timeliness" (OECD, 2008). The time difference between the desired delivery date and the actual date of data release is referred to as "punctuality". Forth, accessibility relates to the physical conditions under which consumers may obtain statistics: distribution methods and delivery time availability of micro or macro data. In addition, we can use the term "clarity" for referring to the information environment in statistics: suitable metadata (textual material, explanations, documentation, etc.) given with the statistics, graphs, maps, and other illustrations, and the availability of information on the statistics' quality. Finally, comparability plays a central role in the selection of variables and data used for representing the phenomena in the composite indicator.

Each variable selected will be described in its correlation to its vector and the composite index. The index is composed of four pillars and each of them is the result of the aggregation of different sub-pillars. Each sub-pillar is composed of variables/indicators, hence the following section is deemed to illustrate the rationale behind each variable included in the GESI.

2.4.3 FIRST PILLAR: ECONOMY

	VARIABLE	SOURCE
ECONOMY	GDP BASED ON PPP (Abs. Value)	IMF/ STATISTA
	GDP GROWTH RATE (%)	IMF/ STATISTA
	GDP PER CAPITA (Abs. Value)	IMF/ STATISTA
	CURRENT ACCOUNT BALANCE (% GDP)	IMF
	HUMAN DEVELOPMENT INDEX	UNDP
	INFLATION (%)	IMF/ STATISTA

Tab 1. Economic Pillar. Source: Author's Elaboration

GDP: GDP is the total value of goods and services produced within a nation in a specific period. The GDP is expressed in the dollar in order to standardize the measurement and the scale of each observation. In addition, the dollar plays the role of an international benchmark for expressing the value of goods and services. The GDP is crucial for understanding the stability and weight of a potential gas exporter. High GDP means more internal gas demand for electricity production and industrial production of energy-intensive sectors.

GDP GROWTH RATE: It compares the year-over-year (or quarterly) change in a country's economic output to measure how fast an economy is growing. From the economic point of view, the country boosting its GDP annual growth experiences a positive outcome in terms of stability and social peace because there is more economic development and value to distribute to the population even if this positive outcome belongs to the energy sector. Indeed, many governments used to finance a significant portion of their public budget through resources that come from utility revenues. However, a high GDP growth rate seems to be negative in terms of export capacity because the domestic demand will grow and the exporting capacity will be lower in case of less investment in the upstream segment of the supply chain.

GDP PER CAPITA: It shows a country's GDP divided by its total population. Higher GDP growth per capita increases the final amount of energy consumed by individual households. Indeed,

higher GDP per capita means an increased amount of gas produced to fulfilling the domestic demand. per capita and gas exporting capacity.

CURRENT ACCOUNT BALANCE TO GDP: It records the value of exports and imports of both goods and services and international transfers of capital. A country's current account balance may be positive (a surplus) or negative (a deficit); in either case, the country's capital account balance will register an equal and opposite amount. Exports are recorded as credits in the balance of payments, while imports are recorded as debits. A positive current account balance indicates that the nation is a net lender to the rest of the world, while a negative current account balance indicates that it is a net borrower. A current account surplus increases a nation's net foreign assets by the amount of the surplus, while a current account deficit decreases it by the amount of the deficit. A positive current account balance shows that the country is stable and competitive with foreign markets because it generates credit and not debt. In contrast, a negative current account can lead to a balance of payments crisis and capital outflows of the country, i.e. the private and public debt can not be refinanced. Generally, a negative current account shows economic weakness and consequently potential political instability in case of crisis.

HUMAN DEVELOPMENT INDEX (HDI): The Human Development Index (HDI) measures the status of life in any given place based on life expectancy, education levels, and income per capita. It measures the degree of improvement in the quality of life in a specific country. Improvement of life expectancy and education make the GDP higher because they have positive externalities on the growth and geopolitical stability of the country. Educated people tend to create more wealth for the national economy because they increase the final value-added on produced goods. The value added is remunerated according to its value, hence with higher education, the wage (i.e. the remuneration of labor as a production factor) would be higher. An increase in income can bring higher consumption of energy because of the improvement in living standards.

INFLATION: Inflation is the rate of increase in prices over a given period of time. Inflation is typically a broad measure, such as the overall increase in prices or the increase in the cost of living in a country. A higher inflation rate shows that the internal economy is too fast, i.e. the income increases too fast hence there is an excess supply of currency without an adjustment of the demand. In rentier states, the value of the currency is heavily reliant on the export of fossil fuels hence lower export or lower energy prices would harm the value of the currency because the reserves of foreign currency decrease, and consequently even the capacity to maintain a target exchange rate gets ineffective. With a weaker currency, the imported good would be more expensive, thus the inflation skyrockets because of higher prices. Nevertheless, the theory of economic equilibrium teaches that

the economic system adjusts the internal trade-off with the aim to find a new balance that in this case refers to an improvement of the trade balance. As a matter of fact, high inflation makes local products (even fossil energy products) cheaper, hence the foreign demand would be higher.

2.4.4 SECOND PILLAR: ENERGY

ENERGY (GAS)	EXPORT OF GAS (Abs. Value)	GECF
	PRODUCTION (Abs. Value)	WORLD ENERGY OUTLOOK
	CONSUMPTION (Abs. Value)	BP/STATISTA
	ELECTRICITY GEN. FROM GAS (Abs. Value)	OUR WORLD IN DATA
	DURATION (R/P) (Abs. Value)	BRITISH PETROLEUM
	PROVEN RESERVES (%)	BRITISH PETROLEUM

Tab 2. Energetic Pillar. Source: Author's Elaboration

EXPORT OF NATURAL GAS: It is the total amount (expressed in Bcm) exported by the country. The fossil fuel exported can increase the flows of foreign currency in the country producing relevant positive externalities on the foreign reserves stocked. In addition, for exporting countries gas revenues represents an important portion of the national GDP that helps to ensure economic growth and a positive balance of payments. However, with the expansion of the domestic demand, it is required an increase in the capacity of extraction for maintaining the existing, quota of export. Indeed, many exporters have to monitor their domestic market and the energy efficiency of their systems in order to avoid the erosion of their exporting capacity and their ability to comply with supply contracts.

PRODUCTION: The absolute value of gas production shows the capacity of a country to produce fossil fuels according to their capacity. The huge producer tends to be an affordable supplier for fossil fuel importing countries, hence this variable is positively correlated to the index.

CONSUMPTION: The increase in the consumption of natural gas is negative in terms of exporting capacity in the long term. In fact, the evolution of consumption will lead a country to refrain from its availability for external supply of gas, the domestic demand is prioritized by local authorities. As result, there must a positive correlation between growing consumption and marketed production

aimed to meet the domestic demand even if there is no certainty that the amount the export would follow the same path.

ELECTRICITY GEN. FROM GAS: Gas is a fossil fuel that can be used to generate electricity. By burning gas, we create heat which powers a turbine. The rotation of this turbine spins a generator which creates electricity. If a country has more than the 50% of its electricity processed from gas, means that this dependence is very high. If the GDP, the internal consumption, or the industrial production of a country increase in a context with high gas electrification dependence, we will have a higher increase in gas consumption and a further reduction of the gas exporting capacity of the country. As a result, it can be argued that there is a negative correlation between electricity generation from gas and the total resources available for export to Italy.

DURATION OF GAS RESERVES (R/P): This number represents the number of years that the reserves would last if production and use were continued at the current rate. Natural gas reserves (and R/P ratios) are smaller than coal reserves but larger than the R/P ratio of oil. Estimates suggest that at the rate of current use, there is around 60 years' worth of natural gas remaining. However, this ratio needs to be interpreted carefully as this assumes current production levels. Production has been increasing steadily for the past few years with improved technologies and may continue to increase. The duration of reserves plays a central role in a long-term and sustainable energetic partnership with the exporter country. The duration integrates a broad range of information to aggregate in the composite index because the estimation of the production involves the current capacity of extraction from reserves. at a given investment and technological environment. A low value shows that the country needs an important degree of investment and technological improvement in order to increase its production and extract value from its soil. In addition, some reserves can require more investments because of their location in the depth of the subsoil.

TOTAL RESERVES: The total amount of gas available in the subsoil gas fields. However, none of them are available for the extraction and exploitation of natural resources of the country. The high level of gas reserves can make the country more reliable in terms of the long-term commitment of contractual and energetic cooperation because there is a long-term income ensured by the exploitation of whether resources in the subsoil.

2.4.5 THIRD PILLAR: SOCIO-POLITICAL

SOC-POL	CORRUPTION PERCEPTION INDEX (CPI)	TRANSPARENCY INT.
	DOING BUSINESS INDEX	WORLD BANK
	POLITICAL STABILITY INDEX	WORLD BANK
	GINI INDEX	WORLD BANK
	FRACTIONALIZATION INDEX	SPRINGER
	UNEMPLOYMENT (%)	IMF

Tab 3. Socio-Political Pillar. Source: Author's Elaboration

CORRUPTION PERCEPTION INDEX: The term Corruption Perceptions Index (CPI) refers to an index that scores countries on the perceived levels of government corruption by country. Scores range from 0 to 100, with zero indicating high levels of corruption and 100 indicating low levels. The CPI is published annually by Transparency International, an organization that seeks to stop bribery, fraud, and other forms of public sector corruption. Corruption is one of the main drivers of institutional instability and it plays a central role in the assessment of socio-political dynamics. In many Mediterranean countries, corruption is decentralized and it is the consequence of the influence of local centers of power. A high score (i.e. close to zero) allows the evaluation of the country as unstable and with widespread disease among the population. This information can highlight the inability of local institutions to deliver services to their citizens and the local environment. In addition, a high perceived corruption index undermines citizens' ability to identify with local politics.

DOING BUSINESS INDEX: The index provides objective measures of business regulations and their enforcement across 190 economies and selected cities at the subnational and regional levels. It looks at domestic small and medium-sized companies and measures the regulations applying to them through their life cycle. Doing Business captures several important dimensions of the regulatory environment as it applies to local firms. It provides quantitative indicators on regulation for starting a business, dealing with construction permits, getting electricity, registering property, getting credit, protecting minority investors, paying taxes, trading across borders, enforcing contracts, and resolving insolvency. This index also measures the features of employing workers. Although does not present rankings of economies on the employing worker's indicators or include the topic in the aggregate ease of doing business score or ranking on the ease of doing business, it does present the data for these

indicators. A positive outcome of this indicator indicates a more attractive business environment, hence specific investments in strategic sectors, i.e. gas sector, seem to be more attractive and rapid in the process of return of the capital invested. Within this framework, the contract enforcement ranking has been used as a proxy measure for understanding how the legal and regulatory framework works in a sample of countries. Low positive outcomes in terms of contract enforcement can bring investors in the gas sector (which involves a widespread supply chain with many market operations regulated by contracts) to choose another country for their investments. It is interesting to see how this index is statistically related to other aspects of the socio-political environment.

GINI INDEX: It measures the extent to which the distribution of income or consumption expenditure among individuals or households within an economy deviates from a perfectly equal distribution. A Lorenz curve plots the cumulative percentages of total income received against the cumulative number of recipients, starting with the poorest individual or household. The Gini index measures the area between the Lorenz curve and a hypothetical line of absolute equality, expressed as a percentage of the maximum area under the line. Thus a Gini index of 0 represents perfect equality, while an index of 100 implies perfect inequality. High levels of income distribution inequality can represent a weak legitimacy of local authorities and further instability in case of an economic crisis.

POLITICAL STABILITY INDEX: It captures perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including politically motivated violence and terrorism. The index is expressed in a score from a given range and the lower grade shows a negative perception concerning the stability of the government and its ability to implement effective policies. Political stability is related to the outbreaks of violence for political-motivated issues. The lower level of stability can harm the ranking of a country because there is an unstable political regime where investments are weakened. In addition, the instability of governments can harm the long-term political definition of a foreign policy aligned with Italian international interests.

FRACTIONALIZATION: It is the distinction between groups, that has played an important theoretical role in the governance-trust system. Linguistic, ethnic, tribal, religious, and political fractionalization influences trust levels and informal and formal institutions that can determine economic development and institutional stability. In fact, countries with a high score of ethnic, linguistic, and religious differences tend to be less stable, and political instability could harm economic and energetic interests in the country that exports gas. The institutional boundaries are often informal and the distribution of resources must be performed in order to avoid further conflicts. Foreign investors, especially in commodities, need to build safe and stable relationships with local

powers aimed to protect their assets. A high degree of fractionalization, related to weak institutions, let the operating business environment highly unpredictable.

UNEMPLOYMENT: According to the OECD, the unemployment rate is related to "*the unemployed are people of working age who are without work, are available for work, and have taken specific steps to find work*" (OECD, 2022). The uniform application of this definition results in estimates of unemployment rates that are more internationally comparable than estimates based on national definitions of unemployment. This indicator is measured in the numbers of unemployed people as a percentage of the labor force and it is seasonally adjusted. The labor force is defined as "*the total number of unemployed people plus those in employment*" (OECD, 2020). A high rate of employment can increase social disorder and people are more likely to protest and participate in riots against the government. In the context of high unemployment, the government is forced to increase the social expenditures for the welfare state, hence investments in infrastructure can be postponed and the gas sector can lose production capacity if additional investments are missed or avoided.

2.4.6 FOURTH PILLAR: RELATION WITH ITALY (country-specific component)

REL - ITA	EXPORT SHARE TO ITALY (%)	STATISTA
	IMPORT SHARE FROM ITALY (%)	WORLD BANK (WITS)
	FDI INWARD FROM ITALY (Abs. Value)	BANK OF ITALY
	ITA GAS IMPORTS (Abs. Value)	MINISTERY OF ENERGY TRANSITION
	RELATIONS WITH TURKEY (%)	WITS
	RELATIONS WITH RUSSIA (Abs. Value)	OBSERVATORY OF ECONOMIC COMPLEXITY

Tab 4. Relation - Italy Pillar. Source: Author's Elaboration

EXPORT SHARE TO ITALY: To measure and represent the relations between the gas supplier and Italy, it should be considered the economic dimension. As matter of fact, governments are influenced by several international aspects, and building energetic flows can help to strengthen

other forms of cooperation. Indeed, fossil fuel exporters own a considerable quantity of foreign reserves currency generated by the trade energetic flows and local banks and firms use these reserves for importing industrial products from their energetic customers. This relationship tends to fulfill itself and reinforce political and economic flows between the two countries. Italy imports most of its domestic energy consumption, hence it balances the trade flows by exporting its products to gas suppliers. An important share of the supplier export can account for strong ties between Italy and the energy exporter, i.e. it is positively correlated.

FDI INWARD FROM ITALY: A common type of inward investment is the foreign direct investment (FDI). This occurs when one company purchases another business or establishes new operations for an existing business in a country different than the one of its origin. In addition, financial and economic flows from Italy towards the country can occur when Italy has strong stakes in the foreign economy and some segments of the business communities are mutually dependent and integrated.

ITALIAN GAS IMPORTS: Italy heavily relies on the importation of energy products in order to sustain its economy. The existing reserves of oil and gas fields are not enough to satisfy the energy needs of the peninsula, and the internal production is steadily declining for many years. This condition brought Italy to rely dramatically on external imports from international suppliers. The Italian energy imports account for roughly 80% of the total domestic consumption, hence the dependence exposes Italy to external energetic and geopolitical shocks such as interruption of supply and high price volatility. A reduction of energy supply to Italy for geopolitical reasons can bring the inflation rate skyrocketing and negative economic impact in terms of reduction in consumption, diminished return of investments, and increase in fragilization of the industrial system. If the importer heavily relies on the supplier, It will be negatively affected in case of shortage caused by economic and political disruption, hence high volumetric dependence on a single supplier could harm the Italian national security.

RELATION WITH TURKEY: Turkey plays a central role in the Mediterranean area and it aims to enforce its political will in order to establish the latest version of the Ottoman Empire. In the current international system, major countries tend to define their sphere of influence aimed to protect national interests and geopolitical goals. The cartography of influence and power is represented by the historical vector, i.e. Turkey aims to influence the local and regional dynamics of MENA countries by following its historical background as a commercial and military Empire. The creation of several portions of influence is named regionalization of the globalized world order and it leads to multipolar world order. From the historical standpoint, Ankara established its sphere of influence in

North Africa and the Mediterranean area, hence it struggles against the Italian interests in the same area. In addition, Italy and Turkey have conflicting stakes because they need to manage their relations with the Libyan government and ensure geopolitical projection in North Africa. In order to strengthen national security, both countries are required to increase their military and naval projection for ensuring the security of trade flows and energy supply. The increase of the Turkish influence in the Mediterranean is proportional to the erosion of the Italian stakes in the same area, so energy exporters with good relations with Ankara could harm in the medium term the stability, effectiveness, and sustainability of the energy supply to Rome because resources are limited and volumes can be mutually excludable. Ankara has to ensure the energetic supply as Italy, hence geopolitical influence in specific countries can impact the security of long-term energy supply. In order to reduce gas imports from Russia, huge volumes of natural gas must be ensured and several geopolitical mechanisms are supposed to be aligned for long-term sustainability. As a proxy, this thesis will utilize the trade relations, i.e. the import share from Turkey for assessing the level of dependency of the sampled countries on the Turkish economy.

RELATION WITH RUSSIA: Russia exports almost 45% of the Italian energy import and It accounts for the largest gas supplier to Italy. As a matter of fact, Italy needs to diversify its energy portfolio in order to protect its economic ecosystem and ensure national security. Italy needs to decrease the imports from Russia and it looks for alternative suppliers in the Mediterranean area aiming to detect some possible routes. However, in the previous years, Moscow has established its presence in many countries in the area and it aims to shape new ties with local actors at the national and sub-national levels. For example, most of the countries of the Mediterranean area shared positive relations with Moscow, here we can mention Syria, Egypt, Libya (presence in Cyrenaica), and Algeria. Most of these countries entail contradictory political stakes with EU countries and Russia because they can not substitute energy gains from Europe and at the same time they need weapon supply from Russia and several security initiatives have taken place with Moscow. As a consequence, most of the countries analysed will continue to get ambiguous relationships with both Russia and Italy. However, Italy should monitor the widespread Russian influence in targeted countries in order to avoid local governments would act against the national interests of Rome. Moscow uses to establish long-term partnerships with governments through the export of its military component, weapons trade, and export of wheat and other important product for the food security of MENA countries. Therefore, the export of grains and weapons accounts for the second source of foreign reserves for the Russian Federation

2.4.7 SELECTION OF DATA AND IMPUTATION

Generally, the credibility of data refers to confidence that users place in those products based simply on their image of the data producer as international institutions preparing the report and other data outlooks. Due to this brand image, the trust of data users seems to be deeply rooted in international agencies with a strong engagement with transparency and accountability of the processes. This plethora of procedures and rules of conduct preserve the objectivity of the data and this implies that the data are perceived to be produced professionally in accordance with appropriate statistical standards and policies and that practices are transparent, e.g. datasets are not manipulated, nor their release time is set in response to political pressure. Data produced by "official sources" (e.g. national statistical offices or other public bodies working under national statistical regulations or codes of conduct) should be referred to other sources.

Particularly relevant is the data selection for representing the variable of the theoretical framework. Most of the variables considered are quantitative, thus they are freely available on international data sets from international economic and financial institutions. For example, for this index we used the International Monetary Fund (IMF) database, the World Bank (WB), British Petroleum (BP) reports, Bank of Italy (BoI), and Ministery of Energetic Transition, UNDP and Transparency International (TI). The historical datasets can help to provide an idea of the evolution of the phenomena and it accounts for changes that occurred in the dimension considered. The accuracy of basic data is extremely important in the context of composite indicators due to the data represents the raw matter and the starting point of the analysis. This relevant aspect leads to the issue of the credibility of the source which becomes crucial.

However, datasets for specific countries or variables can be hard to detect and classify into a dataset, hence historical data or forecasting of further values are not easily reliable. Missing data often hinders the development of robust composite indicators. Data can be missing in a random or non-random fashion. The missing patterns could be (OECD, 2008: 24):

i) Missing completely at random (MCAR): It refers to the missing values that are not dependent on the variable of interest or other variables included in the dataset. For example, people who do not report their income have, on average, the same income as people who do report officially income and consequently, the dataset will report even for them the income;

ii) Missing at random (MAR): Missing values do not depend on the variable of interest, but are conditional on other variables in the data set. For example, the missing values in income would be MAR if the missing data on income depends on marital. In addition, the missing data can be caused by the design of the survey where an answer is not answered because of the structure of the questionnaire;

iii) Not missing At random (NMAR): missing values depend on the values themselves because some data are less likely to be freely reported by governments. For example, the Gini Index which measures the distribution of income among the households can show a high degree of inequalities among citizens, hence social peace can be weakened.

There are three general methods for dealing with missing data: (i) case deletion, (ii) single imputation, or (iii) multiple imputations. The first is known as "complete case analysis" and it simply omits the missing records from the analysis. However, this approach ignores the possibility to compute biased samples with deleted information and the final outcomes can provided results that are not anchored with the reality of the phenomena considered. Furthermore, standard errors will generally be larger in a reduced sample, given that less information is used. Some scholars argue that if a variable has more than 5% missing values, cases are not deleted, hence this procedure can be considered a rule of thumb (OECD, 2008: 24). The other approaches provide for the imputation of missing values in order to obtain a complete sample of variables. There are several methods that can be applied for this purpose, e.g. "*mean/median/mode substitution, regression imputation, hot-and cold-deck imputation, expectation-maximization imputation, or multiple imputations"* (OECD, 2008: 25).

Otherwise, "a *single imputation is known to underestimate the variance because it partially reflects the imputation uncertainty*" (OECD, 2008: 25). The multiple imputation method, which provides several values for each missing value, can more effectively represent the uncertainty due to imputation. No imputation model is free of assumptions and the outcomes of the imputation should be checked for their statistical properties, such as distributional characteristics, and whether negative imputed values are possible. This process aims to reach, before moving to the next steps, at least 65% of data coverage across each indicator and each country.

2.4.8 ASSUMPTION ABOUT THE DATA COLLECTION

In order to reduce the impact of outliers, the data for the selected variables were aggregated for the period 2000 - 2010 before being used as inputs for the analysis. This time frame was deemed sufficiently broad such that the aggregated statistics could appropriately represent each country's risk level. The range selected can enhance the theoretical requirements for the data formulation. Nevertheless, none of the data are always available for each year because some variables have a different time interval in which they register further development, hence some data are calculated not yearly. As a result, during the development of the composite index, some assumptions have been developed in order to overcome the metrics limitation. The assumption used is the following:

i) DURATION (R/P): The duration of reserves is the amount of life period projected for the gas reserves at a given production level. Many countries are not able to sustain their capacity because of the short amount of reserves discovered or recoverable from their onshore/offshore fields. As a consequence, this value can change according to gas discoveries through upstream exploration or improvement in the production capacity that accounts for the rate of extraction and achievement in terms of refining (downstream in the supply chain). The production capacity can be stagnant due to lack of investment or technical limitations, hence many data available are not consistent with the long-term commitment of suppliers. Within this assumption, it has been selected the latest value available taken from the World Energy Outlook 2021 released by the British Petroleum;

ii) PROVEN RESERVES: Proven reserves are the number of natural resources that a corporation may reasonably anticipate harvesting from a certain deposit. Geological and engineering data acquired through seismic testing and exploratory drilling are used to establish proven reserves. As regards Algeria, the data from Statista clearly shows that the volume of the proven reserves did not change in the last decade. Hence, there is no assumption of this value even if the table shows the same data for 2010, 2015, and 2020;

iii) FRACTIONALIZATION: This value shows the level of social differences in terms of ethnicity and linguistic and religious patterns. Fractionalization seems to be a structural factor that does not change rapidly and easily over time. Some scholars have developed some quantitative methods for assessing the local dynamics of fractionalization and its implication for economic development. It can be mentioned the work of Fearon that aims to assess ethnic groupings across nations for empirical evaluation. After resolving conceptual and practical challenges, Fearon gives a list of 822 ethnic groups in 160 nations

that accounted for at least 1% of the population in the early 1990s (Fearon, 2003). The work provides for the creation of a cultural fractionalization measure that employs the structural difference between languages as a proxy for the cultural distance between nation groups. "Primordialists" stated that ethnic groupings are either permanent, biological entities or, if social norms, that they are deeply established, historically inflexible customs. Even if everything is given to change, ethnic diversity and social fractionalization is a long-term and structural factor that tends to fulfill themselves in the long run. Consequently, it is easier to assume that the value of fractionalization will last for many years. In addition, there are no latest publications able to detect dynamic changes in these societies and create a scale used to compare each country;

iv) GINI INDEX: The Gini index, often known as the Gini coefficient, evaluates the distribution of income across a population. It is a gauge of economic inequality, assessing income distribution or, less typically, wealth distribution among a population. The coefficient runs from 0 to 1, with 0 indicating perfect equality and 1 indicating complete inequality. Values greater than one are theoretically possible owing to a lack of income or riches. The Gini index represents long-term phenomena because the distribution of the value yearly produced by an economic system seems to change slowly, hence it captures the structural changes in society. As a consequence, the social changes are not captured for each year and the analyst waits for more consolidated data series for the computation. In addition, the Gini Index allows many political implications because it represents the level of inequality of a country, hence and any worsening or slight improvement in this index may cast a negative light on the work of governments in tackling long-term inequality. Implications may be the erosion of the legitimacy of local institutional actors and a considerable erosion of consensus towards the government. As a consequence, local authorities, especially after strong social and economic turmoil, are less likely to publish official data about income inequality. In our sample, even for Algeria and Azerbaijan, the Gini index computed is the last value available through International institutions, i.e. the World Bank.

2.5.1 NORMALISATION AND WEIGHTING

2.5.2 DIFFERENT TECHNIQUES FOR NORMALIZATION

Normalization is the adjustment of variables onto a common scale, prior to any data aggregation. It seeks to achieve variable comparability in the following areas: several units of measurement and various ranges of variance.

Normalization serves the purpose of avoiding that during the creation of an indicator the analyst would add together values coming from different dimensions and unity of measurements. In fact, indicators are stated in a wide range of statistical units, ranges, and scales. They must first be adjusted on characteristics such as size/population/income and smoothed across time to account for cyclical variations. Then, to prevent “adding apples and pears”, they must be placed on a common base/ground. This task of standardization of the different dimensions is accomplished by the normalisation process. However, there are several methods that an analyst can use for the normalisation process, i.e. the decision of performing one of them should be weighted according to the data properties of the sample.

Because the indicators in a data collection frequently have distinct measurement units, normalisation is essential prior to any data aggregation. The normalisation approach should take into account the data qualities as well as the composite indicator's aims. Some considerations may dictate the choice of the normalisation approach, such as whether hard or soft data are accessible if unusual behavior should be rewarded/penalized, or whether knowledge on absolute levels is important (JRC, 2022). Furthermore, whether benchmarking against a reference nation is desired, and whether the variance in the indicators has to be accounted for, should be considered. In the case of extreme data, for example, normalisation approaches based on standard deviation or distance from the mean are preferable. If the composite indicator values per nation are required, special consideration must be given to the selection of normalisation procedure (JRC, 2022). Prior normalization takes properly into account the sign of the indicators, i.e. positive vs. negative orientation towards the index. Before the transformation, we have to ensure that higher values in the dataset mean better results, if not, reverse the original direction.

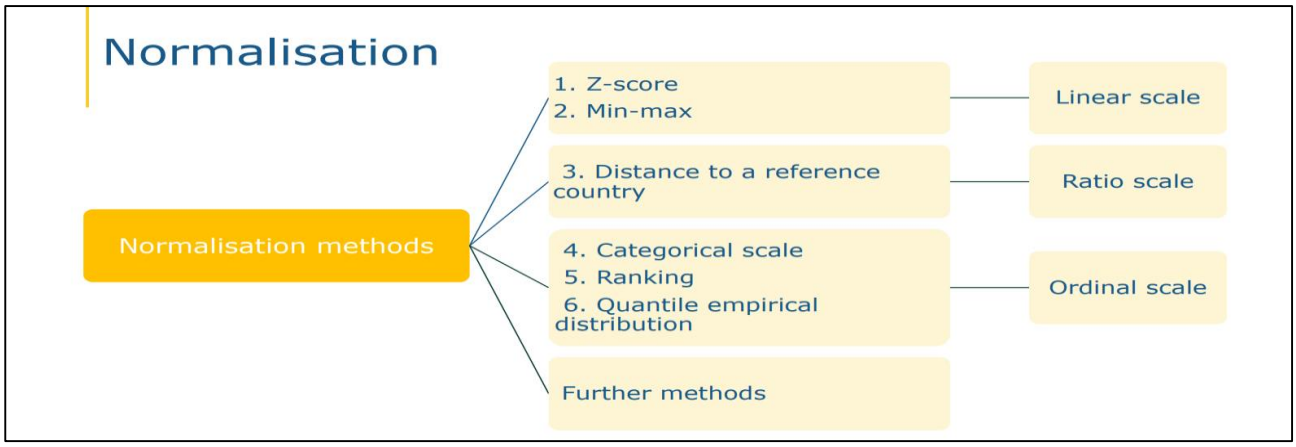

Fig 7. Normalization Methods. Source: JRC

There are several approaches for normalisation, hence we can list the most relevant for the purpose of this thesis.

The most basic normalisation approach is ranking. This technique is unaffected by outliers and allows nations' performance to be tracked over time in terms of relative positions (rankings). The disadvantages are the loss of absolute-level information and the inability to make any conclusions regarding performance differences. The ranking is performed at each point in time for time-dependent investigations. As a result, country performance may be tracked in terms of relative positions (rankings). However, it is impossible to track each country's absolute performance over time: a country may improve from one year to the next, but its position declines as other countries improve quicker (JRC, 2022).

One of the widest used methods for the normalisation is the standardization (also known as z-scores) which is the process of converting indications to a common scale having a mean of zero and a standard deviation of one (OECD, 2008: 26). As a result, indicators with extreme values have a stronger impact on the composite indicator. This may be undesirable if the goal is to promote extraordinary behavior, i.e., unless an exceptionally good result on a few indications is regarded to be better than a lot of typical scores. This impact can be addressed in the aggregation process, for example, by not including the best and worst individual indicator scores in the index, or by giving differing weights depending on the "desirability" of the individual indicator scores.

The third approach is the so-called re-scaling method. Here, each indicator is computed for a specific nation and time period as the ratio of the difference between the raw indicator value and the minimum divided by the range. The range, rather than the standard deviation, is used in this technique. The range of all normalized metrics is the same (0,1), hence each variable assumes a value between

zero and one, representing the maximum and minimum. However, it can be argued that there are some cons, i.e. such an approach is that the minima and maxima may be unreliable outliers that distort the normalised indicator. This strategy amplifies the influence of the indicators on the composite index for indicator values within a limited interval.

Another important method widely used by analyst is the normalisation according to distance to a reference country. The method divides "*a specific nation's indicator value at a particular point in time by the value of a reference country at a starting time*" (JRC, 2022). The normalisation takes into account the evolution of indicators through time using this denominator; alternatively, a denominator that evolves over time can be used. Distance to a reference determines the relative position of a goal be reached within a certain time frame. For example, the Kyoto Protocol specified an 8% reduction target for CO2 emissions for European Union countries by 2010. An external benchmark country might likewise be used as a comparison. In order to provide an example, the United States and Japan are frequently cited as benchmarks for the composite indicators developed within the scope of the EU's Lisbon agenda (OECD, 2008: 28). Similarly, the reference nation might be the group's average and be awarded a value of 1, with other countries receiving scores based on their distance from the average.

Each indicator is given a category rating, which can be numerical (e.g. one, two, three) or qualitative (e.g. "completely accomplished," "partially achieved," or "not achieved"). Scores are often calculated using the percentiles of the distribution of the indicator value across nations. In order to provide an example, the countries ranked between 100 and 95 can be charged with the highest points, and by going down the score provided are smaller proportionally. Categorical scales offer the benefit of not affecting the normalised value if the indicator value changes somewhat (for example, over time). Nevertheless, in certain circumstances, this might be a negative because a considerable amount of information about the variance across nations in the normalised indicators is lost (JRC, 2022). Another downside is that, if the original values have minimal variance, the percentile banding pushes classification on the data, regardless of the pattern of the underlying data (JRC, 2022). One potential option is to alter the percentile groups across the different indicators to generate normalised categorical indicators with almost normal distributions.

Another method of normalisation is to determine if the indicators are above or below an arbitrarily defined percentage threshold around the mean. If the indicator value is more than the percentage threshold around the mean, the normalised value is 1, otherwise, it is -1. This indicates that the threshold produces a neutral zone around the mean with a normalised value of zero. The goal is to reduce the strong discontinuity (from -1 to +1) that would otherwise occur across the mean value

to two mild discontinuities (from -1 to 0 and 0 to +1) that exist across the thresholds. The technique's efficiency and resilience in the presence of outliers are its main advantages. The downsides are that the critical limit is arbitrarily set and that absolute level information is lost.

2.5.3 WEIGHTING

There is no universally accepted process for weighting separate indicators before combining them into a composite index. Different weights can be allocated to component series to represent their economic relevance (gathering expenditures, coverage, dependability, and economic rationale), statistical appropriateness, cyclical conformance, data speed, and so on. Weights often have a significant influence on the composite indicator value and the consequent ranking, particularly when greater weight is applied to indications on which certain nations excel or fail. As a result, weighting models must be made plain and visible. Individual weights can be applied to indicators when they are combined into a composite measure. This permits the influence or significance of each indicator to be modified based on the idea being assessed. Weighting methods might be statistical, based on public/expert opinion, or a combination of the two. In this index, the theoretical framework can play a crucial role in terms of weighting, i.e. each variable will be scored according to the influence considered.

Some authors can suggest the equal weighting approach in order to simplify the process and avoiding to formulate assumption that does not necessarily represent the statistical reality. Equal weighting is the most common scheme appearing in composite indicators, i.e. it provides a number of pros especially when the nature of phenomena should be tested. However, equal weighting does not mean not distributing weights at all and it does not mean equal “contribution” of the indicators to the composite indicator. Nevertheless, it seems theoretically inconsistent to assign the same weight, hence the process of weighting was iterative according to the correlation degree. Within this technique, there is no *a priori* knowledge and no clear reference about the importance of the elements, and no agreement between stakeholders.

2.5.4 MULTIVARIATE ANALYSIS AND PRINCIPAL COMPONENT ANALYSIS

Some criticalities can occur during the realization of the index because the final product can be rich in terms of the element, but “information poor”. The underlying nature of the data needs to be carefully analysed before the construction of a composite indicator. As a matter of fact, some preliminary steps should be performed because they are helpful in assessing the suitability of the data

set and can provide a further understanding of the implications of the methodological choices. Methodological choices include weighting and aggregation of information that can be grouped and analyzed through two dimensions of the data set: individual indicators and countries.

Large datasets are increasingly widespread in many disciplines. In order to interpret such datasets, a method is required to reduce their dimensionality in an interpretable way. However, most of the information in the data must be preserved. Within this framework, several approaches have been developed in order to reach this purpose, hence the principal component analysis (PCA) is one of the oldest and most widely used. The basic assumption of this method is to reduce the dimensionality of a dataset while preserving as much 'variability' (i.e. statistical information) as possible (Jolliffe & Cadima, 2016). It can argue that "*the goal of principal components analysis (PCA) is to reveal how different variables change in relation to each other and how they are associated*" (OECD, 2008: 26). This statistical technique is useful for gaining insight into the structure of the data set of the composite.

However, there are some cons to consider before moving to the next step, because it is important to avoid carrying out multivariate analysis if the sample is small compared to the number of indicators since results will not have known statistical properties. In addition, the correlations obtained due to this method do not necessarily represent the real influence of the individual indicators on the phenomenon being measured. The modification of the basic data can highlight the strong sensitivity to the introduction of new data or countries of sample. Indeed, the presence of outliers may introduce a spurious variability in the data. When the focus is on a limited set of countries, the sensitivity of the index can be higher.

The PCA (principal component analysis) approach was employed in the study to compute the natural gas supply security index. PCA is a well-known and widely used multivariate statistical approach in specialized areas, and it is also employed in the energy research literature to calculate the oil vulnerability index. The method's goal is to minimize the dimension of the variables in the dataset such that the correlated variables may be transformed into uncorrelated variables termed components, which are linear combinations of the original variables. The PCA approach computes the dependent variable as a synthetic index score by assuming index variables are linearly connected to the dependent variable and reflecting each country's natural gas supply security.

The next chapter will move to the quantitative realization of the GESI with the aim to explain and comment on the result and score the sample of countries.

CHAPTER 3: DEVELOPMENT OF THE INDEX – Geopolitical Energy Security Index (GESI)

3.1.1 OVERVIEW OF THE CHAPTER

The following chapter intends to analyse the concrete applications of the theoretical outlines developed in the previous chapter and provide some explanations about the functioning of the COIN program applied for the creation of composite indicators. Realized by the European Commission, the tool aggregates the different dimensions of the conceptual framework by repeating operations in various excel spreadsheets for the treatment and processing of the input data. The tool is the direct application of the theory sketched in the previous chapter, with the result of facilitating the communicability, effectiveness, and efficiency of the processes. The following chapter will summarise the various steps performed following the functioning indications elaborated by the programmers of the tool and it will be shown how the theory is applied to the concrete case of the index of the thesis. The following index aims to provide an evaluation of a phenomenon that is not directly observable but has important tangible effects on Italian energy security.

The composite indicator aims to analyse, by aggregating four dimensions, the natural gas export capacity of the countries taken in the sample. More precisely, it intends to detect which dimensions, interrelated with each other, can influence the export capacity of a producing country. The index, named Geopolitical Energy Security Index, is tailor-made because it not only considers a specific commodity, i.e. natural gas, but also tries to show possible correlations with foreign policy dynamics of the target country and Italy. Composite indicators measure multi-dimensional phenomena with multiple ramifications, hence the correlation between each of these dimensions can be indirectly explained with the composite index explaining correlations between different aspects of a country. At the same time, multiple dimensions contribute to making a country a good gas exporter and making it available and attractive for building lasting political, energy, and diplomatic relations.

In addition, a detailed analysis of the theoretical framework will be added without mentioning the description of the variables, which has already been done in the previous chapter, but the structure of the sub-pillars of the composite index will be recalled with particular care. The sub-pillars belong to the second stage of aggregation of the variables, in an intermediate position between pillars and aggregation factors. It is important to emphasize the importance of this step, which allows us to obtain

an anchorage between macro dimensions (seemingly removed from the micro variables), and the factors representing the political, social, and energy realities of the countries sampled.

Finally, the chapter will illustrate the results and the possible interpretation of the outcomes provided by the GESI. Some critical points are going to be discussed and the chapter will define possible ideas for future research.

3.1.2 COIN – TOOL FOR BUILDING THE COMPOSITE INDICATOR

The development of composite indicators involves a wide range of operations, statistical tools, and procedures with the aim to combine factors belonging to a different aspect of reality. Composite indicators are powerful practical tools that can help policymakers summarise complex and interdependent phenomena. The advantages of composite indicators are that they can provide an overall perspective on the wider picture, and they are easy to interpret and communicate. In addition, the composite indicators can help to shape the policy agenda of governments and drive the development of policies and institutions with the aim to reach certain standards. On the other hand, caution is needed to avoid situations where composite indicators may send misleading or partial policy messages because they are poorly constructed or misinterpreted.

In order to facilitate and ensure the high-quality development of composite indicators, the European Commission has developed an Excel-based software tool to help develop and analyse composite indicators and scoreboards. COIN Tool aims to provide a powerful and accessible platform for developers to construct, analyse and adjust their composite indicators (Becker et al., 2019). The interface is easily affordable for users, who can follow a series of simple steps which help to build and visualize a composite indicator. The program illustrates an overview for analysing relationships between indicators, testing variations in methodology and checking the robustness of certain assumptions.

3.2.1 DATABASE: DATA ENTRY

The first step is to enter your data, the structure of the index, and methodological characteristics also including aggregation type, normalization type, and weights. These activities are largely conducted in the Database tab, with some input from the Framework tab.

In the beginning, the software requires entering the data which were reported in an Excel tab, i.e. each value has been arranged in a table, where each row corresponds to a unit (typically a country

or region), hence in this case we added the countries of the sample. Each column corresponds to an indicator taken from the theoretical framework. Enter indicator values are entered, i.e. in this case it has been put the value for each factor for different periods, namely 2010, 2015 and 2020. Missing data points should be marked as "n/a". The program is very sensitive to the upload of data and particular attention should be given to decimals, i.e. it requires a point rather than a comma. In addition, in the case of a zero value of the indicator, that is not a missing value, the COIN Tool represents them as "-". In order to provide an example, Italy started to import gas from Azerbaijan only in 2019, hence for 2010 and 2015 the value of gas exports to Italy was zero. Most importantly, it is fundamental to not add or delete columns and rows because some changes within formulas can negatively affect the computation of the program and consequently the final outcome. In the Database Tab, Indicator values should be simply copied in as plain text. If there is existing indicator data, delete it by using the "delete" key or by right-clicking and selecting "clear contents". We entered the unit details as the name of countries and a shortened code (e.g. ALG and AZB).

Each indicator is expected to have its value assigned and then the weight should be entered for each indicator. Weights are relative and do not need to sum to 1. For instance, setting all weights to 1 is equivalent to setting equal weights, a weight of 0 implies not considering the particular indicator in the aggregation. As specified by the authors, *"the next step is to enter a direction for each indicator, where the value of 1 means that higher values of the indicator are associated with higher values of the index/concept (e.g. higher values of the indicator "income" indicate higher values of index "quality of life")"*(Becker et al., 2019: 15). A value of -1 means that higher values of the indicator are associated with lower values of the index/concept (e.g. higher values of the indicator "domestic gas demand" is associated with lower values of index "export capacity").

The next step is to enter upper and lower goalposts for each indicator for the normalization process. If the goalpost bounds are left blank, they default to the minimum and maximum values of each indicator: in this case goalpost normalization is identical to min-max. Finally, the user must design the structure of the index: the index, sub-index, pillar, and sub-pillar to which each indicator belongs. It is important to align each component with its respective pillars and sub-pillars, thus ensuring that each group corresponds to its elements.

3.2.2 FRAMEWORK TAB:

The following subsection illustrates a summary of the structure of the index to assign weights and names to each aggregation level (sub-pillars, pillars, sub-indexes, and index). In the Framework tab, the COIN Tool automatically summarises the index structure provided by the user in the Database tab (Becker et al., 2019: 15). Aggregation weights must be assigned. These, like the indicator weights, are relative and do not have to add up to 1, higher scores of each aggregation are associated with higher scores on the index. Weights are those that are used to aggregate to the next level, for example, weights allocated to sub-pillars are utilized as weights in the arithmetic or geometric mean that results in pillar scores. Each aggregate level should have a name and these are just used to distinguish the aggregation stages in subsequent tabs.

The compilation of this table provides a well-defined and delineated structure of the index in all its branches. Consequently, each element is associated with the weight attributed to it within its group of indicators/pillars/sub pillars. *In terms of compilation, it is essential not to modify the content of any cell by superimposing other elements, hence the only elements that can be compiled are those coloured blue*. The index is composed of four pillars, namely: economy, energy, socio-political and geopolitical-Italy. The first pillar aims to represent the macroeconomic aspect that influences the effective exporting capacity of the country and its stability. The second pillar integrates the energetic background of the country, thus its domestic market and its production capacity should be taken into account if we want to verify the exporting capacity of the national landscape. The third pillar is the socio-political perspective, as well as the political and social stability of the country, which could affect the capacity to fulfil the contractual obligations at the same time, stable social tissue can strengthen local institutions avoiding the public expenditure would be totally absorbed the welfare policies implemented to preserve the social peace. As a matter of fact, without social stability and a favourable economic environment where the enforcement of contracts is ensured, there is limited capacity for further investments in the gas sector. The fourth pillar, geopolitical Italy, reflects the aim of this thesis, i.e. it is a tailor-made pillar customized for the Italian interests. Some dimensions can bring, through appropriate statistical computation, the country more that may lead the exporting country to have a proactive orientation towards Italy because it is perhaps included in the Italian sphere of influence or because it has built strong economic-financial ties with Rome over the years. Furthermore, it is relevant to consider the relations between the exporting country and Italy's competitors on the energy and geopolitical planes, as in this case Russia and Turkey. Policy makers of exporting countries may be influenced by conflicting interests, so Italian institutions can try to monitor this influence of these factors with the other components of energy security.

3.2.3 DATA INSPECTION AND TREATMENT

The COIN Tool dedicates five tabs to illustrating the properties of your data and offering possibilities to treat outliers. This step represents an overview before proceeding with any treatment, and a summary of the statistical features of the data provided, in fact, users may view missing data, min/max values, mean and standard deviation, and flag outliers (Becker et al.,2019: 20). The third tab of COIN refers to the statistical tab of the index where each variable is visualized and the properties of data are illustrated. The goal is to draw attention to possibly "abnormal" numbers such as missing data, zeros, negative values, and outliers. In subsequent tabs, you may choose whether or not to handle or adjust these values. The table shows the relevant information about the indicators, units, and individual data points as possible. This allows users to verify that the highest and the lowest values are within the predicted ranges and that each indicator's and unit's missing data is within acceptable limits (Becker et al., 2019: 21). As a general guideline, at least 65 percent indicator coverage per unit and dimension, thus this threshold is a specific instance and may rely on, among other things, the degree of correlation between indicators within a dimension.

An outlier is a data point that deviates considerably from the normal distribution of the observed data. An outlier can be caused by measurement variability or by experimental mistakes. In statistical analysis, an outlier can generate major problems because the outlier does not necessarily represent the real patterns of the phenomena represented. However, sometimes outlier simply represents the real tendency and evolution of the distribution according to the observed data.

Outlier detection is not easy, and there are several paths to follow. The COIN Tool provides a straightforward univariate technique based on the moments of the indicator distributions and quartiles. The presence of outliers is indicated by "yes" or "no." Outliers are defined as absolute skewness and kurtosis exceeding predefined criteria in a statistic distribution. These levels have default values of 2 and 3.5. Skewness is the extent to which the data are not symmetrical, whether the skewness value is 0, positive, or negative reveals information about the shape of the data.[9] Kurtosis indicates how the tails of distribution differ from the normal distribution, the kurtosis helps to initially understand the general characteristics of the distribution of your data[10].

[9] For more details, see the following link: https://support.minitab.com/en-us/minitab/18/help-and-how-to/statistics/basic-statistics/supporting-topics/data-concepts/how-skewness-and-kurtosis-affect-your-distribution/#:~:text=A%20distribution%20with%20a%20negative,have%20a%20negative%20kurtosis%20value.

Individual outliers are highlighted through the following method, let xi be any value of the ith indicator. Values are colored by green as low outliers if any of the following are true (Becker et al., 2019: 22):

i) $xi < Q1 - a\,(Q3 - Q1)$, where $Q1$ and $Q3$ are the first and third quartiles of the ith indicator, and a is a parameter that can be adjusted. In other words, it flags whether xi is below a certain multiple of the interquartile range;

ii) $xi < \mu i - b\sigma i$, where μi and σi are the mean and standard deviation, respectively, of the ith indicator, and b is a parameter that can be adjusted. In other words, it flags whether xi is below a certain multiple of the standard deviation. $xi < Pc$, where Pc is the cth percentile of the ith indicator. The default for c is zero, which means this criteria is usually switched off, otherwise, outliers will be identified in all indicators;

iii) For high outliers, the criteria are analogous: a) $xi > Q1 - a\,(Q3 - Q1)$, b) $xi > \mu i - b\sigma i$ and c) $xi > P1-$c.

The Winsorisation tab aims to "correct" indicators with outlying values, which are defined as indicators with skew and kurtosis values that exceed the skew and kurtosis criteria. The technique of replacing outliers with the nearest non-outlying value is known as winsorisation. In the presence of a few outlier numbers, the approach is typically utilized (roughly 5 percent of units). The COIN Tool iteratively Winsorises outlying data for each indicator, up to a given maximum number (the default is five values), until the skew and kurtosis are within the set thresholds. If Winsorisation does not reduce skew and kurtosis to acceptable levels, the COIN Tool suggests a Box-Cox transformation.

3.3.1 COIN: DATABASE TAB AND THEORETICAL FRAMEWORK

First and foremost, the user has to fill the sheet named Database sheet where we enter the data. We have entered the values of the variables, avoiding any copies of pre-existing formatting, thus conforming to the standard provided by COIN. The data selection is a complex process where we consulted the data sets published by the leading international institutions to gain an appropriate methodology. A deeper explanation of the criteria for selecting the dataset has been provided in the previous chapter, i.e. here we will highlight just the fact that we choose international institutions because of their internal practices and transparent code of conduct in their statistical methodology. In order to sum up, we have extracted the data for 2010, 2015, and 2020 from: Our World in Data, IMF, Transparency International, OPEC, World Bank, World Energy Outlook, United Nations, Bank of

Italy, Italian Ministry of Energy Transition, and GECF. Data are double-checked within different sources, e.g. the data from economic and energetic factors are confronted between different sources in order to verify the fit. For the decimals, it has been used the comma and not the point. In addition, each set of values (e.g. GDP data)

After copying the data, the countries in our sample and their identification codes were entered. The countries that have been grouped in the sample all share certain characteristics such as:

i) they are gas producing and exporting countries, hence there is structured exploitation of their national resources;
ii) the chosen countries present a dynamic socio-economic context that is at the same time restless and with multiple vectors of instability;
iii) they have relations with Turkey and Russia;
iv) they are gas exporters to Italy.

Indeed, the aim of the index is to correlate different dimensions with the energy security and consequently have a deeper understanding of the complex issues that policymakers must address in order to enhance the Italian energy security and enforce foreign relations with developing countries and increase the influence of Italy by following the patterns of interaction of local contexts. Consulting the databases, we considered the following six countries to be included in our sample, which is respectively: Algeria, Azerbaijan, Libya, Egypt, Qatar, and Nigeria. The name of the countries, their identification code (e.g. ALG), and unit code are horizontally aligned, so the formulae will calculate this input cluster together. The next step is to enter the name of the factors/variables, for convenience, each factor has been entered as adjacent to the related factor in the same subpillar. For the realisation of this composite index, we used 24 factors entered in equal amounts for each of the four pillars of the analysis. Each pillar is composed by minimum 3 subpillars and each subpillar is in turn composed of a minimum of 2 factors. Consequently, we assigned to each pillar, subpillar and factor a code for the computation:

i) each factor has been associated with “ind.Number” , from ind.01 to ind.24;
ii) each pillar is composed of 6 factors.
iii) each pillar was turned into “p.Number”, e.g. p.01, p.02, p.03 and p.04;
iv) The pillars are aggregated to the higher level of the s.01 which is the sub-index before the final indicator. However, in this case, the s.01 matches with the final composite indicator that we named Geopolitical Energy Security Index (GESI).

3.3.2 SUB PILLARS OF THE INDEX

During the use of COIN, the essential novelty of this additional methodological step emerged. The factors/variables, which are part of the pillars, have been grouped with subpillars highlighting specific dimensions of a larger, more complex pillar. Each of the four initial pillars makes up the macro index of the thesis, and in turn, the pillars (set out above) are the result of the arithmetic aggregation of the subpillars that make it up. These components represent minor but interrelated phenomena during the calculation of the index. Finally, underlying the subpillars are the factors that represent the raw material of the calculation. Aggregating the indices and their respective subcomponents helps us to identify correlations and helps to check whether these elements are parts of a bigger picture. The definition of the composite index through subpillar can be summed up as follow:

Economy: Growth, Country Competitiveness, and Economic Speed. Economic development generates higher demand for fossil fuels because improved economic conditions lead to an increase in consumption and investments that will use domestic energy resources as inputs, reducing the volumes available to importers. Otherwise, in rentier states the increase in GDP is positively correlated to the expansion of the energy sector;

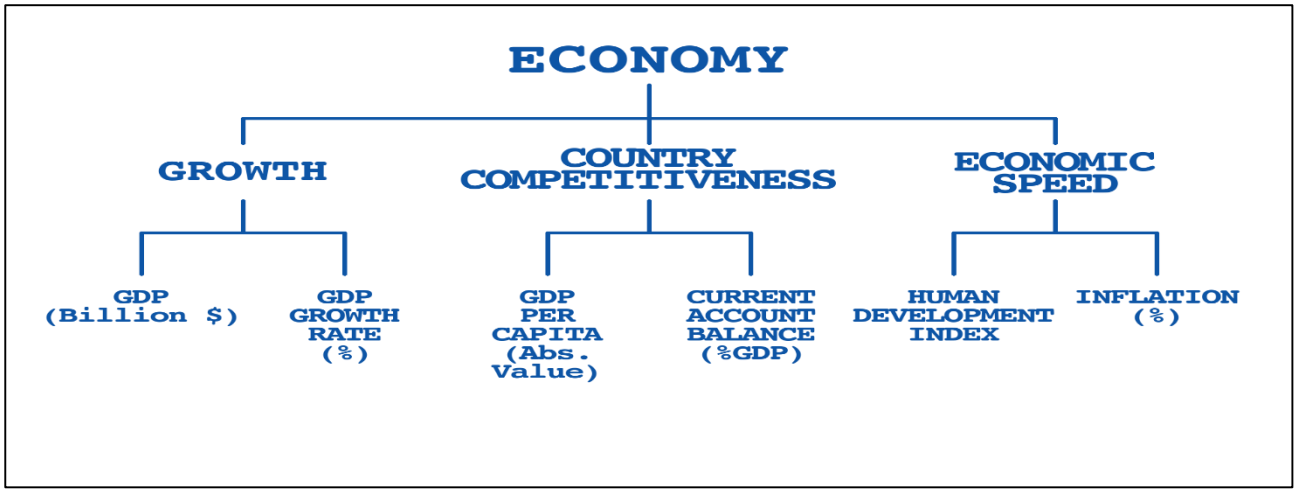

Fig 8. Economic Pillar. Source: Author's Elaboration

Energy: Export of Gas, Extractive Capacity, Gasification of Energy and Reserves. The focus of the analysis is on the potential of the exporting country's energy system. Indeed, production and consumption (in terms of total volumes) affect the attractiveness of the country. Furthermore, it is

important to note that a large share of the electricity produced is often derived from the combustion of the gas as an essential resource, so a high rate of gasification in the domestic electricity sector, especially if accompanied by an increase in individual consumption, can reduce the share of hydrocarbons that can be allocated abroad. For example, consumption growth forecasting is one of the key indicators used by policymakers in committing their energy companies to long-term supply contracts.

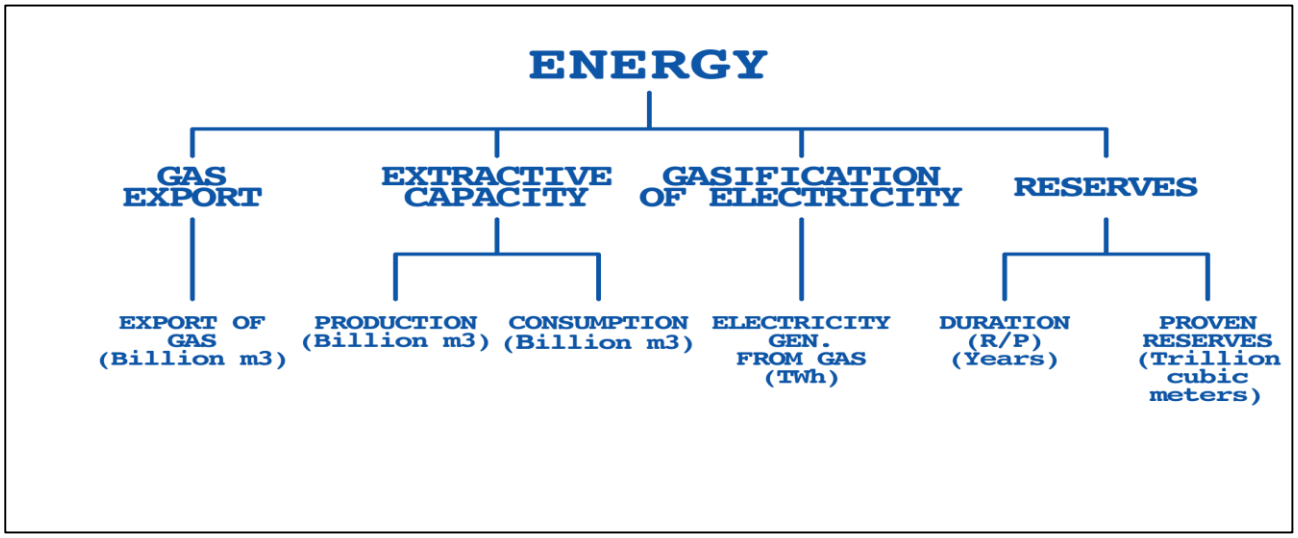

Fig 9. Energy Pillar. Source: Author's Elaboration

Socio-Political: Normative Landscape, Social Stability, and Social Discontent. The creation of links of energy interdependence between two countries is mainly based on the mutual trust that counterparts place in each other. Indeed, energy dependence, especially via pipelines, forces countries to strengthen their ties in many ways to avoid excessive investment costs being passed on to only one of the two parties. It all starts with a political will that must be stable in the medium to long term to prevent the moods of a given moment from affecting the resilience of supply lines. The fiduciary relationship between the parties risks being interrupted and reduced due to domestic political contingencies. In fact, it is worth noting that instability due to the general discontent of the population, inter-ethnic conflicts, high prevalence of corrupt practices in all ganglia of society, and time pressure to terminate contracts can concretely undermine the basis of cooperation between two countries. The sub-pillars attempt to relate this phenomenon in its many facets.

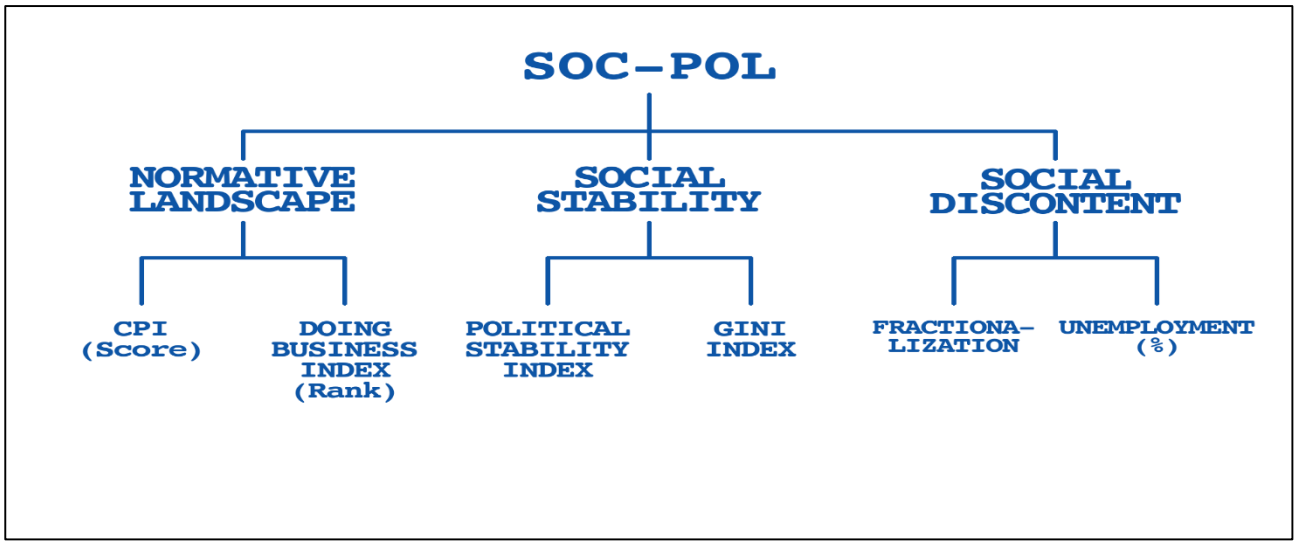

Fig 10. Soc-Political Pillar. Source: Author's Elaboration

Geopolitical-Italy: Bilateral Trade, Italian Influence and External Actors Involvement. The thesis index is customized to check the relationships (good or bad) that Italy can boast with its suppliers. The sub-pillars reflect the level of dependence that the two countries have built up in terms of energy, trade, and finance. Inward FDI is the proxy measure for assessing Italian influence on local politics and long-term privileged relationships with suppliers for mitigating political risks. In this equation, Russia and Turkey's influence must be introduced as a source of political risk for the Italian energy flows. The two powers can enforce a sort of bargaining power and leverage the grey zones in the institutions of the sample.

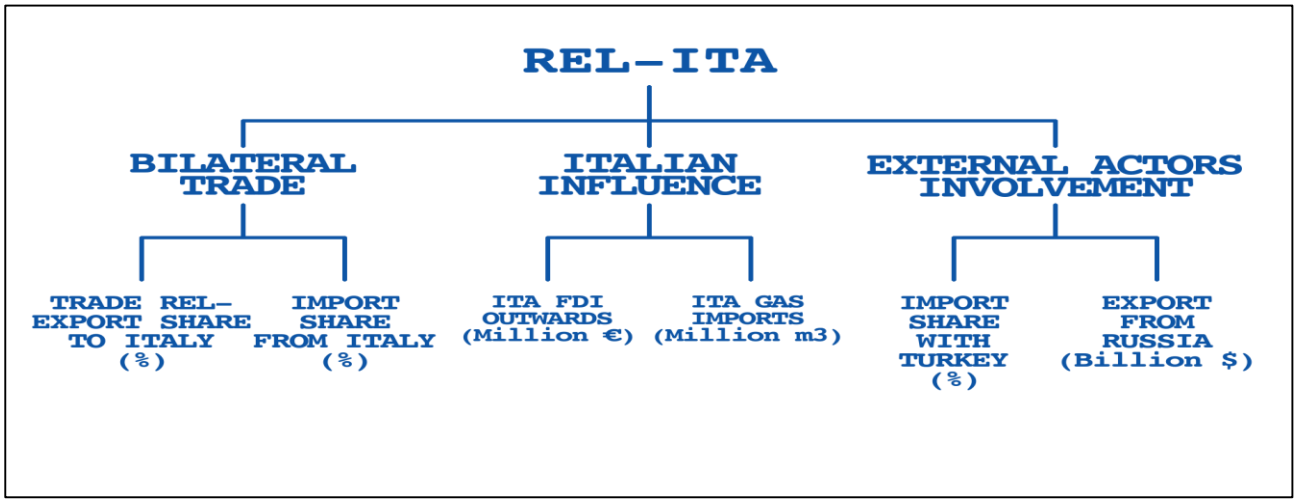

Fig 11. Relation-Italy Pillar. Source: Author's Elaboration

3.3.3 ASSESSMENT OF THE AGGREGATION LEVELS

The level of aggregation is automatically reported on the second page of the COIN which deals with the theoretical framework. The framework tab imports the structure of the composite indicator from the Database tab**.** It summarises the structure and allows weights and names to be assigned to each aggregation level (sub-pillars, pillars, sub-indexes, and index). The next step requires the user to be careful with the imputation of elements. As a matter of fact, after uploading the values and the factors, the COIN requires entering the weight for each indicator. These are used as weights when indicators are aggregated to the sub-pillar level and weights are relative and do *not* need to sum to 1. The relative value is because the weight of a factor is considered in relation to the other weights of the factor at a specific level of aggregation. A weight of 0 implies not considering the particular indicator in the aggregation and it is generally associated with factors that seem to have a very low correlation with the pillars, sub pillars, or the index itself.

Values of the weight are important because there is part of the aggregation activities and they are deeply involved in the formula. For each level of aggregation, the user has to choose the method of aggregation between arithmetic and geometric. We decide to adopt the arithmetic mean for each level of aggregation. The arithmetic mean is the well-known weighted average of scores. Let x_i, c , $x_2\,, c, x_3, c$ be the values of three indicators comprising a sub-pillar s, for unit c. The sub-pillar score is calculated as follows: $sc = \frac{1}{3} \times (w_1\, x_1, c + \, w_2 x_2, c + \, w_3 x_3, c)$, where w_1 , w_2 and w_3 are the indicator weights that sum to 1 for indicators X_1 , X_2 , and X_3 respectively. More properly, we can sum up the formula as follows: $sc = \frac{1}{\sum W_i (W_i X_I, C)}$.

Considering all factors equally influencing the index reveals a certain theoretical inconsistency that may later reveal its frailties when the correlation index is analysed. Therefore, it is important to assign different weights to the aggregation factors, reflecting on the theoretical elements of reference. Indeed, weight is the preferred indicator that converts theoretical assumptions into data and calculations. In fact, as a second step, the COIN program will provide the user with the possibility of modifying the weights assigned to the factors in order to assess how the correlations are best suited. Any changes in this respect will be analysed appropriately in the appropriate section.

Another step to address is represented by entering a direction for each indicator. A value of 1 means that higher values of the indicator are associated with higher values of the index/concept (e.g. higher values of the indicator “export of gas” is positively associated with higher capacity to export gas and being a good supplier). A value of -1 implies that the increase of the value of the indicator values is linked with lower values of the index/concept. To provide an example, higher values of

indicator “gas consumption” is associated with lower values of index “exporting capacity” because there are fewer resources to export. According to theoretical considerations, we highlight the specific direction of the factors. Positive and negative correlations play a central role in the development of the index because variables tend to manifest their connection through the correlation method. The values should be carefully analysed from their theoretical perspective according to the result of the index. The correlation between variables shows us if there is an underlying connection between the different levels of aggregation. The next paragraph will manage the normalisation process and its implication for the construction of the composite index.

3.3.4 DESCRIPTIVE ASSESSMENT OF THE INDICATORS

This section will provide an overview of the specific outliers and general statistical units of the indicators for what concerns 2010, 2015 and 2020. We can see that the COIN highlighted some values in red with the aim to show the user the outliers detected. Outliers are such values that distort the curve of distribution, i.e. they can represent a statistical unbalance and lead to error in the calculation. However, some outliers can be caused by the normal distribution of the sample, hence it is required to be carefully managed.

Figure 5 shows the initial assessment of descriptive statistics for 2010. We see that GDP per capita is considered an outlier because its kurtosis is very high, hence it means that the distribution tends to have heavy tails. This asymmetry is caused by the different economic development that characterizes some countries such as Qatar where the income per capita is higher respect countries of sub-Saharan Africa, Middle Asia and North Africa. Dealing with Qatar, we can argue that there are the same phenomena but are concerned for the total amount of gas reserves. As a matter of fact, Qatar presents the second highest reserves worldwide in terms of trillion of cubic meters, i.e. only the Russian Federation claims the primacy (BP, 2021). Looking at table 5, the doing business index has negative skewness thus the performance varies according to the countries because policymakers have developed different measures with the aim to ensure or improve the contract enforcement during the daily operating activities of firms. Some countries have experienced different development pathways, i.e. they developed a favourable business environment before others, hence they are outliers respecting the relative distribution of the others. The same hypothesis can be used for explaining the different trends in the unemployment rate, because some countries such as Azerbaijan developed their energy sector only in the last year, and consequently the total unemployment rate was higher. Moving to the corruption perception index, we can see that some institutions were more delegitimized that the elites of other countries, which means that there was higher social discontent in countries that

experienced the Arab revolutions in 2011. By 2010, there is some evidence that suggests the economic relations with Italy were underdeveloped for some countries or almost unexistent (see Azerbaijan), in contrast, other countries in the sample are more interrelated with the Italian economy because of the historical path dependence (see Libya, Algeria). It can be argued that a large part of the economic-commercial relations between Italy and the countries in the sample is related to the relative expansion and development of energy supply relations. In fact, in 2010, some countries were not exporters of gas to Italy and therefore had not even opened their economies to foreign financial flows.

	GDP	GDP GROWTH (%)	GDP PER CAPITA	CAB (%)	HDI	INFLATION (%)	EXPORT GAS	PROD.	CONS	ELECT. GAS	DURATION	RESERVES	CPI (Score)	DOING BUSINESS INDEX(Rank)	POL. STAB.	GINI INDEX	FRACTIONALIZATION	UNEMPLOYMENT (%)	EXP. SHARE IT.	IMP. SHARE IT.	IT FDI	IT GAS IMP	IMP SHARE TURK	RUS EXP
Min	52,91	0,03	2.328,43	-0,02	0,48	-0,02	2,66	16,00	4,30	8,00	28,00	1,00	21,00	26,00	-2,21	0,28	0,15	0,00	0,00	0,02	13,13	-	0,01	0,14
Max	369,06	0,18	69.796,14	0,28	0,83	0,14	121,80	123,10	43,40	103,00	144,00	25,10	68,00	148,00	1,15	0,41	0,81	1,00	0,42	4,52	6.567,00	870,00	0,12	2,64
Mean	166,95	0,08	16.137,72	0,13	0,70	0,06	37,23	53,78	18,88	36,50	87,27	6,52	34,83	89,00	-0,85	0,34	0,33	0,23	0,16	0,81	2.070,48	152,20	0,05	0,79
Standard deviation	118,07	0,06	26.487,46	0,12	0,12	0,06	45,27	41,82	15,39	34,55	45,49	9,24	16,94	45,49	1,12	0,06	0,28	0,38	0,18	1,82	2.890,66	351,79	0,05	0,96
Skewness	1,09	1,41	2,37	-0,00	-1,28	0,12	1,69	0,93	0,74	1,89	-0,43	2,29	2,02	-0,24	1,15	0,71	1,94	2,30	0,76	2,45	1,07	2,44	0,69	1,91
Kurtosis	0,78	1,03	5,68	-1,84	2,06	-0,93	2,74	0,08	-0,62	3,77	-1,38	5,38	4,43	-1,01	2,42	-1,69	3,75	5,40	-1,44	5,99	-1,02	5,98	-1,74	3,53
Outliers detected	no	no	yes	no	no	no	no	no	no	no	no	yes	yes	no	no	no	no	yes	no	yes	no	yes	no	no
First quartile (Q1)	81,66	0,04	3.312,28	0,05	0,68	0,03	7,96	19,95	6,65	18,75	51,68	1,65	26,25	59,50	-1,28	0,30	0,16	0,04	0,04	0,06	52,00	1,54	0,02	0,24
Median (Q2)	140,35	0,05	5.180,76	0,14	0,72	0,05	19,88	44,95	16,75	23,50	102,15	3,30	30,00	94,50	-1,08	0,31	0,19	0,07	0,10	0,08	476,38	7,78	0,04	0,34
Third quartile (Q3)	212,77	0,10	10.033,27	0,21	0,78	0,10	46,33	72,80	25,78	38,75	109,88	4,80	33,75	116,00	-0,68	0,38	0,32	0,17	0,29	0,10	3.853,69	23,10	0,09	0,89

Fig 12. Statistics for 2010. Source: Author's Elaboration

For what concerns 2015, we look to indicators and their skewness. If the skewness is between -0.5 and 0.5, the data are nearly symmetrical. If the skewness is between -1 and -0.5 (negative skewed) or between 0.5 and 1(positive skewed), the data are slightly skewed. If the skewness is lower than -1 (negative skewed) or greater than 1 (positive skewed), the data are extremely skewed. Positive skewness means that the tail on the right side of the distribution is longer or fatter, hence the mean and median will be greater than the mode. The skewness is higher than one for each indicator excluded inflation, human development index, and doing business rank (which is highly negatively skewed). It can be argued that there are important asymmetries among statistical observations because some countries collapsed for the Arab Spring, i.e. there was a rapid and dramatic deterioration of each indicator. These asymmetries are alimented by the fact that some countries such as Libya collapsed and others such as Qatar did not experience relevant political mobilization and riots against the government. In fact, there is relevant negative skewness for what concerns current account balance to GDP, and doing business index (probably because of the deterioration of the business environment and contract enforcement). The asymmetries are given by the geopolitical turmoil because there is a contradiction between stable and unstable countries and their outcomes are reflected in the indicators' value. As regards Kurtosis in figure 6, we can see that the Russian bilateral trade with some countries such as Azerbaijan and Egypt shows a long-term economic and bilateral cooperation between Moscow

and the considered country, i.e. the Kurtosis is high because there is a relevant gap between the bilateral trade of the Russian Federation depending on the country. Otherwise, some other gaps highlight the structural difference in income and economic outcome between countries of the sample, such as the GDP per capita, the import share from Italy, and the total amount of reserves (given by nature). Such gaps are shown by the row that detects the outliers for each distribution of indicators.

	GDP	GDP GROWTH (%)	GDP PER CAPITA	CAB (%)	HDI	INFLATION (%)	EXPORT GAS	PROD.	CONS	ELECT. GAS	DURATION	RESERVES	CPI (Score)	DOING BUSINESS INDEX(Rank)	POL. STAB.	GINI INDEX	FRACTIONALIZATION	UNEMPLOYMENT (%)	EXP. SHARE IT.	IMP. SHARE IT.	IT FDI	IT GAS IMP	IMP SHARE TURK	RUS EXP
Min	17,22	-0,13	2723,37	-54,29	0,53	0,04	0,00	14,70	8,07	14,00	28,00	1,30	16,00	31,00	-2,20	30,20	0,15	0,02	0,02	0,04	159,00	0,00	0,01	0,09
Max	492,44	4,75	66346,91	8,50	0,84	0,94	124,62	175,80	46,00	113,00	144,00	24,30	71,00	152,00	1,00	41,10	0,81	0,19	0,35	2,36	7705,00	7,64	0,16	4,31
Mean	203,38	1,95	16450,98	-11,58	0,68	0,23	33,89	63,48	26,39	46,50	87,27	6,48	35,67	112,17	-1,04	33,95	0,33	0,09	0,13	0,46	2751,55	3,45	0,06	1,04
Standard deviation	179,54	2,28	27907,97	22,40	0,11	0,35	47,61	60,00	18,04	36,90	45,49	8,88	18,83	43,06	1,17	4,38	0,28	0,06	0,13	0,93	3623,42	3,75	0,06	1,64
Skewness	0,84	0,34	2,23	-1,80	-0,03	2,38	1,81	1,67	0,05	1,45	-0,43	2,27	1,59	-1,68	1,17	1,12	1,94	0,53	1,16	2,44	0,97	0,10	1,39	2,20
Kurtosis	-0,18	-2,55	4,98	3,52	0,16	5,73	3,40	2,89	-3,11	1,77	-1,38	5,31	3,32	3,24	1,23	-0,34	3,75	-0,89	0,99	5,98	-1,81	-3,05	1,60	4,93
Outliers detected	no	no	yes	no	no	yes	no	no	no	no	no	yes	no	no	no	no	no	no	no	yes	no	no	no	yes
First quartile (Q1)	78,57	0,02	3731,18	-13,25	0,63	0,06	2,10	24,75	11,10	24,25	51,68	1,65	26,75	108,00	-1,82	31,05	0,16	0,04	0,03	0,05	340,15	0,06	0,02	0,14
Median (Q2)	163,86	1,35	4153,32	-3,40	0,69	0,10	17,49	45,10	24,95	32,00	102,15	3,30	32,50	123,00	-1,30	32,00	0,19	0,08	0,10	0,08	609,24	2,98	0,04	0,32
Third quartile (Q3)	290,55	3,94	5300,14	-1,11	0,73	0,14	39,46	72,95	42,17	57,75	109,88	5,03	36,00	136,50	-0,65	36,25	0,32	0,12	0,17	0,12	5534,58	6,75	0,08	0,92

Fig 13. Statistics for 2015. Source: Author's Elaboration

Moving to 2020, unemployment and import share from Italy illustrate that there is an asymmetrical economic impact of covid-19 among countries in the sample. At the same time, we can argue that Italy entails different bilateral trade relations. i.e. it exports more in some countries respect others. However, the indicator "Ita gas import" is dramatically different among the distribution because geopolitical turmoils have affected the reliability of some countries as gas suppliers in the Italian energetic portfolio. For example, the Libyan scenario leads local institutions to decrease the exploitation of natural resources and their export to Italy. Negative skewness of Current Account Balance and inflation exposes that there is an asymmetric trend among countries, i.e. Qatar has different economic development respect Egypt, hence the degree of growth and the dependence on the export of gas influences the balance of payments and, consequently, the inflation rate. In fact, most of the exporters of natural gas sustain their currencies through the export of fossils for international currency such as the dollar. It can be argued that the covid 19 has boosted the negative economic outcome of the sample even if the effects are country-specific and asymmetric, however, It can be argued that the different components of the macroeconomic outcome lead the countries to perform differently even if there was a global economic slowdown.

	GDP	GDP GROWTH (%)	GDP PER CAPITA	CAB (%)	HDI	INFLATION (%)	EXPORT GAS	PROD.	CONS	ELECT. GAS	DURATION	RESERVES	CPI (Score)	DOING BUSINESS INDEX(Rank)	POL. STAB.	GINI INDEX	FRACTIONALIZATION	UNEMPLOYMENT (%)	EXP. SHARE IT.	IMP. SHARE IT.	IT FDI	IT GAS IMP	IMP SHARE TURK	RUS EXP
Min	19,21	-3,59	2891,46	-12,68	0,53	-2,72	2,91	13,30	7,70	16,00	28,00	1,50	17,00	28,00	-2,48	28,60	0,15	0,03	0,02	0,03	144,00	0,18	0,01	0,12
Max	429,42	3,57	54184,97	-0,53	0,84	0,28	127,46	171,30	57,80	130,00	144,00	23,80	63,00	166,00	0,67	41,10	0,81	19,39	0,34	1,84	9988,00	184,00	0,12	5,14
Mean	191,26	-0,49	13649,38	-5,81	0,68	-0,37	37,84	66,63	31,30	52,33	87,27	6,67	33,83	114,00	-1,12	32,93	0,33	3,30	0,14	0,36	3884,85	36,32	0,07	1,58
Standard deviation	168,53	2,65	22665,28	5,27	0,11	1,16	45,99	56,66	21,29	44,09	45,49	8,53	15,82	54,02	1,07	4,59	0,28	7,88	0,14	0,73	4179,02	72,51	0,05	1,87
Skewness	0,63	0,79	2,23	-0,77	-0,03	-2,41	1,99	1,52	0,01	1,33	-0,43	2,28	1,44	-0,87	0,71	1,34	1,94	2,45	0,96	2,44	0,95	2,42	-0,19	1,80
Kurtosis	-1,51	1,36	4,99	-1,80	0,16	5,86	4,21	2,65	-2,09	1,16	-1,38	5,35	2,85	-0,56	1,33	1,56	3,75	6,00	-1,55	5,97	-1,48	5,90	-2,63	3,38
Outliers detected	no	no	yes	no	no	yes	no	no	no	no	no	yes	no	no	no	no	no	yes	no	yes	no	yes	no	no
First quartile (Q1)	68,32	-1,79	3337,32	-10,16	0,63	0,03	11,99	31,70	11,90	22,25	51,68	2,28	25,50	83,50	-1,70	30,00	0,16	0,07	0,04	0,04	1518,09	5,08	0,02	0,43
Median (Q2)	146,53	-0,60	3600,84	-3,51	0,69	0,04	22,85	53,95	35,00	35,00	102,15	3,50	31,50	130,00	-1,11	31,55	0,19	0,09	0,06	0,06	1649,52	7,08	0,07	0,97
Third quartile (Q3)	309,33	-0,04	4232,32	-2,56	0,73	0,11	37,65	75,75	44,12	68,75	109,88	5,25	35,25	154,00	-0,90	34,38	0,32	0,13	0,23	0,10	6715,20	13,13	0,11	1,78

Fig 14. Statistics for 2020. Source: Author's Elaboration

In order to sum up, it can be argued that there is a consistent asymmetry between countries for each year. Indeed, the kurtosis and the skewness are often high or very low for particular indicators. Such asymmetries are deemed to demonstrate that countries are strongly asymmetric, hence Italian policymakers should carefully adapt their analytical tool to assess local dynamics and their change over time. Within this framework, the asymmetries can be a source of major concern for assessing correctly the situation of suppliers of natural gas. Therefore, the next section will deal with the normalization and treatment of outliers.

3.3.5 NORMALISATION OF THE DATA AND OUTLIERS

As mentioned in chapter 2, the normalisation plays a central role before data aggregation. In fact, for aggregating different parameters, we previously need to standardize into the same scale the values of the factors. Within this framework, the COIN tool provides the possibility to set alternative methods for the normalisation process, and then it runs automatically the formulas according to a given framework. We have chosen the Min-Max transformation, hence the highest value between the given observations for each country would be assigned to the maximum score of 100, and the lowest will be graded with 0. The Min-Max formula relies on the mean and standard deviation, thus we have set the cluster with 50 as a medium score and 10 as the value of the standard deviation (a measure of how close to the mean value the actual data points are). Min-max normalisation is probably the most common approach. For a given factor X, the normalised scores x are calculated as:

$$x = \left[\frac{X - \min(x)}{\max(x) - \min(x)}\right] \times 100$$ (Becker et al., 2019)

The method represents a linear transformation, which scales values onto the interval [0,100]. The COIN Tool allows the user to adjust this range according to the preference of the user.

Once the framework (pillars, subpillars, and indicators), the directions of correlations and the respective weights for each indicator in relation to its aggregation group have been set correctly, it is appropriate to check the operations performed by COIN. On the page called "Statistics", we can observe an initial analysis of the input data. This tab is mostly descriptive and provides an overview of the statistical properties of the data, before any treatment. The user can check missing data, min/max values, mean and standard deviation, and whether outliers are flagged. The program sets by default the minimum indicator coverage percentage that is supposed to be higher than 65%. For each factor and year composing the dataset, we provided enough data in order to be always above the benchmark stated by the tool (Becker et al., 2019: 18). For some indicators (e.g. export of gas to Italy from Azerbaijan), the data were available but they presented zero value, hence the program has highlighted them with the orange color representing in the legend the “zero value”.

The program wants to detect and analyse the data for potential outliers for developing treatment. However, every outlier treatment method alters the original data, hence we have to ponder the choice of transforming the data only if necessary. We avoided tailored-made solutions such as using different methods to treat different indicators across the framework. The identification of the outliers is done according to the skewness and the Kurtosis analysis. In probability theory and statistics, skewness is a measure of the asymmetry of the probability distribution of a real-valued random variable about its mean. The skewness value can be positive, zero, negative, or undefined. The kurtosis index is one of the indices relating to the shape of a distribution, which is a measure of the 'thickness' of the tails of a density function, i.e. the degree of “flattening” of a distribution. We checked the default skewness and kurtosis thresholds which are used to detect distributions that may need treating. However, some of the data come from several countries characterized by different economic and energetic landscapes. For example, the data of Qatar in terms of per capita income are not statistical fluctuation concerning the normal distribution but they reflect the concrete reality of each country and their disparities, i.e. even asymmetries play a role in the development of composite indicators.

Detecting outliers is not straightforward, and many approaches exist. The COIN tool offers a simple univariate approach based on the moments of the indicator distributions, as well as quartiles. The presence of outliers is detected as “yes” or “no” in row 9 of the Excel file. An indicator distribution is defined as having outliers if its absolute skewness and kurtosis both exceed specified

thresholds. Default values for these thresholds are 2 and 3.5, respectively. The description of the quartile method has been discussed in the previous sections.

Some clarification can be useful for addressing the issue of the outliers detected because some consideration can help to clarify the nature of the sample used. Looking at the Statistics tab, we can see that the program identified 7 indicators presenting some outliers, namely: GDP per capita, Gas Export, Electricity Generation from Gas, CPI, Total Proved Reserves, Unemployment and Import Share from Italy. Most of the indicators are given by the different regional clusters of Qatar which is the country with the biggest amount of proven reserves worldwide and because of its strong GDP per capita. Another interesting outlier is represented by the gas reinjection which is heavily influenced by the technological capacity of the country to efficiently exploit its natural resources. As a matter of fact, a considerable amount of the gas extracted is used for maintaining the gas field. Because of this technical limitation, we included the gas reinjection factor in order to enrich our theoretical framework. As regards the political stability index, Qatar has a more stable political regime and the process of legitimation of the institutions seems to be consistently stronger respect to the world mean and respect for the other countries included in the sample. This variable plays a crucial role because Italy is expected to diversify its energy portfolio by relying on flat energetic indicators, i.e. the political risk must be involved in the trade-off between potential alternative suppliers from the Russian natural gas. Within this sample of countries, Azerbaijan between 2010 and 2019, is represented as an outlier as regards the "export of gas to Italy" because Baku started to export gas through the TAP pipeline only in 2019, hence the zero value was reported for that data for clusters 2010 and 2015.

At this point, the question arises as to how to deal with outliers even when these are induced by structural differences between countries. This question must be answered on a case-by-case basis, thus If the outliers are due simply to the shape of the distribution, care is required. Outliers are problematic because they fill the scale of the indicator with a lot of empty space, and the indicator will be dominated by the value of a few outlying points. On the other hand, many indicators are naturally skewed, and treating data represents a departure from measured reality.

The COIN provides the winsonorization technique aimed to mitigate the presence of outliers. Capping numeric outliers so they fall precisely at the edge of the main distribution (i.e. make them closer to the other observed values). Values distorting the indicator distribution are replaced by the next highest (pos. skew) / lowest (neg. skew) value, up to the point where skewness or kurtosis enters within our desired ranges as follows: skewness < 2 or kurtosis < 3.5 (Becker et al., 2019).

3.3.6 BOX-COX AND DATA MANAGEMENT:

Where indicators may have outliers, the COIN Tool successively reduces points until the skew and kurtosis fall within the thresholds supplied in the Statistics tab. The COIN can manage up to a maximum of 5 winsorized points per indicator. The treated results are displayed in the TreatedData tab.

Winsorisation is the process of replacing outliers with the closest non-outlying value. The method is usually used in the presence of a few outlier values. For each indicator, the COIN Tool iteratively winsorises outlying values, up to a specified maximum number (defaulting to five values), until the skew and kurtosis are within the specified thresholds. If winsorisation does not bring skew and kurtosis within thresholds, the COIN Tool will advise the user to address the transformations in the Box-Cox. The program considers if the skewness is left or right-distributed, and then it tries to perform a number of possible operations.

If the indicator cannot be successfully winsorised, the Box-Cox row will show a "1". The process is unsuccessfully tracked if the skewness and the kurtosis after the process are still higher than the threshold provided. The table shows a new row with the value of the indicator with the new skewness and kurtosis. Within the cluster of 2010, seven values have not been successfully winsorised, hence the COIN used the Box-Cox operations. To offer alternative data treatment for indicators that cannot successfully be winsorised, the Box-Cox table provides some transformations in order to overcome this issue. During this phase, the user is not required to add any type of input even if it is supposed to understand the logic of the transformations performed by the programme.

The first column is the untransformed data (also with no winsorisation). The following three columns are as follows (Becker et al., 2019: 24):

i) The natural log transform with minimum zero, i.e. $new\ value = \ln\ [X_i - \min(X_i) + 1\ ]$.

ii) square root transformation (SQRT) such that new min = 0, The square root transforms with minimum zero, i.e. $\sqrt{x_i - \min(x_i)}$;

iii) The log-median transform (LNMED) forces the minimum value to zero and the median to be equal to the mid-range value. This implies that in most cases skewness and kurtosis will be within the defined thresholds. It is defined as: $100\ \ln(1 + ax_i) \times (1 + 100a)$.

Where $a = 100 - \frac{2x_i}{x_i^2}$, hence $\tilde{x}i$ is the sample median, and in all cases, the xi are previously scaled onto [0,100][11].

In the Excel file, on the Box-Cox page, Row 7 indicates which indicators still present problems for each transformation. Each of the four columns per indicator (original value, log transformation, sqrt, and log median transformation) are reported on this page and the new skewness and kurtosis values are automatically reported. The program conserves the possibility to colour in red such indicators that are still exceeding the set thresholds, otherwise, the transformations are automatically carried over to the next tab.

3.3.7 DISCUSSION OF THE CORRELATIONS

Correlation illustrates the relationship between indicators and aggregations, and this step plays a central role in the development of the composite indicators. The correlation method is the Pearson's coefficient that is used in statistics as a measure of the statistical relationship, or association, between two continuous variables. It is based on the method of covariance, hence this coefficient is typically used for jointly normally distributed data that follow a bivariate normal distribution. In correlated data, the change in the magnitude of 1 variable is associated with a change in the magnitude of another variable, either in the same (positive correlation) or in the opposite (negative correlation) direction (Becker et al., 2019).

We monitored negative correlations between the same subpillar and high collinear correlation in order to enhance an effective process of aggregation. In fact, high collinearity (i.e. 0.92) can be considered as a double-counting because they could share the same information to the total aggregation. Otherwise, a negative correlation within the same subpillar could lead to some issues during the aggregation. The IndCorrel Tab shows the correlation between indicators, the values of the Pearson correlation coefficients take into account the effects of the direction. Correlations are taken from the final data set selected in the TreatedData tab. In this tab, the correlation values are not dependent on the normalisation and aggregation methods. The correlation matrix helps to spot issues with the way that indicators are associated. In the ideal case, indicators would all be positively well-correlated, but not so strongly correlated that they are collinear.

[11] Here, the formula implemented on Excel: new value = 0.5 [ln [1 + (old value – min) (max + min – 2 sample median) / ((sample median – min) ^ 2)] / ln [(max – sample median) / (sample median – min)] * direction + 0.5 (1 - direction)

The threshold values for high and negative correlations, and high and positive and highly collinear indicators should be checked for avoiding double-counting or other issues, hence the value with suspicious outcomes assume generally -0.5, 0.5, and 0.92. These changes made by the users are reported by the correlation matrix. As regards negative correlations, especially within the same sub-pillar, we should consider the hypothesis to change the direction of the indicator in order to test the new correlation because by reversing the correlation in the input table (Database Tab) we can discover an underlying connection between the same and another level of aggregation. Otherwise, *a persistent negative correlation, especially between indicators in the same pillar and subpillar, could mean that the user would have to move the factor to another subpillar or another aggregation pillar*.

However, *the theoretical framework can involve some negative correlations between the index and certain factors. Indicators can be negatively correlated one each other and of course with the highest value of aggregation represented by the composite index*. The implications of these hypotheses will be discussed in the appropriate section where we will check the implications in terms of indicator correlation with the overall index and the other aggregation levels.

3.3.8 REBALANCING TAB

The following section aims to provide a deep understanding of the dynamics that users can face after the development of the correlation matrix discussed in the previous section. After the correlation matrix between indicators, the COIN requires to manage the rebalancing tab. This tab illustrates the correlations between each indicator, sub-pillar, pillar, and sub-index, and aggregation levels above it. It can be argued that this function plays a central role in rebalancing the framework according to empirical observation. As matter of fact, we had the opportunity to adjust weights based on the information provided by the tab, i.e. new weights for each indicator and aggregation level has been developed, hence we adjusted the point with a low-correlation parameter. While the IndCorrel tab shows the correlations between indicators, the Rebalancing tab shows correlations between each indicator, sub-pillar, pillar, and sub-index, and aggregation levels above it. In order to provide an example, the table named “INDICATOR” shows the correlation of each indicator with its sub-pillar, pillar, sub-index, and index. Each table also shows the initial indicator weights and has a row of “adjusted weights” which can be entered by the user. Then, It shows the correlations based on the initial weights, as well as those based on the adjusted weights.

Although the broad consideration of the concept represented by the indicator weight and its initial intuitiveness makes it one of the fundamental tools for aggregation, this straightforwardness

betrays several considerations that could prove to be elucidating the theoretical scope of this concept. Indeed, the discussion on the weights deserves special interest because It involves several theoretic implications. A common misconception in composite indicators is that by assigning equal weights to indicators, we are giving equal importance to each indicator of the cluster. However, it can be argued that the conventional definition of "importance" seems to be ineffective in tackling the statistical reality. The final effect of each indicator is dependent not only on its weight, but on its correlation with other indicators, and their weights. One way of measuring importance is to use the correlation coefficient of the indicator with the index. In other words, "*a high correlation means that the index contains much of the information in the indicator, whereas a low correlation means the opposite*" (Becker et al., 2019: 31).

Some critics can state that we need ideally to develop an index that contains a balanced contribution of information from each indicator. This implies that correlation values (between indicator and index) should be roughly similar. Otherwise, the index is much more representative of some indicators than others. The same argument applies to weighting sub-pillars, pillars, and sub-indexes. During this process of rebalancing, we adjusted weights accordingly to the correlations in order to maximize the information contribution coming from each level of aggregation. In order to achieve a good balance, sometimes the weights may have to be very different from each other, and this may be difficult to communicate to users of the index. It may be preferable to strike a compromise between statistical balance and a simple weighting scheme.

3.4.1 HYPOTHESES TESTING ON THE RESULTS

This section will comment on the outcome after the process of development of the composite index. Indeed, after the input, the process of the outliers, the correlation management and the rebalancing, the development of the index is concluded. The COIN visualizes the results of the composite indicator in order to show the rankings between the countries included in the sample. The same process has been performed for 2010, 2015, and 2020. The aim is to comment on the results of the index by assessing each dimension considered and how different subpillars have been graded according to theoretical considerations. In order to clarify the comment, we can identify some hypotheses that we expect to verify through the empirical results:

i) A Geopolitical crisis can decrease the level of political commitment to long term energy relations ;

ii) Economic development mitigates shocks and can help to ensure the long term commitment of the country;

iii) The domestic energy demand can affect the long term energy supply side of the country;

iv) Do the policymakers of the analysed countries behave ambiguously to protect dual interests with both Italy and its competitors?

3.4.2 COMMENT ON RESULTS 2010

Heatmap of scores

Rank	Unit	GESI	GESI	Economy	Energy	Socio-political	Relation-ITA
Rank	Unit	Index	si.01	p.01	p.02	p.03	p.04
1	QAT	89,41	89,41	82,23	92,42	92,76	80,58
2	NIG	51,01	51,01	28,90	50,74	61,75	98,66
3	ALG	47,89	47,89	45,50	54,11	32,20	70,41
4	AZB	44,22	44,22	53,87	44,27	39,32	24,72
5	LYB	40,84	40,84	57,09	39,93	24,00	50,52
6	EGY	32,93	32,93	38,78	18,67	53,26	42,30

Figure 15. GESI 2010. Source: Author's Elaboration

The objective of the composite index is to measure the geopolitical stability of a country exporting natural gas to Italy. Some pillars scored zero because it has been established as default during the normalisation process, i.e. the highest value of the series gets 100. Each pillar comes from the aggregation of different dimensions that are the subpillars and each of them is composed by multiple dimensions able to explain its concept.

The GDP and other dimensions are taken from macroeconomics can be influenced by the size of the economy, i.e. more populated countries tend to perform better because they are higher in absolute terms. The economic pillar is positively correlated to GESI because a process of high economic growth provides appreciable stability to geopolitical stability and the reliability of the energy sector. Indeed, more resources generate higher investments in the sector that can boost economic development such as the energy sector. In addition, a strong economic performance can suggest that domestic energy security is ensured. The correlation is explained also on the opposite side because more energetic security means higher return from the export of natural gas.

Fossil fuel exporting countries such as Qatar are named by the literature as *rentier* states, i.e. they rely too much on fossil revenues exported and other domestic baskets of goods are totally imported. As a result, a decrease in oil and gas prices can harm the demand and the flows of dollars in their economic systems, otherwise, the importation of products and services remains the

sustainment of the population, hence these dynamics brought to a loss of international competitiveness and a negative current account balance.

Qatar scores better than the rest of the sample and it almost doubled the second-best performance made by Nigeria. Qatar shows a significant superiority in economic, energetic, and socio-political terms even if it is close to the median value of the fourth pillar final score. Until the end of 2010, Libya performed well in terms of economic stability concerning other North African countries. The North Africa region shows a critical profile of risk, i.e. the third pillar of the GESI shows the criticalities of the last socio-political environment before the Arab Springs, hence the aggregation shows significant explanatory power of the geopolitical landscape. For example, Egypt, Libya and Algeria were less stable because of the Arab Springs[12], hence the social discontent harmed the stability of local institutions. Indeed, the riots, protests, and violent guerrilla action of certain branches of the population had challenged the capacity of local institutions to fulfill their international obligation, hence their prerogative was often eroded or paralyzed by the circumstances, thus even energy companies showed significant limitation in their extracting capacity. As regards Azerbaijan, in 2011 some revolts caused by corruption, unemployment, low wages, political differences, and political repression have deeply shaped the political arena, hence the GESI shows how social issues can create a security and stability problem that affect the overall indicators. Dealing with the energetic standpoint, it can be argued that Qatar played one of the major roles in terms of gas supply worldwide, hence the score of Doha is inevitably higher rather than the other countries in the sample. Algeria has a positive energy outcome and it exploits its resources intending to sustain both the energy demand and the export. Looking at the relationship with Italy, Egypt scored worst than the others, probably because of the strategic and economic bilateral partnership with Russia.

Rank	Unit	Growth	Country Competitiveness	Economic Speed	Gas Export	Extractive capacity	Gasification of Electricity	Reserves	Normative landscape	Social Stability	Social Discontent	Bilateral Trade	Italian Influence	External Actors Involvment
		sp.01	sp.02	sp.03	sp.04	sp.05	sp.06	sp.07	sp.08	sp.09	sp.10	sp.11	sp.12	sp.13
1	QAT	60,56	86,12	100,00	100,00	100,00	81,05	100,00	78,28	100,00	100,00	64,60	6,44	96,55
2	NIG	77,74	8,96	-	20,24	13,91	89,47	60,30	51,01	46,30	87,93	97,32	-	100,00
3	ALG	18,55	50,05	67,90	42,13	57,33	63,16	23,33	73,84	14,14	8,61	57,08	51,59	83,75
4	AZB	5,54	86,76	69,32	3,05	0,28	100,00	29,70	25,13	39,51	53,31	7,25	0,98	42,18
5	LYB	2,54	78,96	89,77	-	-	86,32	40,51	9,02	25,17	37,81	34,96	0,61	0,61
6	EGY	34,77	28,73	52,84	8,66	40,15	-	15,22	83,13	29,12	47,51	60,11	87,04	24,49

Figure 16. GESI Sub-Pillars 2010. Source: Author's Elaboration

[12] The Arab Spring was a series of anti-government protests, uprisings, and armed rebellions that spread across much of the Arab world in the early 2010s. It began in response to corruption and economic stagnation and was first started in Tunisi.

However, it is important to look at the specific subpillars for developing an effective picture of reality:

QATAR: there are no criticalities with the economic and the energetic subpillars, the country scored better almost in all the domains even if there is not perfect energetic efficiency for what concerns the gasification of electricity. From the Italian point of view, the influence of Rome (by 2010) is low with respect to other long terms allies such as Algeria. Concerning external influence, there are no relevant criticalities to detect in terms of Russian or Turkish influences.

NIGERIA: There is an important economic growth that generally creates more stability. According to the theory of economic liberalisation and openness, economic growth can boost the stability of the country because the openness of economies generally permits the country to exploit its competitive advantages such as low labour costs, natural resources, and poor environmental regulation, and FDI coming to the rest of the world. However, the real and structural reason for labour productivity is the Human development index that integrates the level of education with economic development and a higher quality of life. Probably, the economic data taken in absolute terms, can not completely represent the real development of the country, i.e. Nigeria has a huge population and the gross measures are higher than other counties, however, the other sub-pillars involve a critical aspect such as low country competitiveness, high inflation, and low HDI. It can be argued that the theoretical framework of the GESI helps to detect several perspectives on broad and complex phenomena, without losing the specificity of the analysis that is reduced by the use of superficial measures such as GDP. By 2010, Nigeria's gas had a low exporting capacity, hence the feasibility and the attractiveness of the country were lower. As a result, the Italian FDI was lower because the competitiveness and attractiveness of the economy were low, even if there was a high bilateral trade.

ALGERIA: Algeria scored better than others in terms of extractive capacity because the country did an important amount of investments in the energy sector, particularly on the upstream side of the supply chain. Despite this fact, there are higher levels of gas reinjection in the fields with respect to the volumes of other countries. The energy sector for exporting countries affects the economic growth and the index of human development, especially if we have high exports of natural resources. The reinjection can reduce the final export capacity, i.e. the number of foreign reserves aimed to sustain the economic growth. However, the degree of affinity between Algeria and Italy is appreciable because Rome used to be a long-term customer of Algeria's natural gas (through the Enrico Mattei Pipeline). Foreign actors' involvement seems to be balanced and they do not represent a considerable menace to the Italian stakeholders.

EGYPT: The country has low economic growth and the competitiveness of the economy is less than the average, hence there is low HDI. In addition, Egypt was a dynamic and fast-growing economy with more population respect to other countries in the sample. As a result, the domestic demand for natural gas is high and the local production is deemed to meet this demand, i.e. the export is lower. Looking at the socio-political aspect, as for the other Islamic countries, Egypt registered a low level of political stability and a high level of discontent. In terms of foreign policy, there is a significant influence and interdependence with Russia, especially from the side of food security. By 2010, Italy had developed commercial ties because of the fast-growing economic cycle and the strategic position of the country. However, it is interesting to note that Egypt remained more stable than Libya and Algeria. In fact, the first protest in Egypt started in 2011, hence the third pillar shows the "temperature of the social turmoil" of the Arab Springs. The level of social discontent can impact the legitimation of institutions and Algeria and Libya showed significant levels of risk and popular discontent from which protests were fed.

LIBYA: The country has long been divided between various ethnicities and groups including North Africa's indigenous Berber inhabitants, Arabs who arrived later, and ethnic African tribal groups from further south. Cultural divisions between its two major cities of Tripoli and Benghazi[13], i.e. there are up to 140 tribes. The regime of Muhammad Geddaffi was used to stabilize the context before the civil war, even if by 2010 there was significant social instability and the level of discontent against institutions was considerably high. The country had solid bilateral relationships with Rome, i.e. the gas supply was affecting the Italian foreign policy.

AZERBAIJAN: it performed poorly in terms of external actors' involvement (last sub-pillar) because in 2010 the Russian and Turkish influences were stronger than now (especially the Russian Federation's projection of power), and the Italian government had not already built solid diplomatic, commercial and energetic relationships. As a matter of fact, the index assigned the lowest value to the country with the strongest economic ties with Russia and Turkey, e.g. Egypt shows significant trade relations with Russia and Nigeria registered the lowest value. In addition, Azerbaijan remained for a long time under the geo-economic influence as a former soviet nation (see chapter 2). Within this framework, it can be argued that offering alternative energy routes and access to new markets can strengthen the GESI score of countries. Hence, one policy suggestion can highlights the importance of interconnectivity and investments in new supply routes in order to overcome Russia influence on the country. Higher investments from Italy can enforce the national interest and at the same time reduce the international projection of influence of Moscow.

[13] This fragmentation can be traced to before the Romans.

The data shows that the significant losses of the exporting capacity to fulfill long-term energy supply can be caused by high energy inefficiency. In order to sum up, the sampled countries present some profiles of risk detected by the GESI. The social turmoil and poor economic performance have demonstrated significant correlation, hence there is a significant body of literature that describes the economic disruption as the main root of the Arab Spring. The GESI help to assess to which degree the variables change one other, i.e. this procedure helps to highlight the existence of the underlying phenomena named geopolitical and energy security risk.

3.4.3 COMMENTS RESULTS IN 2015

Heatmap of scores

Rank	Unit	GESI	GESI	ECONOMY	ENERGY	SOCIO-POLITICAL	RELATION-ITA
Rank	Unit	Index	si.01	p.01	p.02	p.03	p.04
1	QAT	84,61	84,61	91,30	88,00	87,93	80,15
2	ALG	55,97	55,97	31,51	50,40	31,95	73,98
3	NIG	48,29	48,29	45,87	51,88	50,22	47,26
4	EGY	44,27	44,27	50,13	26,07	18,33	57,03
5	AZB	34,43	34,43	18,83	47,83	47,39	30,85
6	LYB	31,81	31,81	21,77	41,67	4,85	40,86

Figure 17. GESI Sub-Pillars 2015. Source: Author's Elaboration

The same process has been reiterated for 2015, and some interesting findings can be reported. As regards the maximum and the minimum value, Qatar scored better than the rest of the sample and Libya provided the worst outcome. After the Libyan civil war of 2011, which led to the overthrow of the Gaddafi-controlled regime, no alternative state entity or institutional system emerged, resulting in large-scale instability. Since the colonel, no other political leader has managed to hold together the country's different souls represented by the historical cleavage between Tripolitania and Cyrenaica where ancient tribes struggle for control of the territory and its resources. As a result, the energetic, economic and socio-political pillars provide very low values. The GESI for Libya is the lowest of the sample, hence it reflects the geopolitical situation that used to characterize the Libyan scenario a few years after the collapse of its institutions.

As regards the economic pillar, Qatar performed better than other countries because the economic oil and gas prices were higher respect 2010, hence the total revenues boost the economic growth. As a matter of fact, by 2015, Qatar was the only country with a positive current account (i.e. current account surplus % to GDP) because energy prices ensured constant cash flows inward the

country. In addition, the human development index and private consumption produce positive externalities on economic growth (higher level of aggregation) and the higher energy prices make the balance of payments positive. Azerbaijan seems to have the weakest economic power, the GESI reflects this critical aspect.

From an energetic standpoint, Algeria was the second-best exporter of natural gas and its energy sector demonstrated to be more solid with respect to other countries in the sample. Relations with Italy are positive because of important long-term energy relations and other bilateral trade partnerships. There is no significant influence of Russia on the country, i.e. it means that Algerian institutions share more stakes and advantages from building positive cooperation plans with Italy rather than external actors because of the long-term energetic partnership (through the Enrico Mattei Pipeline) and other trade relations. Looking at Egypt in 2015, the country has strongly reduced its energy export compared to 2010 because of its growing domestic demand. As a matter of fact, the Egyptian economic system presents several advantages such as: a well-diversified industrial base, Abundant cheap labor costs, relatively-developed infrastructure base, and strategic position in terms of geostrategic international interests (e.g. the Suez Canal is controlled by Egypt), low cost of production inputs (energy and utilities). Indeed, these factors have brought to a fast-growing environment, hence the energy demand for domestic consumption skyrocketed.

The social forces can shape the political environment in particular if we have a young population, with a high fertility rate and a weak economic system, i.e. social stability and local politics can be negatively affected.

	Growth	Country Competitiveness	Economic Speed	Gas Export	Extractive capacity	Gasification of Electricity	Reserves	Normative landscape	Social Stability	Social Stability	Bilateral Trade	Italian Influence	External Actors Involvment
	sp.01	sp.02	sp.03	sp.04	sp.05	sp.06	sp.07	sp.08	sp.09	sp.10	sp.11	sp.12	sp.13
QAT	65,21	100,00	100,00	100,00	96,44	74,75	100,00	69,83	100,00	100,00	100,00	41,54	98,91
ALG	17,36	31,26	38,70	34,91	61,20	49,49	22,58	31,40	26,52	35,22	26,52	100,00	91,85
NIG	78,50	81,47	11,75	21,91	14,22	89,90	60,65	14,05	38,16	92,43	49,68	3,46	88,63
EGY	79,23	41,11	40,09	0,19	58,66	-	12,95	18,18	18,28	18,50	94,31	46,18	30,60
AZB	4,98	44,91	12,72	6,16	5,27	100,00	29,70	61,82	26,56	43,36	56,51	0,93	35,10
LYB	-	-	43,53	-	-	88,89	37,09	10,74	2,75	-	-	46,32	76,26

Figure 18. GESI Sub-Pillars 2015. Source: Author's Elaboration

An insight into the level of aggregation within different subpillars can help to tackle the changes that occurred within the countries in the sample.

QATAR: the country scored better than the rest of the sample in all of the dimensions implied by the subpillars. As a matter of fact, it gets the highest GESI rank. It can be argued that Qatar performed poorly if compared to other countries in terms of the "Italian Influence" subpillar, hence

the degree of investments in Doha and the total amount of gas exported to Italy was lower with respect to other countries. As a matter of fact, the Italian import portfolio is characterized by high dependence on pipeline transportation. The Italian energy sector established its dependence on pipelines because it is cheaper and cost-effective in terms of competitive advantages. As regards social stability, normative landscape and social turmoil, it can be argued that Qatar successfully established a long-term business-friendly environment in order to attract foreign capital and diversify the sources of revenue of the country.

ALGERIA: The country presents several aspects of criticalities, especially in terms of social stability, economic growth and the development of a favorable business environment. Indeed, foreign companies tend to invest in countries where there is stability and where property rights and the enforcement of contracts are ensured by the institutional framework. It can be argued that the Algeria energy sector would have benefitted from the development of a stable legal framework where FDI is protected. Algeria should improve its regulatory framework in order to maintain its upstream sector productivity and meet the growing domestic and international demand. The scores of the fourth pillar and related sub pillars show that Italy is one of the main partners of Algeria, hence further economic and political relations can be easily strengthened for ensuring mutual interests.

NIGERIA: the GESI reports a decrease in the geopolitical and energetic security of Nigeria. As a matter of fact, Nigeria performed poorly in terms of energetic output, hence there is no profitable amount of resources to export and most of the marketed production is deemed for the fast-growing domestic demand. Energy consumption tends to increase in developing countries and this phenomenon can potentially harm the security of supply (SOS) of developed countries such as Italy (see chapter 1 for the theoretical explanation from the literature). As a consequence, the increase in domestic demand can reduce the capacity of a country to fulfil long-term contracts of gas supply to importers. Within this framework, GESI successfully tackles this energetic turnover and its implication for the energetic policies that shape the geopolitical scenario. In addition, there is no significant

EGYPT: Social stability (e.g. protests and Arab springs), high Russian influence (captured by the Russia trade relations), and the weak energetic sector have declined the score of Egypt respect 2010. Since the 1950s, the Cairo has established strong political partnerships with Moscow and the economic relations remained a constant between the two countries bilateral relations. As a matter of fact, the Egyptian leadership shows relevant stakes with Russia such as weapon export and the food cooperation, i.e. Moscow is one the biggest exporter of wheat to Egypt, hence the economic and food security can be dramatically hit by eventual disruption. Therefore, the energy efficiency is weak

because the levels of gasification of electricity are very high and consequently the domestic needs for highly populated countries seem to climb to significant levels.

AZERBAIJAN: By 2015, Baku remained weak and underdeveloped, i.e. its energetic sector seems to be highly reliant on Russian infrastructure (see chapter 2), hence there is no national sovereignty. In addition, because of cultural, energetic, and historical similarities, Azerbaijan felts under the influence of Turkey in order to balance (or even start to dismantle) the influence of Moscow in the country. As a consequence, the fourth pillar, through the third subpillar of the related aggregation group, shows the political influence of external actors involved in the region. It can be seen that Italian influence is the weakest indicator of the total index.

LIBYA: Tripoli performed very poorly because of the domestic situation given the civil war that is still going. No formal or informal actors have gained significant influence in order to manage the economic landscape. The energy export is very low because several infrastructures were damaged and some oil and gas fields fell under the control of opposing factions, hence the economic recovery provided the export of fossil fuel failed to be accomplished. Even Italian influence started to decrease because the new political actors established strategic partnerships with Russia and particularly Turkey. It can be argued that since 2015, Ankara improves its efforts in the Mediterranean area because of the Neo-Ottoman strategic design promoted by the Turkish President Recep Taypp Erdogan.

By 2015, the GESI detected some common patterns of interaction for measuring the geopolitical and energetic stability of alternative gas suppliers towards Italy. The Arab Springs, the ongoing process of economic development of many countries, and the renewed projection of power of Russia and Turkey have affected the reliability of the energy suppliers. It can be argued that Italian decision-makers have to monitor ongoing structural phenomena of political and economic changes in order to understand which suppliers were more reliable. As mentioned, the critical geopolitical scenario could have influenced the Italian government and energy companies to disregard alternative suppliers since Russian gas was more reliable because of the political stability.

3.4.4 COMMENT ON RESULTS FOR 2020

The latest geopolitical rate of the sample country can be provided thanks to the GESI framework applied to the data.

Heatmap of scores

Rank	Unit	GESI	GESI	Economy	Energy	Socio-Political	Relation-Ita
Rank	Unit	Index	si.01	p.01	p.02	p.03	p.04
1	QUA	70,62	70,62	72,54	83,89	87,68	49,12
2	EGY	58,32	58,32	63,46	24,66	54,86	79,64
3	NIG	49,52	49,52	56,93	58,15	26,09	54,45
4	ALG	48,58	48,58	35,76	42,01	59,56	54,20
5	AZB	31,66	31,66	47,57	48,29	19,86	17,84
6	LIB	24,77	24,77	14,24	41,82	30,31	16,73

Figure 19. GESI 2020. Source: Author's Elaboration

Looking at the outcome, it can be argued that Qatar scored better than other countries' samples even if it got a medium score in the fourth pillar of international relations with Italy. From the geopolitical perspective, we can see that Azerbaijan and Libya were deeply influenced by Russia and Turley. In particular, Ankara projected its influence on the country, i.e. it deepened its economic activities and bilateral trade with Baku. In addition, Turkey provided its military support to Azerbaijan in the Nagorno Karabac war against Armenia. From the energetic perspective of the energy sector, the development of TAP has boosted the Azerian independence from Russian infrastructures even and at the same time, it ensured Turkish energy security because the pipeline passes through its territory. As a consequence, by increasing the gas export from Azerbaijan, Italian decision-makers have to take into account the political return of Turkey as well as more influence on Rome.

Within this framework, the same analysis can be applied to the Libyan scenario where both Russia and Turkey are involved. For example, Russia supported the Eastern militias ruled by General Khalifa Haftar, i.e. the private military company Wagner Group is operating in the Libyan wars in order to gain political advantage and ensure the Moscow's influence in the Mediterranean. In contrast to the Moscow strategic projection, the Turkish armed forces were deeply involved in favor of the internationally recognized government of Al Serraj in Tripoli since 2020. As a matter of fact, the two power has developed an appreciable sphere of influence that can harm the Italian military security in the Mediterranean. It can be argued that the US has incentivized Ankara to intervene in Libya in order to balance the growing Russian influence and consequently reduce the political return for the factions supported by the Kremlin. Within this framework, Italian decision-makers have to deal with a split

country that can influence the free flow of energy sources (especially gas) according to political claims against Rome. The current balance of power in the region is the effect of the substantial retirement and unwillingness of the Italian leadership to manage a concrete policy of stabilization and development of a strategic partnership with Tripoli. In geopolitics, each space left is immediately occupied by another actor, i.e. there is a strong correlation between external actors' involvement in sample countries and the GESI (geopolitical energy security index).

	Growth	Country Competitiveness	Economic Speed	Gas Export	Extractive Capacity	Gasification of electricity	Reserves	Normative Landscape	Social Stability	Social Discontent	Bilateral Trade	Italian Influence	External Actors Involvment
	sp.01	sp.02	sp.03	sp.04	sp.05	sp.06	sp.07	sp.08	sp.09	sp.10	sp.11	sp.12	sp.13
QUA	15,39	92,34	100,00	100,00	77,25	72,81	100,00	81,52	100,00	n/a	70,18	27,12	50,05
EGY	91,93	40,25	69,81	-	64,30	-	12,13	67,39	29,81	n/a	63,82	29,81	83,20
NIG	62,53	71,84	28,97	23,59	22,85	93,86	61,21	23,91	30,46	n/a	96,58	7,81	58,96
ALG	40,33	0,43	84,19	29,33	57,93	47,37	22,02	67,39	43,89	n/a	69,75	76,51	16,34
AZB	27,62	51,31	61,91	8,42	8,15	100,00	40,71	14,13	31,32	n/a	7,72	26,77	19,02
LIB	20,89	1,83	26,20	6,91	-	94,74	34,22	42,39	6,13	n/a	6,13	15,94	4,22

Figure 20. GESI Sub-Pillars 2020. Source: Author's Elaboration

In order to clarify the effective structural changes of the sample, we will discuss the findings in terms of analysis of the subpillars. The social discontent scored “n/a” because the indicators were high collinear with respect the pillar, hence they got zero weight in the aggregation in order to avoid the double counting.

QATAR: It is interesting to highlight that Qatar scored worst for the first time in this analysis. It can be argued that the covid-19 outbreak was substantially the reason why Doha performed poorly with respect to the other countries. In 2020, the world experienced negative prices for fossil fuels, thus many producers of oil and gas started to pay operators able to stock the overproduction that was produced according to the plans of the OPEC+ quotas. However, the global economic lockdown, even if asymmetric in terms of restrictive measures depending on the country, has crushed the global demand of fossil fuels. According to the experts, this phenomenon represents an unusual trend because generally, the energy product basket has a very rigid demand, so despite considerable price increases, the share demanded by the economy remains stable at considerable levels. This unprecedented circumstance has hit fossil fuel exporting countries hard with obvious effects on GDP and per capita wealth. Economic speed involved the inflation index, it can be argued that high

inflation is given to the depreciation of energy prices worldwide. Revenues from gas and oil are expressed in the dollar and subsequently, the Central Banks turn them into local currency in order to maintain or stabilize the value of the local currency. A lower value of the export means less currency reserved, hence the local currency tends to depreciate with respect to foreign benchmarks. As a consequence, countries such as Qatar with high imports of goods and services and weak local production will pay more for foreign goods, i.e. the prices skyrocket. Italian influence with Qatar has been reduced by the major involvement of Turkey. In fact, Baku and Ankara developed a long-term strategic partnership, i.e. they support the Muslim Brotherhood in the MENA region in order to expand this ideology and their network of political commitment against other countries of the region. In particular, Turkey is providing military means and protection to Qatar and its commercial ships and Qatar financially supports the public expenditure of the Turkish government. Bilateral exchanges with Turkey are strong and they reduce the political will to help Italy in its diversification strategy of gas in terms of long period political and economic commitment. In addition, Italy has no financial leverage on Qatar and the historical energetic outcome relation is not particularly favorable because Italy imports most of its gas via pipeline and Qatar exports mainly via LNG.

EGYPT: Cairo remained one of the most stable countries in the MENA region and its degree of political stability is even higher than some Sub-Saharan countries such as Nigeria in the sample. However, long-term political stability is not enough for the GESI. In fact, the stability does not reflect the effective capacity of the gas sector to supply the effective amount of resources that can strengthen Italian energy security. The gas sector experienced growth even if there is a strong domestic demand and further investments are still needed. lockdown policy reduced the extractive capacity, hence Egypt should demonstrate to first stabilize the domestic needs and then open to the export of natural resources. Within this strategy, the development of the Zohr gas field[14] can incentivize further investments in the upstream sector. In terms of foreign relations, the trade between Rome and Cairo are positively oriented despite some diplomatic friction over the last years.

NIGERIA: The country demonstrated to be very resilient if compared to the rest of the sample, e.g. its domestic growth has been only partially eroded by the Covid-19 outbreak. It can be argued that Nigeria developed a more resilient economic sector because of industrial diversification, hence the shock was partially managed and significant damages have been avoided with respect to other energy export-oriented countries. Bilateral trade between Italy and Nigeria is appreciable even if Italy does not have relevant import of LNG from Nigeria, thus there is no significant presence of FDI outward from Italy to Nigeria in order to enforce bilateral economic partnerships. Dealing with

[14] The Zohr gas field is an offshore natural gas field located in the Egyptian sector of the Mediterranean Sea. The field is located in the Shorouk concession, a concession with an area of 3,765 square kilometres which was won by Eni in 2013.

external actor involvement, it can be argued that Nigeria does not show particular attraction for Russia and Turkey, hence this aspect can be explained by geopolitics, i.e. geographic distance. The development of long-term partnerships goes beyond the immediate strategic stakes of Russia and Turkey because they mainly projected their influence on weak African states or in the MENA region with the aim to ensure their national security strategy. As a result, Nigeria does not represent an immediate stake in the actors.

ALGERIA: the country plays a central role in terms of gas supply to Italy, thus Rome and Algeri show significant similarities in terms of cooperation. Because of the low energy prices, Algeria experienced the same phenomena Qatar suffered. In fact, high inflation is caused by losses from the energetic revenues exported to the rest of the world. Algeria shows a competitive normative landscape if compared to the rest of the sample (excluded Qatar), and the enforcement of contracts is assured by the legal framework that protects the FDI, especially in the gas sector. As a matter of fact, the new legislation in terms of legal property rights protection has boosted the country's competitiveness with the aim to attract foreign capital. As mentioned in chapter 2, Algeria's energy demand tends to be incremental by the next decade and the production capacity seems to be stagnant, hence the country needs to stay competitive in order to preserve its market share or even expand it. Within this circumstance, the government aims to attract FDI for increasing exploration and the upstream capabilities of the gas supply chain. As regard relations with Italy, Turkey and Russia maintained their influence, especially with Moscow's export of weapons. However, local policymakers do not want to quit the quota of export and economic partnership with Italy because dealing with everyone is highly profitable as explained by the sub pillar named "Italian influence". Hence, the hypothesis of the ambiguous and acrobatic policies of gas suppliers is confirmed.

AZERBAIJAN: Even if the Russian influence decrease, the Turkish proportionally expands its quota in Baku's behavior. The economic and military support between Ankara and Baku seems to be overwhelming each possible advantage offered by Italy. However, through the TAP pipeline, Rome and Baku deepened their bilateral ties and Italy improved its energy diversification strategy. As a consequence, the export of gas to Italy represents important financial revenue for the country, in fact, Italy has improved its effort for building new infrastructure and exploiting this new alternative route with respect the Russian gas. Indeed, the Italian government accepted new alternative routes even if Azerbaijan provides more expensive gas, i.e. the strategic perspective prevailed over the economic one. In addition, Azerbaijan shares a willingness to deepen the energy relations with Italy, such as the construction of an additional pipeline in order to double the TAP. However, there are some criticalities because the economic development of Azerbaijan is limited by a rigid legal framework for FDI and widespread levels of corruption.

LIBYA: it is crucial to recall the complex geopolitical context characterizing the Libyan chessboard. The country is essentially split in two with two distinct and competing governments and very often dangerous collisions are generated between the authorities in Tripoli and those in Tobruk. In fact, the export of hydrocarbons cannot be guaranteed in terms of constant flows and there are high levels of political violence that can involve the extraction of resources from underground. Because of this geopolitical instability, bilateral trade with the Italian economy is very low and energy flows are not safely ensured. Indeed, a strong reliance on Libyan export could lead to insecurity of energy supply, hence the GESI provided this assessment for the risk mitigation of the Libyan scenario.

3.4.5 A GENERAL OVERVIEW AND DISCUSSION OF THE FINAL OUTCOMES

The following section aims to analyse the outcome of the GESI in relation to the theoretical framework developed. *Concerning the GESI, the index aims to analyse the geopolitical stability of the country with particular attention to gas export towards Italy. The GESI assesses structural dynamics that can increase or mitigate risks for the security of supply. Within this framework, the composite index can be a policy tool for strengthening the Italian energy security strategy with the aim to reduce gas dependence on Russian flows. The GESI answers the following question: which countries are more reliable in terms of geopolitical stability of long-term gas supply to Italy?*

However, the energy aspect alone is not able to provide a clear and complete picture of the broader puzzle, hence the GESI is composed of four pillars in order to tackle the complex phenomena. Each pillar is a proxy measure and the correlation among multiple dimensions from different frameworks can suggest the existence of a broader phenomenon. The score of the GESI is based on a multiple aggregation model where each pillar, subpillars, and individual indicators are weighted and scored according to the level of correlation they have one each other. It is important to clarify that correlation does not mean causation, thus the coefficient of correlation is a diagnostic tool for detecting high-collinear and communicating to which degree variable changes in the function of the others, i.e. the variation of one component explains the variation of the others.

The development of the GESI helped us to verify some initial hypotheses that can be summed up as follows:

i) An exporter must deal with the domestic demand for energy sources because of its internal economic and social development that can prevent the capacity to fulfil long-term energetic obligations with other countries (e.g. with Italy). The long term energy supply side must be tackled in order to have a strategic perspective;

ii) Geopolitical crisis and disruption can decrease the level of political commitment to long-term energy supply deals;

iii) Economic development can mitigate shocks and can help to ensure the long-term commitment of the country;

iv) Verify if policymakers present ambiguous and "acrobatic" traits of behavior in shaping the foreign agenda.

Country	2010	2015	2020
QAT	89,41	79,28	70,62
NIG	51,01	47,10	58,32
ALG	47,89	44,12	49,52
AZB	44,22	37,91	48,58
LYB	40,84	32,75	31,66
EGY	32,93	31,39	24,77

Country	2010	2015	2020
QAT	-	-11,3%	-10,9%
NIG	-	-7,7%	23,8%
ALG	-	-7,9%	12,2%
AZB	-	-14,3%	28,2%
LYB	-	-19,8%	-3,3%
EGY	-	-4,7%	-21,1%

Figure 21. GESI's Tables on Absolute terms and Year-to-Year Percentage Variation. Source: Author's Elaboration

Looking at the results in the figure, it can be argued that each of these hypotheses has been detected in the sampled countries. Arab springs, Turkish *Mavi Vatan* geostrategic projection, and Moscow's exposure to the Mediterranean have affected the score of the GESI. We can see that social turmoil, geopolitical competition and structural changes from the energetic supply side can increase the level of political risk, hence the Italia energetic security should entail such changes for assessing such risks. In addition, the Covid-19 hit dramatically the energy sectors of sample countries, nevertheless, the demand exposure represents an important issues to discuss, e.g. there are Algeria, Egypt and Nigeria that experienced divergent trends in terms of energy production and raising of domestic demand. Within this framework, Algeria and Egypt can be seen as the most appropriate case study to analyse[15] because it shows an ongoing process of economic and industrial development with relevant changes in its per capita income, hence domestic gas demand is going to increase because of the subsidies policy made by the government. In addition, the political stability of the local regime is not easily tackle but we can monitor the levels of political violence and other indicators like

[15] See chapter 2 for a detailed explanation.

the corruption perception of the local population. In fact, the perception can account for more than reality especially if there is a widespread sense of intolerance against the ruling class and bureaucracies. Social violence externalizes in geopolitical crises and civil wars, i.e. instability can raise from the internal social body and, secondly, external actors can intervene in the conflict and modulate the conflict as a proxy war in order to implement their political agenda. The Libyan scenario represents the emblematic example of this political risk, hence the GESI accounts for these possible disruptions. In fact, Italy substantially reduced imports from Libya in order to avoid interruption of supply because of geopolitical risk. It can be argued that the GESI can help to tackle this disruption and help the government to mitigate the potential impact of such clusters of risks.

The figure below graphically visualizes the evolution of the GESI index with the aim to tackle the structural changes in the last decade. We can see that Qatar, Libya, and Egypt experienced a deterioration of their geopolitical situation that affected their reliability of alternative gas suppliers in long-term political partnerships. In contrast, Nigeria, Algeria, and Azerbaijan have improved their score despite the covid-19, hence they should be considered good target countries for the broader Italian energy diversification strategy. Even Qatar made the best performance even if it exports most of its gas via LNG, hence Italy should try to import more LNG from Doha. The development of LNG terminals for regasification induces the Italian government to increase investments in this step of the supply-chain.

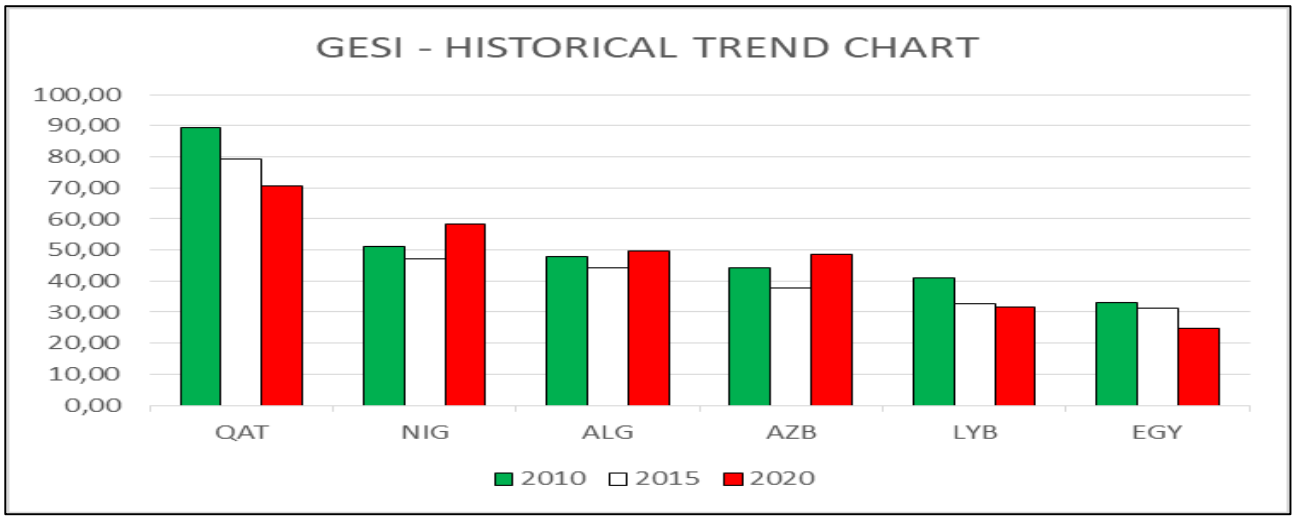

Figure 22. GESI Bar-Chart. Source: Author's Elaboration

As regards the theoretical framework (see chapter 1), no single variable can be used to estimate these risk components and a group or vector of highly correlated variables can be identified for each component. The GESI is composed of four underlying dimensions of geopolitical energy risk or partial risk factors. As argued by Chester, the concept of energy security has a temporal

dimension, hence threats to physical supply differ across short, medium, and long term horizons. Short-term risks involve contingent casualties such as accidents, extreme weather conditions, terrorist activities, and other geopolitical disruptions. In contrast to this perspective, the GESI assessed the long-term risks that concern the adequacy of supply to meet demand and the adequacy of the socio-political environment to deliver supply to markets and fulfill contractual obligations and avoid the disruptions of the flows because of an unstable environment. Hence, the main issue of concern is the reliability and continuity of energy flows in order to avoid further fluctuation in the long run. It can be argued that for building a comprehensive national energetic strategy, the policymaker should comply with long term and structural circumstances of the exporting countries. The index deals with the last decade, hence it can tackle how structural dynamics evolved and affected the risk of the sample countries.

The outcome of this work can be compared with the results provided by Munoz et al. (2015) confirming that advanced economies present a lower level of geopolitical energy risk due to their higher socio-political stability and a higher degree of economic development. For instance, Nigeria shares an appreciable economic growth with industrial diversification, hence the economic development can mitigate the risk of instability. However, the GESI aims to analyze only gas exporter countries, hence it tackles the variables able to mitigate or increase the risk of instability with concrete effects on the importers. In addition, the GESI introduces the effects of energy domestic demand because it can decrease supply in the long run. In fact, the GESI has been developed for being a policy tool for long-term strategic planning, hence good-scored countries must present the ability to fulfill long-term energy commitments. Even though economic development can mitigate the socio-political instability, it can be argued that a country with poor energy volumes available is not useful to the Italian energy diversification strategy.

Finally, the GESI introduces the geopolitical aspect of relations with Italy (the fourth pillar) that can increase or reduce the attractiveness of the country because it is influenced by countries with contrasting interests against Italy. However, it is interesting to highlight that the local decision-makers of sample countries can manage contrasting interests, i.e. we call this issue the “acrobatic behaviour” of ruling classes. As a result, It is reported that the energy interests that many countries have with Italy can counterbalance the Turkish or Russian presence because the local ruling classes have no interest to exclude profits from all sides. However, in the context of competitive dynamics, increasing collaboration with those countries can be a kind of self-fulfilling mechanism that reduces the external actor involvement because the dependency with the Italia market would be a sort of stabilizer of the bilateral relations.

3.4.6 LIMITATIONS AND FUTURE RESEARCH

The GESI has followed the classical methodology for building composite indicators for assessing complex and multivariate phenomena. In this form, the GESI shows some limitations that this section will report in order to draft possible alternatives for further research.

First, the sample of countries is composed of six countries considered for three different years reflecting the trends of the last decade. The number of factors introduced is set at 24 elements for each country. It is important to highlight that the value assumed can be quite divergent if compared to an absolute scale. In fact, some countries such as Qatar can present higher income per capita respect Libya or Egypt, hence some outliers can be detected and this difference con influences the normalization process. However, these outliers are not caused by statistical oscillation in the historical series but reflect different structural patterns of economic systems. Some countries can be divergent because the GESI is tailor-made for the Italian case study, hence the countries in the sample are assumed to be gas exporters to Italy and not simple fossil exporters. Hence, the sample inevitably shows a restrictive number of countries.

Second, the sample is based on gas suppliers to Italy and it reflects the Italian mainstream foreign policy. Therefore, all the results are not universally applicable to all the contexts and all the benchmarked areas. However, this issue reflects the constitutive nature of the GESI which is a tool for the policymakers of a specific country. As a matter of fact, If we had introduced all exporting countries in the world or an extremely large and heterogeneous geographic portion, there would have been many countries with weak or zero values at the aggregation level of the “Relation-Italy” and related subpillars, so there would have been no objective assessment of the country’s profile with the Italian interests.

Third, there are some assumptions in the collection, i.e. some data has been imputed or assumed constant during the time because of the lack of availability of internationally verified datasets (see chapter 2). Indeed, a more precise measurement can require the development of additional indexes. For example, the Gini index, fractionalisation, and total reserves. Those variables have been considered constant because many data were not available for each year due to technical and political reasons. From the technical standpoint, many of these indicators are long-term oriented and their evolution profile is slow compared to other variables.

Within this framework, it is interesting to outline some modifications to extend the representative value of the GESI in future research. The advice can be listed as follows:

First, introduce the component of the external energy demand of the rest of the world or some specific target countries in order to make GESI more dynamic. For example, many MENA countries export to Asia, hence the Eastern hemisphere presents levels of demand that are skyrocketing[16], i.e. prices (the willingness to pay) are higher respect Italy. Future research can introduce a new pillar with "International Demand of Gas". Second, expanding the number of countries introduced in the sample in order to provide more statistical variance of the data. Third, creating a cluster of countries can help to reduce the presence of outliers and to tackle the ongoing regional dynamics of specific contexts. Forth, introducing a risk mitigation (direction +1) indicator or subpillar, in renewable energies can be used for assessing the reliability of the exporter of gas. Indeed, energy efficiency and development of renewable energy power plants can reduce the domestic demand for gas for electrification resulting in more energy sources to sell abroad. Fifth, the subpillar "External Actors Involvement" can be divided into two different subpillars, namely "Influence-Russia" and "Influence-Turkey". The two subpillars should include variables such as: trade relations, alignment in international organizations, and weapon delivery bilateral initiatives or the number of bilateral treaties.

The GESI can measure the factors that affect the geopolitical risk of gas supply to Italy, its usefulness is proportional to the degree of precision through which we measure the structural patterns of interaction of the four pillars. Indeed, we can increase the ability to identify the state of the art of many countries, involving increasingly precise variables about energy demand (domestic and external), foreign influences of other countries, and proxy measures of social discontent,

The scope of each composite indicator is to describe complex dynamics that can not be reduced to the observation of single components or a simple mean of some isolated factors. The role of this thesis was to make the geopolitical dimension of energy security intelligible and provide a consolidated theoretical framework for future research and discussion.

[16] There is the same phenomena in Africa.

CONCLUSION

Since the lastest century, the issue of energy security of supply has raised major concern among policymakers because unforeseen disruption of the flows or unrealistic long-term sustainability can dramatically harm the security of entire nations. This formula is particularly true when policymakers shift to the Italian case because the Mediterranean Peninsula does not exploit its resources, hence it increases the dependence on foreign suppliers. There is a wide range of indicators that scholars developed in order to measure and detect the criticalities in the composition of the energetic portfolio. The first chapter analyzed relevant pieces of literature on energy security with the aim to draft a comprehensive perspective on the issues concerning energy security. Therefore, risk indicators play a central role in assessing weaknesses and opportunities. Indeed, the energy dependence harms national security, economic growth and, definitely, stability of the socio-political landscape. After decades of unconditioned limitations, the Russian Federation has built a significant dominance in the European and Italian energy import share. As a consequence, this market prominence represents both the first source of financial gains for Moscow and either political leverage of the Kremlin. As a result, the gas supply can be implemented within the framework of the hybrid warfare strategic doctrine. The fossil flows are the main tool used by Moscow for weakening the western alliance because the rise in inflation (from the supply side) dramatically erodes the real wages and the economic growth, i.e. governments have to deal with rising discontent against certain foreign policy decisions. Therefore, a long-sighted long-term diversification strategy is necessary for ensuring national security and sovereignty for what concerns foreign policy alignment and price stability.

Many experts have employed a wide variety of methodologies to ensure a comprehensive and timely assessment of energy flows. However, the energy carrier is only one of many aspects to be taken into account when planning an energy diversification strategy aimed at medium/long-term sustainability. Therefore, it is essential to place the energy factor within the socio-political reality of the candidate countries. First of all, a consolidated assessment of the geopolitical landscape of the potential alternative suppliers must be performed. As suggested by Munoz et al. (2015), each geopolitical situation is hardly stationary, contrary to the prediction of future economic variables, the geopolitical aspect can not be estimated with a certain degree of probability. As a matter of fact, the most experienced analysts are not able to foresee how the geopolitical situation will evolve in the near future without a certain considerable amount of probability of error. Because of this methodological limitation, the assessment of the geopolitical landscape (e.g. geopolitical risk index)

in the future traditionally relies on the scenarios technique. However, scenario analysis could greatly benefit from being supported by quantitative tools to monitor the contexts of interest.

The second chapter highlights the contribution of this thesis to the development of a single quantitative indicator able to represent the geopolitical risk, overcoming the qualitative description of these phenomena. The chapter develops from the methodological point of view the theoretical framework that serves as the foundation of the composite indicator. Additionally, the thesis highlights the analysis of energy security through the composite indicator and would greatly benefit in the capacity to assess the long-term stability of gas suppliers to Italy. More precisely, it can be argued that the index is deemed to assess the geopolitical and energetic stability of countries that can offer alternative gas routes to Italy. The index is named Geopolitical Energy Security Index (GESI) and it is structured by four mutually-related pillars. The pillars are respectively economic, energy, socio-political, and bilateral relations with Italy. The fourth pillar can be considered as the country-specific component of the set of variables used. Furthermore, this fourth pillar incorporates proxy variables among its components that are intended to measure the influence of external actors such as Russia and Turkey in the international affairs of the target country. Within this framework, the GESI is composed of four pillars and underlying sub-pillars aimed to tackle complex phenomena that are aggregated at a higher level. Each aggregation level shows a certain degree of correlation, i.e. how much the variable describes each other and the system of weights ensures the effective balance among the indicators. Each of the dimensions is aggregated in the index that assumes a value between 0 and 100.

The third chapter deals with the quantitative development of the GESI and it develops a bridge between the outcomes for each year and the overall geopolitical interpretation concerning the performance of the last decade reported by the six countries in the sample. In particular, the thesis analysed the last decade through 2010, 2015, and 2020. As a result, the GESI provided the overall assessment of structural dynamics that characterize the last decade in most MENA countries or sub-Saharan countries. The development of the GESI helped to verify some initial hypotheses concerning the ongoing dynamics that affect the exporting capacity of sampled countries. Indeed, Italian policymakers should carefully assume the following outcomes as drivers that can shape the long-term commitment of these geopolitical actors. As result, the GESI suggested that an exporter must deal with the domestic demand for energy sources because of its internal economic and social development that can prevent the capacity to fulfill long-term energetic obligations with other countries (e.g. with Italy). In addition, the geopolitical aspect and the internal socio-political dimension can disrupt the level of political commitment to long-term energy supply deals. Another outcome to highlight is the

positive outcome produced by economic development, i.e. it mitigates shocks and helps to ensure the long-term commitment of the country. Finally, the GESI verified that increase in external actors' involvement is not mutually excludable from the Italian energy policy even if it can aliment entropic dynamics because of the friction between opposing spheres of influence. The research discovered that this friction can be contained and mitigated by the historical depth (path dependence) of the relationship between Italy and the country in the sample. Moreover, this pattern has been explained by the ambiguous and "acrobatic" foreign policy conducted by local elites, i.e. they do not renounce economic benefits from natural gas export and either they will cut or reduce ties with Turkey and Russia because of the political and military supports. It can be argued that building energy relations can boost the geopolitical security of both countries and at the same time it represents a self-fulfilling mechanism (but not a causal relation) for enforcing good bilateral relations because energy investments are capital intensive and the energy sector is long-term oriented.

The last section shows the percentage dynamic change of the GESI in the last decade. We can see that Qatar, Libya, and Egypt experienced a deterioration of their geopolitical situation that affected their reliability of alternative gas suppliers in long-term political partnerships. The GESI assessed the impact of Arab Springs on the social, energetic and economic stability of the MENA countries, moreover, the effects of Covid-19 raised major concern in the sustainability of the energetic pillar of the index with considerable externalities on the overall index. In contrast, Nigeria, Algeria, and Azerbaijan have improved their score despite the Covid-19, hence they should be considered good target countries for the broader Italian energy diversification strategy. Even Qatar made the best performance despite the declining trend, however, it exports most of its gas via LNG, hence Italy should try to import more LNG from Doha. Within this assumption, the development of LNG terminals for regasification requires the Italian government to increase investments in this step of the supply-chain.

Finally, the third chapter outlined possible ideas for future research to improve the GESI. For instance, the GESI ought to introduce more sub-pillars related to the energy sector and monitor the development of energy efficiency and investments in renewable energy sources. In addition, the composite indicator could assess the affordability perspective, i.e. comparing the prices of natural gas offered by sample countries on a comparative scale. Finally, efforts could be increased to strengthen proxy measures to delineate the influence of Russia and Turkey on the policies of the target countries.

To conclude, the thesis provided a solid theoretical framework involving multiple dimensions aimed to represent the complex phenomena of energy security of supply that can not be disentangled from the geopolitical and social sights because the ongoing dynamics of the last decades shows that

countries are more unstable despite the increase of gas production and export capacity, i.e. decision makers should tackle such drivers in order to develop a long term and sustainable diversification strategy for what concerns the supply of natural gas.

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APPENDIX

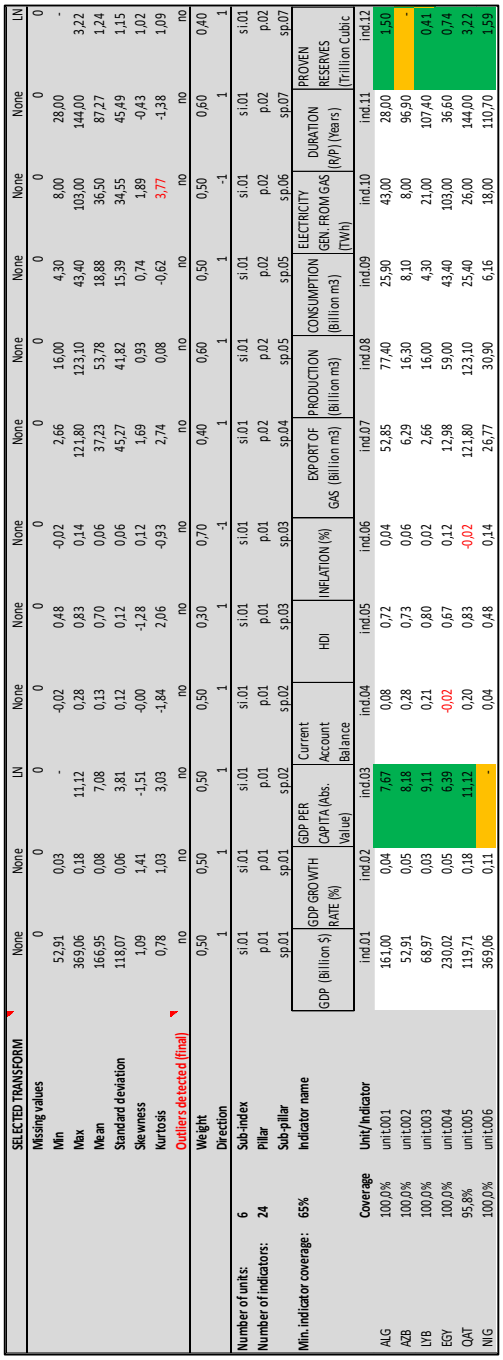
STATISTICS 2010

Number of indicators:	24	Sub-index		si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01
Number of units:	6	Pillar		p.01	p.01	p.01	p.01	p.01	p.02	p.02	p.02	p.02	p.02	p.02	p.02
		Sub-pillar		sp.01	sp.01	sp.02	sp.02	sp.03	sp.03	sp.04	sp.05	sp.05	sp.06	sp.07	sp.07
Min. indicator coverage	65%	Indicator name		GDP (Billion $)	GDP GROWTH RATE (%)	GDP PER CAPITA (Abs. Value)	Current Account Balance (%GDP)	HDI	INFLATION (%)	EXPORT OF GAS (Billion m3)	PRODUCTION (Billion m3)	CONSUMPTION (Billion m3)	EGEN.FROM GAS (TWh)	DURATION (R/P) (Years)	PROVEN RESERVES (Trillion Cubic
Indicators with data	Coverage	Unit name	Unit/Indicator	ind.01	ind.02	ind.03	ind.04	ind.05	ind.06	ind.07	ind.08	ind.09	ind.10	ind.11	ind.12
24	100,0%	ALG	unit.001	161,00	0,04	4.480,72	0,08	0,72	0,04	52,85	77,40	25,90	43,00	28,00	4,50
24	100,0%	AZB	unit.002	52,91	0,05	5.880,81	0,28	0,73	0,06	6,29	16,30	8,10	8,00	96,90	1,00
24	100,0%	LYB	unit.003	68,97	0,03	11.417,42	0,21	0,80	0,02	2,66	16,00	4,30	21,00	107,40	1,50
24	100,0%	EGY	unit.004	230,02	0,05	2.922,80	-0,02	0,67	0,12	12,98	59,00	43,40	103,00	36,60	2,10
23	95,8%	QAT	unit.005	119,71	0,18	69.796,14	0,20	0,83	-0,02	121,80	123,10	25,40	26,00	144,00	25,10
24	100,0%	NIG	unit.006	369,06	0,11	2.328,43	0,04	0,48	0,14	26,77	30,90	6,16	18,00	110,70	4,90

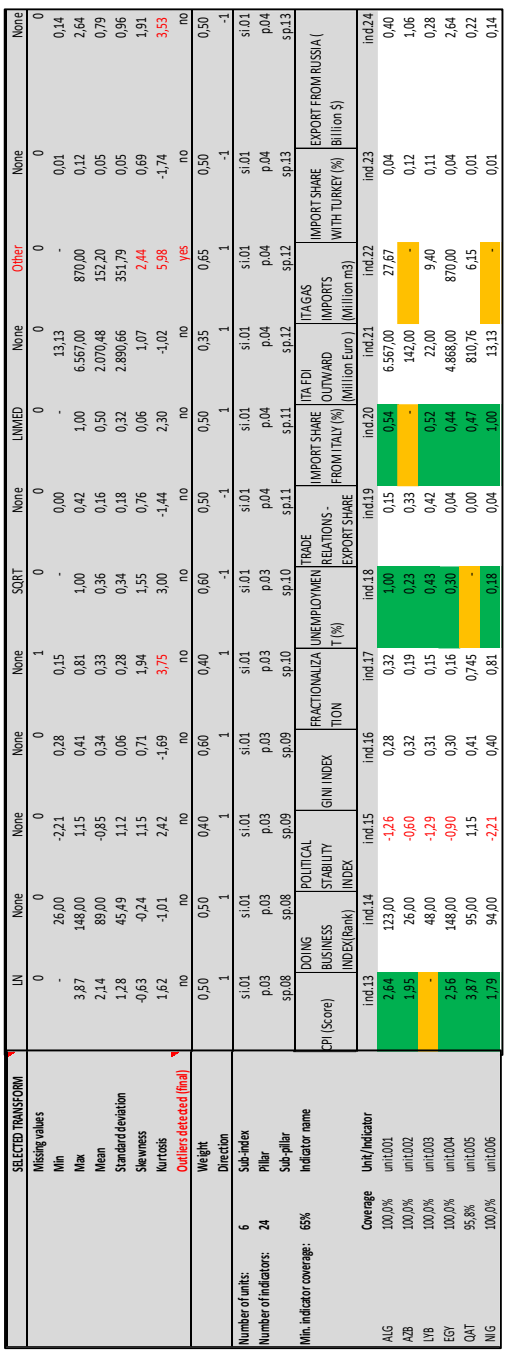
Number of indicators:	24	Sub-index		si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01
Number of units:	6	Pillar		p.03	p.03	p.03	p.03	p.03	p.03	p.04	p.04	p.04	p.04	p.04	p.04
		Sub-pillar		sp.08	sp.08	sp.09	sp.09	sp.10	sp.10	sp.11	sp.11	sp.12	sp.12	sp.13	sp.13
Min. indicator coverage	65%	Indicator name		CPI (Score)	DOING BUSINESS INDEX(Rank)	POLITICAL STABILITY INDEX	GINI INDEX	FRACTIONALIZATION	UNEMPLOYMENT (%)	TRADE RELATIONS - EXPORT SHARE	IMPORT SHARE FROM ITALY (%)	ITA FDI OUTWARD (Million Euro)	ITA GAS IMPORTS (Million m3)	IMPORT SHARE WITH TURKEY (%)	EXPORT FROM RUSSIA (Billion $)
Indicators with data	Coverage	Unit name	Unit/Indicator	ind.13	ind.14	ind.15	ind.16	ind.17	ind.18	ind.19	ind.20	ind.21	ind.22	ind.23	ind.24
24	100,0%	ALG	unit.001	34,00	123,00	-1,26	0,28	0,32	1,00	0,15	0,10	6.567,00	27,67	0,04	0,40
24	100,0%	AZB	unit.002	27,00	26,00	-0,60	0,32	0,19	0,06	0,33	0,02	142,00	-	0,12	1,06
24	100,0%	LYB	unit.003	21,00	48,00	-1,29	0,31	0,15	0,19	0,42	0,09	22,00	9,40	0,11	0,28
24	100,0%	EGY	unit.004	33,00	148,00	-0,90	0,30	0,16	0,09	0,04	0,06	4.868,00	870,00	0,04	2,64
23	95,8%	QAT	unit.005	68,00	95,00	1,15	0,41	0,745	0,00	0,00	0,07	810,76	6,15	0,01	0,22
24	100,0%	NIG	unit.006	26,00	94,00	-2,21	0,40	0,81	0,04	0,04	4,52	13,13	-	0,01	0,14

Fig 23. Statistics 2010. Source: Author's Elaboration with COIN

TREATED DATA 2010



		SELECTED TRANSFORM	None	None	None	LN	None	None	None	None	None	None	None	None	None	None	LN
		Missing values	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Min	52,91	0,03	-	-0,02	0,48	-0,02	2,66	16,00	4,30	8,00	28,00	-			
		Max	369,06	0,18	11,12	0,28	0,83	0,14	121,80	123,10	43,40	103,00	144,00	3,22			
		Mean	166,95	0,08	7,08	0,13	0,70	0,06	37,23	53,78	18,88	36,50	87,27	1,24			
		Standard deviation	118,07	0,06	3,81	0,12	0,12	0,06	45,27	41,82	15,39	34,55	45,49	1,15			
		Skewness	1,09	1,41	-1,51	-0,00	-1,28	0,12	1,69	0,93	0,74	1,89	-0,43	1,02			
		Kurtosis	0,78	1,03	3,03	-1,84	2,06	-0,93	2,74	0,08	-0,62	3,77	-1,38	1,09			
		Outliers detected (final)	no	no	no	no	no	no	no	no	no	no	no	no			
		Weight	0,50	0,50	0,50	0,50	0,30	0,70	0,40	0,60	0,50	0,50	0,60	0,40			
		Direction	1	1	1	1	1	-1	1	1	1	-1	1	1			
Number of units:	6	Sub-index	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01			
Number of indicators:	24	Pillar	p.01	p.01	p.01	p.01	p.01	p.01	p.02	p.02	p.02	p.02	p.02	p.02			
		Sub-pillar	sp.01	sp.01	sp.02	sp.02	sp.03	sp.03	sp.04	sp.05	sp.05	sp.06	sp.07	sp.07			
Min. indicator coverage:	65%	Indicator name	GDP (Billion $)	GDP GROWTH RATE (%)	GDP PER CAPITA (Abs. Value)	Current Account Balance	HDI	INFLATION (%)	EXPORT OF GAS (Billion m3)	PRODUCTION (Billion m3)	CONSUMPTION (Billion m3)	ELECTRICITY GEN. FROM GAS (TWh)	DURATION (R/P) (Years)	PROVEN RESERVES (Trillion Cubic			
			ind.01	ind.02	ind.03	ind.04	ind.05	ind.06	ind.07	ind.08	ind.09	ind.10	ind.11	ind.12			
	Coverage	Unit/Indicator															
ALG	100,0%	unit.001	161,00	0,04	7,67	0,08	0,72	0,04	52,85	77,40	25,90	43,00	28,00	1,50			
AZB	100,0%	unit.002	52,91	0,05	8,18	0,28	0,73	0,06	6,29	16,30	8,10	8,00	96,90	-			
LYB	100,0%	unit.003	68,97	0,03	9,11	0,21	0,80	0,02	2,66	16,00	4,30	21,00	107,40	0,41			
EGY	100,0%	unit.004	230,02	0,05	6,39	-0,02	0,67	0,12	12,98	59,00	43,40	103,00	36,60	0,74			
QAT	95,8%	unit.005	119,71	0,18	11,12	0,20	0,83	-0,02	121,80	123,10	25,40	26,00	144,00	3,22			
NIG	100,0%	unit.006	369,06	0,11	-	0,04	0,48	0,14	26,77	30,90	6,16	18,00	110,70	1,59			



		SELECTED TRANSFORM	LN	None	None	None	None	None	SQRT	None	LNMED	None	Other	None	None	None	None
		Missing values	0	0	0	0	1	0	0	0	0	0	0	0			0
		Min	-	26,00	-2,21	0,28	0,15	-	0,00	-	13,13	-	0,01				0,14
		Max	3,87	148,00	1,15	0,41	0,81	1,00	0,42	1,00	6.567,00	870,00	0,12				2,64
		Mean	2,14	89,00	-0,85	0,34	0,33	0,36	0,16	0,50	2.070,48	152,20	0,05				0,79
		Standard deviation	1,28	45,49	1,12	0,06	0,28	0,34	0,18	0,32	2.890,66	351,79	0,05				0,96
		Skewness	-0,63	-0,24	1,15	0,71	1,94	1,55	0,76	0,06	1,07	2,44	0,69				1,91
		Kurtosis	1,62	-1,01	2,42	-1,69	3,75	3,00	-1,44	2,30	-1,02	5,98	-1,74				3,53
		Outliers deteded (final)	no	no	no	no	no	no	no	no	no	yes	no				no
		Weight	0,50	0,50	0,40	0,60	0,40	0,60	0,50	0,50	0,35	0,65	0,50				0,50
		Direction	1	1	1	1	1	-1	-1	1	1	1	-1				-1
Number of units:	6	Sub-index	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01				si.01
Number of indicators:	24	Pillar	p.03	p.03	p.03	p.03	p.03	p.03	p.04	p.04	p.04	p.04	p.04				p.04
		Sub-pillar	sp.08	sp.08	sp.09	sp.09	sp.10	sp.10	sp.11	sp.11	sp.12	sp.12	sp.13				sp.13
Min. indicator coverage:	65%	Indicator name	CPI (Score)	DOING BUSINESS INDEX(Rank)	POLITICAL STABILITY INDEX	GINI INDEX	FRACTIONALIZATION	UNEMPLOYMENT (%)	TRADE RELATIONS - EXPORT SHARE	IMPORT SHARE FROM ITALY (%)	ITA FDI OUTWARD (Million Euro)	ITA GAS IMPORTS (Million m3)	IMPORT SHARE WITH TURKEY (%)	EXPORT FROM RUSSIA (Billion $)			
			ind.13	ind.14	ind.15	ind.16	ind.17	ind.18	ind.19	ind.20	ind.21	ind.22	ind.23	ind.24			
	Coverage	Unit/Indicator															
ALG	100,0%	unit.001	2,64	123,00	-1,26	0,28	0,32	1,00	0,15	0,54	6.567,00	27,67	0,04	0,40			
AZB	100,0%	unit.002	1,95	26,00	-0,60	0,32	0,19	0,23	0,33	-	142,00	-	0,12	1,06			
LYB	100,0%	unit.003	-	48,00	-1,29	0,31	0,15	0,43	0,42	0,52	22,00	9,40	0,11	0,28			
EGY	100,0%	unit.004	2,56	148,00	-0,90	0,30	0,16	0,30	0,04	0,44	4.868,00	870,00	0,04	2,64			
QAT	95,8%	unit.005	3,87	95,00	1,15	0,41	0,745	-	0,00	0,47	810,76	6,15	0,01	0,22			
NIG	100,0%	unit.006	1,79	94,00	-2,21	0,40	0,81	0,18	0,04	1,00	13,13	-	0,01	0,14			

Fig 24. Treated Data 2010. Source: Author's Elaboration with COIN

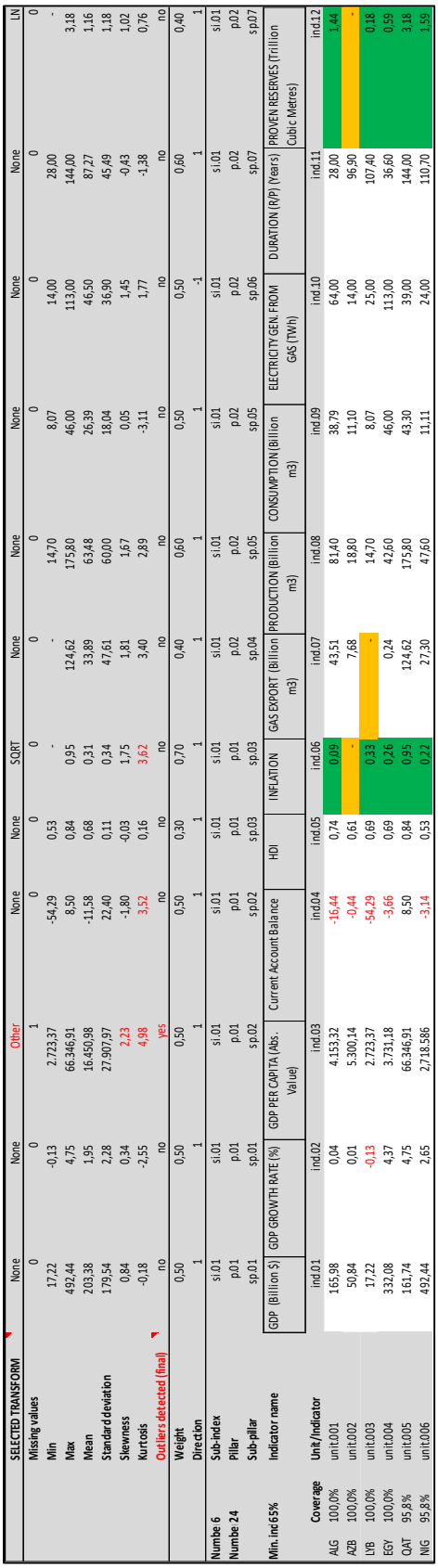
STATISTICS 2015

Number of indicators:	24		Sub-index	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01
Number of units:	6		Pillar	p.01	p.01	p.01	p.01	p.01	p.01	p.02	p.02	p.02	p.02	p.02	p.02
			Sub-pillar	sp.01	sp.01	sp.02	sp.02	sp.03	sp.03	sp.04	sp.05	sp.05	sp.06	sp.07	sp.07
Min. indicator coverage	65%		Indicator name	GDP (Billion $)	GDP GROWTH RATE (%)	GDP PER CAPITA (Abs. Value)	Current Account Balance	HDI	INFLATION	GAS EXPORT (Billion m3)	PRODUCTION (Billion m3)	CONSUMPTION (Billion m3)	ELECTRICITY GEN. FROM GAS (TWh)	DURATION (R/P) (Years)	PROVEN RESERVES (Trillion Cubic
Indicators with data	Coverage	Unit name	Unit/Indicator	ind.01	ind.02	ind.03	ind.04	ind.05	ind.06	ind.07	ind.08	ind.09	ind.10	ind.11	ind.12
24	100,0%	ALG	unit.001	165,98	0,04	4.153,32	-16,44	0,74	0,05	43,51	81,40	38,79	64,00	28,00	4,50
24	100,0%	AZB	unit.002	50,84	0,01	5.300,14	-0,44	0,61	0,04	7,68	18,80	11,10	14,00	96,90	1,30
24	100,0%	LYB	unit.003	17,22	-0,13	2.723,37	-54,29	0,69	0,15	-	14,70	8,07	25,00	107,40	1,50
24	100,0%	EGY	unit.004	332,08	4,37	3.731,18	-3,66	0,69	0,11	0,24	42,60	46,00	113,00	36,60	2,10
23	95,8%	QAT	unit.005	161,74	4,75	66.346,91	8,50	0,84	0,94	124,62	175,80	43,30	39,00	144,00	24,30
23	95,8%	NIG	unit.006	492,44	2,65	2,718.586	-3,14	0,53	0,09	27,30	47,60	11,11	24,00	110,70	5,20

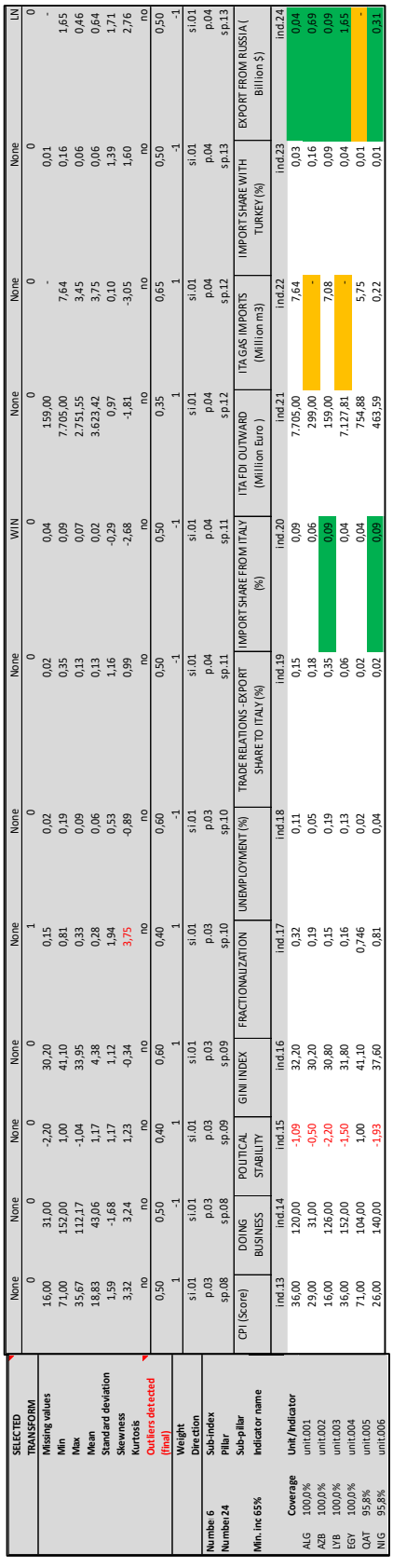
		si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01
		p.03	p.03	p.03	p.03	p.03	p.03	p.04	p.04	p.04	p.04	p.04	p.04
		sp.08	sp.08	sp.09	sp.09	sp.10	sp.10	sp.11	sp.11	sp.12	sp.12	sp.13	sp.13
		CPI (Score)	DOING BUSINESS INDEX(Rank)	POLITICAL STABILITY INDEX	GINI INDEX	FRACTIONALIZATION	UNEMPLOYMENT (%)	TRADE RELATIONS - EXPORT SHARE	IMPORT SHARE FROM ITALY (%)	ITA FDI OUTWARD (Million Euro)	ITA GAS IMPORTS (Million m3)	IMPORT SHARE WITH TURKEY (%)	EXPORT FROM RUSSIA (Billion $)
		ind.13	ind.14	ind.15	ind.16	ind.17	ind.18	ind.19	ind.20	ind.21	ind.22	ind.23	ind.24
ALG	unit.001	36,00	120,00	-1,09	32,20	0,32	0,11	0,15	0,09	7.705,00	7,64	0,03	0,12
AZB	unit.002	29,00	31,00	-0,50	30,20	0,19	0,05	0,18	0,06	299,00	-	0,16	1,07
LYB	unit.003	16,00	126,00	-2,20	30,80	0,15	0,19	0,35	0,13	159,00	7,08	0,09	0,18
EGY	unit.004	36,00	152,00	-1,50	31,80	0,16	0,13	0,06	0,04	7.127,81	-	0,04	4,31
QAT	unit.005	71,00	104,00	1,00	41,10	0,746	0,02	0,02	0,04	754,88	5,75	0,01	0,09
NIG	unit.006	26,00	140,00	-1,93	37,60	0,81	0,04	0,02	2,36	463,59	0,22	0,01	0,45

Fig 25. Statistics 2015. Source: Author's Elaboration with COIN

TREATED DATA 2015



SELECTED TRANSFORM		None	None	Other	None	None	SQRT	None	None	None	None	None	None	LN
Missing values		0	0	1	0	0	0	0	0	0	0	0	0	0
Min		17,22	-0,13	2.723,37	-54,29	0,53	-	14,70	8,07	14,00	28,00	0,01	28,00	-
Max		492,44	4,75	66.346,91	8,50	0,84	0,95	124,62	175,80	46,00	113,00	144,00	144,00	3,18
Mean		203,38	1,95	16.450,98	-11,58	0,68	0,31	33,89	63,48	26,39	46,50	87,27	87,27	1,16
Standard deviation		179,54	2,28	27.907,97	22,40	0,11	0,34	47,61	60,00	18,04	36,90	45,49	45,49	1,18
Skewness		0,84	0,34	2,23	-1,80	-0,03	1,75	1,81	1,67	0,05	1,45	-0,43	-0,43	1,02
Kurtosis		-0,18	-2,55	4,98	3,52	0,16	3,62	3,40	2,89	-3,11	1,77	-1,38	-1,38	0,76
Outliers detected (final)		no	no	yes	no	no	no	no	no	no	no	no	no	no
Weight		0,50	0,50	0,50	0,50	0,30	0,70	0,40	0,60	0,50	0,50	0,60	0,60	0,40
Direction		1	1	1	1	1	1	1	1	1	-1	1	1	1
Numbe 6	Sub-index	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01
Numbe 24	Pillar	p.01	p.01	p.01	p.01	p.01	p.01	p.02	p.02	p.02	p.02	p.02	p.02	p.02
	Sub-pillar	sp.01	sp.01	sp.02	sp.02	sp.03	sp.03	sp.04	sp.05	sp.05	sp.06	sp.07	sp.07	sp.07
Min. inc 65%	Indicator name	GDP (Billion $)	GDP GROWTH RATE (%)	GDP PER CAPITA (Abs. Value)	Current Account Balance	HDI	INFLATION	GAS EXPORT (Billion m3)	PRODUCTION (Billion m3)	CONSUMPTION (Billion m3)	ELECTRICITY GEN. FROM GAS (TWh)	DURATION (R/P) (Years)	PROVEN RESERVES (Trillion Cubic Metres)	
Coverage	Unit/Indicator	ind.01	ind.02	ind.03	ind.04	ind.05	ind.06	ind.07	ind.08	ind.09	ind.10	ind.11	ind.12	
ALG 100,0%	unit.001	165,98	0,04	4.153,32	-16,44	0,74	0,09	43,51	81,40	38,79	64,00	28,00	1,44	
AZB 100,0%	unit.002	50,84	0,01	5.300,14	-0,44	0,61	-	7,68	18,80	11,10	14,00	96,90	-	
LYB 100,0%	unit.003	17,22	-0,13	2.723,37	-54,29	0,69	0,33	-	14,70	8,07	25,00	107,40	0,18	
EGY 100,0%	unit.004	332,08	4,37	3.731,18	-3,66	0,69	0,26	0,24	42,60	46,00	113,00	36,60	0,59	
QAT 95,8%	unit.005	161,74	4,75	66.346,91	8,50	0,84	0,95	124,62	175,80	43,30	39,00	144,00	3,18	
NIG 95,8%	unit.006	492,44	2,65	2.718.586	-3,14	0,53	0,22	27,30	47,60	11,11	24,00	110,70	1,59	



SELECTED TRANSFORM		None	None	None	None	None	None	None	WIN	None	None	None	None	LN
Missing values		0	0	0	1	0	0	0	0	0	0	0	0	0
Min		16,00	31,00	30,20	0,15	0,02	0,02	0,04	0,04	159,00	-	0,01	-	-
Max		71,00	152,00	41,10	0,81	0,19	0,35	0,09	0,09	7.705,00	7,64	0,16	1,65	1,65
Mean		35,67	112,17	33,95	0,33	0,09	0,13	0,07	0,02	2.751,55	3,45	0,06	0,46	0,46
Standard deviation		18,83	43,06	4,38	0,28	0,06	0,13	0,02	-0,29	3.623,42	3,75	0,06	0,64	0,64
Skewness		1,59	-1,68	1,12	1,94	0,53	1,16	-0,29	-2,68	0,97	0,10	1,39	1,71	1,71
Kurtosis		3,32	3,24	-0,34	3,75	-0,89	0,99	-2,68	no	-1,81	-3,05	1,60	2,76	2,76
Outliers detected (final)		no	no	no	no	no	no	no	no	no	no	no	no	no
Weight		0,50	0,50	0,40	0,40	0,60	0,50	0,50	0,50	0,35	0,65	0,50	0,50	0,50
Direction		1	-1	1	1	-1	-1	-1	-1	1	1	-1	-1	-1
Numbe 6	Sub-index	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01
Numbe 24	Pillar	p.03	p.03	p.03	p.03	p.03	p.03	p.04	p.04	p.04	p.04	p.04	p.04	p.04
	Sub-pillar	sp.08	sp.08	sp.09	sp.10	sp.10	sp.10	sp.11	sp.11	sp.12	sp.12	sp.13	sp.13	sp.13
Min. inc 65%	Indicator name	CPI (Score)	DOING BUSINESS	POLITICAL STABILITY	GINI INDEX	FRACTIONALIZATION	UNEMPLOYMENT (%)	TRADE RELATIONS - EXPORT SHARE TO ITALY (%)	IMPORT SHARE FROM ITALY (%)	ITA FDI OUTWARD (Million Euro)	ITA GAS IMPORTS (Million m3)	IMPORT SHARE WITH TURKEY (%)	EXPORT FROM RUSSIA (Billion $)	
Coverage	Unit/Indicator	ind.13	ind.14	ind.15	ind.16	ind.17	ind.18	ind.19	ind.20	ind.21	ind.22	ind.23	ind.24	
ALG 100,0%	unit.001	36,00	120,00	-1,09	32,20	0,32	0,11	0,15	0,09	7.705,00	7,64	0,03	0,04	
AZB 100,0%	unit.002	29,00	31,00	-0,50	30,20	0,19	0,05	0,18	0,06	299,00	-	0,16	0,69	
LYB 100,0%	unit.003	16,00	126,00	-2,20	30,80	0,15	0,19	0,35	0,09	159,00	7,08	0,09	0,09	
EGY 100,0%	unit.004	36,00	152,00	-1,50	31,80	0,16	0,13	0,06	0,04	7.127,81	-	0,04	1,65	
QAT 95,8%	unit.005	71,00	104,00	1,00	41,10	0,746	0,02	0,02	0,04	754,88	5,75	0,01	-	
NIG 95,8%	unit.006	26,00	140,00	-1,93	37,60	0,81	0,04	0,02	0,09	463,59	0,22	0,01	0,31	

Fig 26. Treated Data 2015. Source: Author's Elaboration with COIN

STATISTICS 2020

Number of indicators:	24	Sub-index			si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01
Number of units:	6	Pillar			p.01	p.01	p.01	p.01	p.01	p.01	p.02	p.02	p.02	p.02	p.02	p.02	p.02	p.02
		Sub-pillar			sp.01	sp.01	sp.02	sp.02	sp.03	sp.03	sp.04	sp.05	sp.05	sp.12	sp.06	sp.07		sp.07
Min. indicator coverage	65%	Indicator name			GDP (Billion $)	GDP GROWTH RATE (%)	GDP PER CAPITA (Abs. Value)	CURRENT ACCOUNT BALANCE (%	HDI	INFLATION (%)	EXPORT OF GAS (Billion m3)	PRODUCTION (Billion m3)	CONSUMPTION (Billion m3)	ELECTRICITY GEN. FROM GAS (TWh)	DURATION (R/P) (Years)	PROVEN RESERVES (Trillion Cubic	
Indicators with data		Coverage	Unit name	Unit/Indicator	ind.01	ind.02	ind.03	ind.04	ind.05	ind.06	ind.07	ind.08	ind.09	ind.10	ind.11	ind.12		
23		95,8%	ALG	unit.001	147,60	-0,055	3.337,32	-12,68	0,74	0,02	39,44	81,50	44,12	76,00	28,00	4,50		
24		100,0%	AZB	unit.002	42,61	-0,04	4.232,32	-0,53	0,61	0,03	13,40	25,80	11,90	16,00	96,90	2,50		
24		100,0%	LIB	unit.003	19,21	-0,60	2.891,46	-12,23	0,69	0,28	11,52	13,30	7,70	22,00	107,40	1,50		
24		100,0%	EGY	unit.004	363,25	3,57	3.600,84	-3,07	0,69	0,06	2,91	58,50	57,80	130,00	36,60	2,20		
23		95,8%	QUA	unit.005	145,45	-3,59	54.184,97	-2,40	0,84	-2,72	127,46	171,30	35,00	47,00	144,00	23,80		
22		91,7%	NIG	unit.006	429,42	-1,79	2.083.162	-3,95	0,53	0,13	32,29	49,40	13,19	23,00	110,70	5,50		

Number of indicators:	24	Sub-index			si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01
Number of units:	6	Pillar			p.03	p.03	p.03	p.03	p.03	p.03	p.04	p.04	p.04	p.04	p.04	p.04	p.04	p.04
		Sub-pillar			sp.08	sp.08	sp.09	sp.09	sp.10	sp.10	sp.11	sp.11	sp.12	sp.12	sp.13	sp.13		sp.13
Min. indicator coverage	65%	Indicator name			CPI (Score)	DOING BUSINESS INDEX(Rank)	POLITICAL STABILITY INDEX	GINI INDEX	FRACTIONALIZATION	UNEMPLOYMENT (%)	TRADE RELATIONS - EXPORT SHARE	IMPORT SHARE FROM ITALY (%)	ITA FDI OUTWARD (Million Euro)	ITA GAS IMPORTS (Million m3)	IMPORT SHARE WITH TURKEY (%)	EXPORT FROM RUSSIA (Billion $)		
Indicators with data		Coverage	Unit name	Unit/Indicator	ind.13	ind.14	ind.15	ind.16	ind.17	ind.18	ind.19	ind.20	ind.21	ind.22	ind.23	ind.24		
23		95,8%	ALG	unit.001	36,00	157,00	-0,86	32,20	0,32	0,14	0,07	0,08	9.988,00	15,10	0,10	0,92		
24		100,0%	AZB	unit.002	30,00	28,00	-1,00	28,60	0,19	0,07	0,29	0,03	1.485,00	7,21	0,12	2,03		
24		100,0%	LIB	unit.003	17,00	145,00	-2,48	30,90	0,15	19,39	0,34	0,11	144,00	4,46	0,11	0,12		
24		100,0%	EGY	unit.004	33,00	166,00	-1,21	29,70	0,16	0,08	0,06	0,04	8.393,05	184,00	0,05	5,14		
23		95,8%	QUA	unit.005	63,00	115,00	0,67	41,10	0,74	0,03	0,02	0,04	1.617,36	6,94	0,01	0,27		
22		91,7%	NIG	unit.006	24,00	73,00	-1,86	35,10	0,81	0,09	0,04	1,84	1.681,68	0,18	0,01	1,02		

Fig 27. Statistics 2020. Source: Author's Elaboration

TREATED DATA 2020:

	SELECTED TRANSFORM	None	None	Other	None	None	WIN	None	None	None	None	None	LN
	Missing values	0	1	1	0	0	0	0	0	1	0	0	0
	Min	19,21	-3,59	2.891,46	-12,68	0,53	0,02	2,91	13,30	7,70	16,00	28,00	-
	Max	429,42	3,57	54.184,97	-0,53	0,84	0,28	127,46	171,30	57,80	130,00	144,00	3,15
	Mean	191,26	-0,49	13.649,38	-5,81	0,68	0,09	37,84	66,63	31,30	52,33	87,27	1,23
	Standard deviation	168,53	2,65	22.665,28	5,27	0,11	0,10	45,99	56,66	21,29	44,09	45,49	1,11
	Skewness	0,63	0,79	2,23	-0,77	-0,03	1,71	1,99	1,52	0,01	1,33	-0,43	1,06
	Kurtosis	-1,51	1,36	4,99	-1,80	0,16	2,61	4,21	2,65	-2,09	1,16	-1,38	1,28
	Outliers detected (final)	no	no	yes	no	no	no	no	no	no	no	no	no
	Weight	0,50	0,50	0,50	0,50	0,30	0,70	0,40	0,60	0,50	0,50	0,60	0,40
	Direction	1	1	1	1	1	-1	1	1	1	-1	1	1
Number of units:	6	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01
Number of indicators:	24	p.01	p.01	p.01	p.01	p.01	p.01	p.02	p.02	p.02	p.02	p.02	p.02
	Sub-pillar	sp.01	sp.01	sp.02	sp.02	sp.03	sp.03	sp.04	sp.05	sp.05	sp.06	sp.07	sp.07
Min. indicator coverage:	65%	Indicator name	GDP (Billion $)	GDP GROWTH RATE (%)	GDP PER CAPITA (Abs. Value)	CURRENT ACCOUNT BALANCE (%	HDI	INFLATION (%)	EXPORT OF GAS (Billion m3)	PRODUCTION (Billion m3)	CONSUMPTION (Billion m3)	ELECTRICITY GEN. FROM GAS (TWh)	DURATION (R/P) (Years)	PROVEN RESERVES (Trillion Cubic
	Coverage	Unit/Indicator	ind.01	ind.02	ind.03	ind.04	ind.05	ind.06	ind.07	ind.08	ind.09	ind.10	ind.11	ind.12
ALG	95,8%	unit.001	147,60	-0,055	3.337,32	-12,68	0,74	0,02	39,44	81,50	44,12	76,00	28,00	1,39
AZB	100,0%	unit.002	42,61	-0,04	4.232,32	-0,53	0,61	0,03	13,40	25,80	11,90	16,00	96,90	0,69
LIB	100,0%	unit.003	19,21	-0,60	2.891,46	-12,23	0,69	0,28	11,52	13,30	7,70	22,00	107,40	-
EGY	100,0%	unit.004	363,25	3,57	3.600,84	-3,07	0,69	0,06	2,91	58,50	57,80	130,00	36,60	0,53
QUA	95,8%	unit.005	145,45	-3,59	54.184,97	-2,40	0,84	0,02	127,46	171,30	35,00	47,00	144,00	3,15
NIG	91,7%	unit.006	429,42	-1,79	2.083,162	-3,95	0,53	0,13	32,29	49,40	13,19	23,00	110,70	1,61

	SELECTED TRANSFORM	None	None	None	None	None	LNMED	None	LNMED	None	LN	None	None
	Missing values	0	0	0	0	1	0	0	0	0	0	0	0
	Min	17,00	28,00	-2,48	28,60	0,15	-0,00	0,02	-	144,00	-	0,01	0,12
	Max	63,00	166,00	0,67	41,10	0,81	1,00	0,34	1,00	9.988,00	5,22	0,12	5,14
	Mean	33,83	114,00	-1,12	32,93	0,33	0,49	0,14	0,51	3.884,85	2,30	0,07	1,58
	Standard deviation	15,82	54,02	1,07	4,59	0,28	0,32	0,14	0,33	4.179,02	1,71	0,05	1,87
	Skewness	1,44	-0,87	0,71	1,34	1,94	0,07	0,96	-0,10	0,95	0,76	-0,19	1,80
	Kurtosis	2,85	-0,56	1,33	1,56	3,75	2,36	-1,55	1,48	-1,48	2,10	-2,63	3,38
	Outliers detected (fin	no	no	no	no	no	no	no	no	no	no	no	no
	Weight	0,50	0,50	0,40	0,60	0,40	0,60	0,50	0,50	0,35	0,65	0,50	0,50
	Direction	1	1	1	1	-1	-1	-1	-1	1	1	-1	1
Number of units:	6	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01	si.01
Number of indicator	24	p.03	p.03	p.03	p.09	p.03	p.03	p.10	p.04	p.04	p.04	p.04	p.04
	Sub-pillar	sp.08	sp.08	sp.09	sp.09	sp.10	sp.10	sp.11	sp.11	sp.12	sp.12	sp.13	sp.13
Min. indicator covers 65%	Indicator name	CPI (Score)	DOING BUSINESS INDEX(Rank)	POLITICAL STABILITY INDEX	GINI INDEX	FRACTIONALIZATION	UNEMPLOYMENT (%)	TRADE RELATIONS - EXPORT SHARE	IMPORT SHARE FROM ITALY (%)	ITA FDI OUTWARD (Million Euro)	ITA GAS IMPORTS (Million m3)	IMPORT SHARE WITH TURKEY (%)	EXPORT FROM RUSSIA(Billion $)
	Coverage	Unit/Indicator	ind.13	ind.14	ind.15	ind.16	ind.17	ind.18	ind.19	ind.20	ind.21	ind.22	ind.23	ind.24
ALG	95,8%	unit.001	36,00	157,00	-0,86	32,20	0,32	0,44	0,07	0,45	9.988,00	2,77	0,10	0,92
AZB	100,0%	unit.002	30,00	28,00	-1,00	28,60	0,19	0,53	0,29	1,00	1.485,00	2,08	0,12	2,03
LIB	100,0%	unit.003	17,00	145,00	-2,48	30,90	0,15	-1,03	0,34	0,40	144,00	1,66	0,11	0,12
EGY	100,0%	unit.004	33,00	166,00	-1,21	29,70	0,16	0,51	0,06	0,60	8.393,05	5,22	0,05	5,14
QUA	95,8%	unit.005	63,00	115,00	0,67	41,10	0,74	1,00	0,02	0,60	1.617,36	2,05	0,01	0,27
NIG	91,7%	unit.006	24,00	73,00	-1,86	35,10	0,81	0,49	0,04	-	1.681,68	-	0,01	1,02

Fig 28. Data Treated 2020. Source: Author's Elaboration with COIN

SUMMARY

The thesis aims to provide a wide range of considerations about the energy security indicators and it is deemed to develop a tailor-made composite indicator for measuring complex phenomena. Indeed, the thesis illustrates the main pathways for building a composite index for *assessing the stability and reliability of alternative gas suppliers to Italy*. Energy security is a source of major concern between policymakers and business leaders because the security of flows is a determinant of social stability and economic growth. The issue of energy security has emerged more strongly in the current public debate due to the current situation in Ukraine. The Russian Federation declared war on the Ukrainian nation on 24 February 2022, which has a disruptive effect on the global political and economic balance. The Russian Federation uses its enormous market power in the field of raw materials and fossil fuels as an inexhaustible source of financial resources to support its Federal budget and at the same time as geopolitical leverage over European countries. A rigid application of the market mechanism increased the overreliance on Russian gas supplied by pipelines, hence Europe and Italy became weaker in political terms. Within this framework, Italian policymakers and international institutions have raised major concerns about this unacceptable and unbalanced dependence on Russian fossils. As a result, a wide-ranging look is needed to start finding possible solutions that lay the foundations for a sustainable long-term strategy of diversification of natural gas supplies.

However, the literature develops a number of indexes that do not detect structural problems because there is no involvement of mutually-correlated factors that changes together through similar patterns. Therefore, this thesis aims to construct a composite indicator that scores and assesses the geopolitical stability of gas suppliers to Italy. The index has been named Geopolitical Energy Security Index (GESI), and it represents the evolution of factors that influence the geopolitical stability of gas suppliers in the last decade, namely 2010, 2015, and 2020. The sample includes countries with natural gas exporting capacity, and economic and political relations with Italy, i.e. the thesis includes Algeria, Azerbaijan, Libya, Egypt, Nigeria, and Qatar.

The GESI monitors a number of underlying and root causes that can destabilize the security of energy supply, i.e. this thesis aims to integrate multiple dimensions for assessing the geopolitical stability of gas suppliers and the structural benchmarks of the evolution of this stability. The research is composed of three chapters, where several topics have been covered and managed as parts of a wider puzzle. First and foremost, the thesis opens with a discussion of the theoretical framework concerning energy security and the related literature. The second chapter illustrates the methodology

for building the GESI and shows the relevance of such indicators applied to energy security issues. The last chapter will present the concrete development of the indicator by using the COIN tool elaborated by the Joint Research Center (JRC) of the European Commission, and finally, the results for the sampled countries are provided and commented.

CHAPTER I:

Chapter 1 aims to untangle the intricate relationships between factors that can influence multidimensional concepts such as energy security. The subject of our study is Italy's energy security, particularly in the natural gas sector. Indeed, the composite indicator involves variables from multiple domains with the aim to tackle multiple phenomena. However, there are phenomena, such as the geopolitical situation, which are not directly observable and cannot simply be represented by a pile of a few untwined variables. Therefore, in the context of high inflation due to supply shortages, as well as an exponential increase in conflict in certain areas of the world, the issue of supply diversification has resurfaced more forcefully in the public debate in recent months. In order to be properly studied, complex phenomena must be represented in their components and then examined in their interactions. Moreover, since the issue of energy security is fundamental to the public debate, as well as to a country's national security, it is essential to build tools that can monitor the evolution of phenomena over time (to adapt them to sudden changes in circumstances) and they should be easily communicated to the general public. Hence, the chapter shows the importance of energy security for Italy because the country is over-reliant on the Russian Federation. Therefore, it is first necessary to analyze the framework within which Italy operates to build its national diversification strategy. The following chapter intends to introduce the European gas market in terms of volumes, dependence, and the functioning of general mechanisms. Therefore, an assessment of these mechanisms is crucial for understanding the fragilities of Italian manufacturing and the economic system as a whole.

The first section of the chapter deals with the European Gas System, Before the 2000s, the majority of natural gas prices in the EU were controlled by long-term contracts that were tied to the price of oil, a system known as oil indexation. Gas prices tracked the patterns in oil prices, with volatility smoothed down, hence this provided a constant reference price that supported large-scale investments in upstream projects, transportation pipelines, and LNG terminals (Zeniewski, 2021). Domestic configuration of interests, domestic power distribution, and institutional conditions are at least the government's foreign policy can shape the energy policies and the long-term planning. For what concerns Europe, the economic profitability of the Russian gas was chosen with respect to the securitization and mitigation of political risk. In addition, lower energy prices can boost economic

development and make the cost of goods traded with international customers more competitive. Otherwise, low energy prices can ensure the international competitiveness of a country (or even Europe), hence it would develop a competitive advantage.

Gas prices in the EU have steadily shifted away from oil indexation and toward "gas-on-gas" (known also as supply and demand) competition, in which prices reflect many suppliers and purchasers of natural gas on spot markets. The Netherlands' Title Transfer Facility (TTF) has emerged as the most liquid hub and important pricing benchmark in the EU. The TTF is a spot market Exchange that brings buyers and sellers of commodities, securities, futures, options, and other financial instruments together. In the spot market, short-term contracts are the majority of the instruments issued by buyers and sellers. The spot price is the current quote for a commodity's immediate purchase, payment, and delivery. This is significant because pricing in derivatives markets, such as futures and options, will unavoidably be dependent on these values. Because of this, spot markets are extremely liquid and dynamic. Commodity producers and consumers will participate in the spot market before hedging in the futures market. Nevertheless, there are some weaknesses of these European prices, i.e. speculation of financial operators because of the high degree of reactivity of short-term contracts, less predictability, and high reliance on the physical infrastructure network for ensuring daily operations.

The Russian invasion of Ukraine started on the 24th of February and involved several aspects of the hybrid warfare doctrine elaborated by the Russian military apparatus. The hybrid threat compounds many tools that traditionally overcome the military means (e.g. cyber, economic, cultural, and energetic advantages) that can be exploited in order to target enemies and incentivize certain political behaviors. Within this framework, it can be argued that Russia used energetic means in order to polarize the Western alliance and divide the stakeholders. This strategy is particularly impactful on Italy because it imports almost 45% of its total import needs from Moscow.

The second session attempts a brief explanation of the Italian process of liberalization of the energy sector. Since the beginning of the 2000s, Italy experienced an important increase in its energy consumption, hence the demand for fossil fuels brought the rapid growth of the gas import. The process of growth has led to a structural process of liberalization (through the European Union) that gave rise to the need for regulation to protect consumers and develop competition. Indeed, since the end of the last century, the natural gas sector was the subject of a considerable amount of legislation at both a national and a European level in order to liberalize the national market and create a single European market. The European liberalization process has affected many sectors of infrastructure services, with the aim to decrease prices and improve consumer welfare and reduce the competitive

disadvantage for new entrants and smaller operators. It can be argued that most of the liberalization reforms have benefited Italy's energy security by protecting consumers from the distorting effects that generally occur in monopoly situations. Russian natural gas was cheap and the development of a pipeline network implies a high standard of reliability. However, such an equation did not consider the political risk factor, i.e. the aggressive foreign policies of Russia and the weaponization of the natural gas dependence.

The third section of the chapter aims to highlight the conceptual framework behind which this thesis constructs its meaning. The dissertation proposes a review of the existing literature considered most relevant to define energy security concepts. In addition, the section sets the broader framework of energy security indexes and illustrates the applications of compound indexes in the field of energy security. First of all, the section reviewed some contributions to the energy security concept and its implication for the national security strategy. The concept of energy security is inherently slippery because it is polysemic, and it is capable of holding multiple dimensions and taking on different specificities depending on the country.

There is a relevant body of literature that deals with the micro-level of analysis. The first issue to identify when talking about energy security is the continuity of the energy flows often described in terms of availability, reliability, relative shortage, or complete disruption across the total supply chain. There is a wide range of scholars that identifies energy security with the possible disruption that can occur within the market mechanism, hence there is a perfect analogy between the supply and demand mismatch and the interruption of the energy mechanism (Chester, 2010). However, it can be argued that there is no consistency within the extension of the market mechanism to energy security because the concept cannot be reduced to only the economic dimension. Energy security shows multiple patterns of interaction, i.e. the functioning overcomes the economic aspect. In addition, they do not properly consider the long-term perspective which is the scope of this thesis. Another critical point is that markets are assumed to work automatically via price adjustments i.e. prices respond to changes in demand or supply, finding equilibrium at the price at which the quantity supplied equals the quantity demanded (Chang, 2002). Otherwise, competing needs, when dealing with the international landscape cannot be satisfied because the actors are heterogeneous.

The last part of the chapter deals with indicators for energy security and it analyses the benchmark literature on composite indicators in order to assign the specific field of this contribution. It can be said that the paper of Munoz et al. (2015) became the benchmark literature of the thesis. Indeed, the thesis aims to collect indicators for developing a composite indicator based on multiple sub-pillars, i.e. it wants to measure the exporting capacity of gas suppliers from the structural point

of view. *The composite index helps to understand if a country is a "good" or a "bad" exporter of gas towards Italy.* Analyzing energy risk quantitatively involves considerable methodological challenges, particularly when dealing with some of its more qualitative features. The goal of this research is to use a multivariate statistical approach called factor analysis to quantify the geopolitical risk of energy supply. Munoz at al. (2015) quantitatively estimates the multidimensional geopolitical risk of energy supply. Factor analysis was used to reveal energy risk, a variable not directly observable i.e. the geopolitical risk that is assumed as the dimension able to put in correlation multiple aspects of the countries involved in the analysis. As an outcome, the authors argued that factors should be integrated into the assessment process. The authors identify four pillars for measuring the geopolitical risk related to the energy sector. Each geopolitical situation is hardly stationary, contrary to the prediction of future economic variables, the geopolitical aspect cannot be estimated with a certain degree of probability and it is not directly observable. Indeed, the contribution of the paper is the development of a single quantitative indicator able to represent the geopolitical risk, overcoming the qualitative description of these phenomena.

To conclude, the chapter summarizes the main theoretical underpinnings of the GESI, i.e. they can be listed as follows: long-term oriented, focus on reliability and accessibility of energy, a multivariate technique for assessing complex phenomena and, finally, the GESI is oriented to policy issues.

CHAPTER II:

The second chapter deals with the methodological part of the thesis, i.e. it highlights the main theoretical and methodological development of the index. In addition, the chapter provides an overview of the theoretical framework, the benchmark countries, and finally the variables used for building the GESI. Composite indicators play a central role in comparing countries' performances and they combine several dimensions to measure complex phenomena through a given quantitative outcome. Such complex indicators can be used to illustrate and analyze complex and sometimes elusive issues from different fields. Because of this flexibility, the explanatory power of these statistical tools has experienced a rapid increase in terms of its implementation in both the national and international sphere as regards the development of instruments for comparing complex and intangible forces that shape the global landscape.

The construction of this index permits to analyse of the macro-structural phenomena that can influence a country's ability to export to Italy and at the same time, it includes international policy

variables to study a possible correlation between a supplier's foreign policy and its ability to export gas to the peninsula. From this point of view, the index can be defined as tailor-made because it studies correlations between Italy and the complex international relationships that could influence the country's alignment with various regional competitors. Composite indicators aim to measure complex dynamics, hence each indicator must show to be rooted in a solid conceptual web of logical relations. The first section aims to clarify and justify the decision of certain pillars and variables for measuring goepolitical reliability of gas supply. As stated by many experts, it can be argued that "*the strengths and weaknesses of composite indicators largely derive from the quality of the underlying variables. Ideally, variables should be selected on the basis of their relevance, analytical soundness, timeliness, accessibility*" (OECD, 2008: 23). The section explained the theoretical foundation of the pillar developed for the GESI.

First, the economic pillar aims to detect the relationship between the creation of value and human development. The country's economic development shapes the capacity to demand energy resources *per se* or to supply for external consumers. The thesis argued that in several fossil fuel exporting countries, there is a strong correlation between budget spending and the revenues generated by the economic sector, thus oscillation in the energy volumes or unforeseen decrease in the production capacity can negatively harm the balance of the public spending and erode the political ties. In addition, most of the fossil fuel exporter countries, also called *rentier states*, experienced in the last decade relevant processes of economic development, hence the basket of goods and services (i.e. energy), consumed by each household is subjected to rapid increases or fluctuations that can harm the resilience and reliability of the energy supply to foreign buyers. Disruption in the economic sector can be correlated to geopolitical crises and the balance of payments or other international crises. In contrast, economic development can be positively correlated to the geopolitical stability of the country and higher energy production and consumption.

As regards the energetic vector, it represents the heart of the theoretical framework of the GESI. As a matter of fact, the energetic mix, and the dependence on gas for the electrification of the country can dramatically affect the capacity to export resources if combined with growing consumption and an improvement of the industrial production in the country. It can be said that this mechanism represents a trade-off between the domestic demand for energy and a given fixed production capacity with a small portion of the increase in the short run because important economic expenditures and investments are required. As a result, exporting countries are supposed to boost their energy efficiency with the aim to manage the domestic demand and ensuring, through additional investments, the export of natural gas. The domestic aspect must be included in our computation in order to weigh the effective capacity of supplying gas for external clients. The emerging economies

seem to be more unstable and they are often unable to fulfill external obligations without strong investments.

The third pillar constitutes the socio-political aspect composite indicator is represented by the political component of the country. There are local dynamics that shape the internal landscape in several geographical areas and destabilize entire nations. Economic inequality can harm the social stability of countries and it can be argued that some empirical tests suggest the presence of a certain threshold level on the Gini scale, after crossing which one can expect a radical increase in levels of socio-political destabilization in general and the intensity of terrorist acts/guerrilla warfare and anti-government demonstrations. In addition, the level of fractionalization of society in religious, cultural, and ethnic terms can incentivize the presence of ineffective and weak institutions where the economic activities can not be developed without occurring in further problems and local institutions become less efficient and unable to provide the basic services to the population. Social conflicts can harm political stability and consequently, governmental commitment in terms of foreign policy and energy contracts can change easily without real justification. Indeed, political stability influences the propensity of foreign firms, even energy sector stakeholders, to invest in the country.

Last but not least, the fourth pillar of the GESI aims to measure the political effectiveness of a potential gas supplier. Neither the capacity to produce more gas nor the domestic environment is enough to score the feasibility of a supplier. There is a political environment to consider before building closer relationships. Indeed, some countries have conflicting interests to protect, hence the political alignment should be involved in the assessment process. Therefore, external actors can build an alternative sphere of influence and share alternative interests in the country, especially in the energy sector. Close commercial, diplomatic, and cultural links between the gas supplier and the transit nations might decrease the importing country's geopolitical risk of energy supply. As a result, the chapter introduces a country-specific component in the fourth pillar in order to make the GESI tailor-made and aligned with the Italian case study. The pillar represents this sort of dependence on hostile actors, it can be measured in trade flows and the level of interconnection and embeddedness between the economies. The same procedure can be applied for measuring the relations with Italy and other actors' influence can be weighted in order to reduce the willingness of the supplier for a long-term political commitment in terms of energy contracts.

After the development of the theoretical framework, the chapter explains the criteria used for the definition of the sample. The countries must be an exporter of natural gas to Italy and they should present political and economic relations with the Italian Republic. Some countries do not entail energy relations with Italy, hence the size of the sample cannot account for many countries to analyse.

Finally, we have selected the following countries: Algeria, Egypt, Libya, Qatar, Nigeria and Azerbaijan. However, we used as benchmark countries two of them namely Algeria and Azerbaijan because they represent an emblematic examples of the structural dynamics that GESI aims to tackle. The following paragraphs will analyse the economic, geopolitical and, energetic situations of these two suppliers. Particular attention is devolved towards an assessment of the energy sector and the geopolitical aspect, e.g. the influence of geopolitical dynamics in the countries that are parts of the sample. A deeper analysis of these two case studies suggests to assess the following dynamics: long-term domestic demand increase, high Russian and Turkish involvement, energy relations with Italy, and ambiguous foreign policy in order to maximize the outcomes of each relation.

After a deep analysis of the countries, the chapter illustrated each of the 24 variables composing the GESI, i.e. the supposed relation between variables and the concept of geopolitical and energetic stability. A detailed analysis of these aspects is given in the chapter, otherwise, here it can be said that in the fourth pillar, for assessing the foreign actors' involvement, we took the export relations between the sample countries and Russia and Turkey.

The variables have been considered for 2010, 2015, and 2020. The value of the data was extracted from various databases and reports of multiple international financial institutions We used the International Monetary Fund (IMF) database, the World Bank (WB), British Petroleum-World Energy Outlook, Bank of Italy (BoI), and Ministery of Energetic Transition, UNDP, Observatory for Economic Complexity (OEC) and Transparency International (TI). Nevertheless, none of the data are always available for each year because some variables have a different time interval in which they register further development, hence some data are calculated not yearly. As a result, during the development of the composite index, some assumptions have been developed in order to overcome the metrics limitation. The assumption has been made about certain indicators such as duration (R/P), proven reserves, fractionalization and Gini index.

The last section of chapter 2 aims to explain the normalization and weighting process. Normalization is the adjustment of variables onto a common scale, prior to any data aggregation. It seeks to achieve variable comparability in the following areas: several units of measurement and various ranges of variance. Normalization serves the purpose of avoiding that during the creation of an indicator the analyst would add together values coming from different dimensions and unity of measurements. In fact, indicators are stated in a wide range of statistical units, ranges, and scales. The section has provided a brief explanation of the most relevant and widely-used methods for normalizing the data. Dealing with the weights of the indicators in the respective aggregation level, it can be said that individual weights can be applied to indicators when they are combined into a

composite measure. This permits the influence or significance of each indicator to be modified based on the idea being assessed. Weighting methods might be statistical, based on public/expert opinion, or a combination of the two. In this index, the theoretical framework can play a crucial role in terms of weighting, i.e. each variable will be scored according to the influence considered. Some authors can suggest the equal weighting approach in order to simplify the process and avoiding to formulate assumption that does not necessarily represent the statistical reality. Equal weighting is the most common scheme appearing in composite indicators, i.e. it provides a number of pros especially when the nature of phenomena should be tested. However, it seems theoretically inconsistent to assign the same weight, hence the process of weighting was iterative according to the correlation degree. Within this technique, there is no *a priori* knowledge and no clear reference about the importance of the elements, and no agreement between stakeholders.

Chapter 2 highlights the main theoretical underpinnings of the thesis and at the same time, it describes the general pathways for developing from the theories' perspective a composite indicator. Chapter 3 shows the effective development of the GESI from a statistical standpoint.

CHAPTER III:

The chapter illustrates the various steps performed following the functioning indications elaborated by the programmers of the tool and it will be shown how the theory is applied to the concrete case of the index of the thesis. The following index aims to provide an evaluation of a phenomenon that is not directly observable but has important tangible effects on Italian energy security. For this chapter the COIN tool (elaborated by the JRC) has been used for the statistical elaboration and for the data visualization, i.e. the tool provides a colored heatmap for visualizing the score for each country.

In the beginning, the software requires entering the data which were reported in an Excel tab, i.e. each value has been arranged in a table, where each row corresponds to a unit (typically a country or region), hence in this case we added the countries of the sample. The next step is to enter upper and lower goalposts for each indicator for the normalization process. If the goalpost bounds are left blank, they default to the minimum and maximum values of each indicator: in this case goalpost normalization is identical to min-max. Finally, the user must design the structure of the index: the index, sub-index, pillar, and sub-pillar to which each indicator belongs. It is important to align each component with its respective pillars and sub-pillars, thus ensuring that each group corresponds to its elements.

The theoretical framework is enriched by the sub pillars considered as an intermediate aggregation level between the pillars and the variables. The chapter explains the *ratio* behind each sub-pillar. The economic pillar is divided into growth, country competitiveness, and economic speed. The energetic pillar is composed of the export of gas, extractive capacity, and gasification of energy and reserves. The Socio-Political environment is dependent on the normative landscape, social stability, and social discontent. Finally, the Relation-Italy pillar is measured by bilateral trade, Italian influence, and external actors' involvement.

After the treatment of the skewness and kurtosis that distort the distribution of the values, the COIN provides a correlation tab where each aggregation level is tested according to the correlation index. After this process, it has been assessed the degree of correlation between each sub pillars, pillar and the highest aggregation level represented by the GESI. Then, we adjusted the weight in the rebalancing tab with the aim to avoid high collinearity or negative correlations between the same aggregation group (especially between the same subpillars). Finally, we visualized the score for each country. The same method has been applied for each of the years, namely 2010, 2015, and 2020. Given the score of the GESI for each year, it has been conducted the evaluation and the comment on the results. Within this framework, we assessed the changes in the country's geopolitical stability for the last decade. First, It has been realized that an exporter must deal with the domestic demand for energy sources because of its internal economic and social development that can prevent the capacity to fulfill long-term energetic obligations with other countries (e.g. with Italy). The long-term energy supply side must be tackled in order to have a strategic perspective. Second, a geopolitical crisis such as the Arab Spring dramatically affected the stability and reliability of energy flows, i.e. socio-political variables get worse as well as the natural gas industry. Hence, it can be stated that disruption can be associated with the level of political commitment to long-term energy supply deals. Third, economic development can mitigate shocks and can help to ensure the long-term commitment of the country. Forth, policymakers present ambiguous and “acrobatic” traits of behavior in shaping the foreign agenda. As a matter of fact, they have relations both with Italy in terms of natural gas and at the same time open their doors to capital and products from Russia and Turkey. In particular, this trend of mutual influence has increased in recent years due to the military support provided by the two countries to the nations included in the sample.

Considering the outcomes of the research, it can be argued that Qatar, Libya, and Egypt experienced a deterioration of their geopolitical situation that affected their reliability of alternative gas suppliers in long-term political partnerships. In contrast, Nigeria, Algeria, and Azerbaijan have improved their score despite the covid-19, hence they should be considered good target countries for the broader Italian energy diversification strategy. Even though Qatar made the best performance

even if it exports most of its gas via LNG, hence Italy should try to import more LNG from Doha. The development of LNG terminals for regasification induces the Italian government to increase investments in this step of the supply chain.

The last section tries to develop a bridge between the current research and the further improvement of the GESI. In this form, the GESI shows some limitations that the section reported in order to draft possible alternatives for further research. First, the sample of countries is composed of six countries considered for three different years reflecting the trends of the last decade. It is important to highlight that the value assumed can be quite divergent if compared to an absolute scale. In fact, some countries such as Qatar can present higher income per capita respect Libya or Egypt, hence some outliers can be detected and this difference con influences the normalization process (and even the aggregation). However, these outliers are not caused by statistical oscillation in the historical series but reflect different structural patterns of economic systems. Second, the sample is based on gas suppliers to Italy and it reflects the Italian mainstream foreign policy. Therefore, all the results are not universally applicable to all the contexts and all the benchmarked areas. However, this issue reflects the constitutive nature of the GESI which is a tool for the policymakers of a specific country. Third, there are some assumptions in the collection, i.e. some data has been imputed or assumed constant during the time because of the lack of availability of internationally verified datasets (see chapter 2). Indeed, a more precise measurement can require the development of additional indexes. For example, the Gini index, fractionalization, and total reserves. Those variables have been considered constant because many data were not available for each year due to technical and political reasons. From the technical standpoint, many of these indicators are long-term oriented and their evolution profile is slow compared to other variables.

Within this framework, the section outlines some modifications to extend the representative value of the GESI in future research. First, introducing the component of the external energy demand of the rest of the world or some specific target countries in order to make GESI more dynamic. Hence, future research can introduce a new pillar with “International Demand of Gas”. Second, expanding the number of countries introduced in the sample in order to provide more statistical variance of the data. Third, creating a cluster of countries can help to reduce the presence of outliers and to tackle the ongoing regional dynamics of specific contexts. Forth, introducing a risk mitigation (direction +1) indicator or subpillar, in renewable energies can be used for assessing the reliability of the exporter of gas. Fifth, the subpillar “External Actors Involvement” can be divided into two different subpillars, namely “Influence-Russia” and “Influence-Turkey”. The two subpillars should include variables such as: trade relations, alignment in international organizations, and weapon delivery bilateral initiatives or the number of bilateral treaties.

The scope of each composite indicator is to describe complex dynamics that cannot be reduced to the observation of single components or a simple mean of some isolated factors. The thesis attempted to assess the geopolitical dimension of energy security that seems to be unobservable in quantitative terms. The theoretical framework provided can be the starting point of future research and discussion about the issue of energy security of supply.