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A Comparative Analysis of International Gas Prices against the South African Gas Energy Price (2012 -2016).

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The aim of this study is to benchmark the evolution of the South African gas price against the international gas prices and to check for alignment of the natural gas price in South Africa against prices of other regions. Three longitudinal data sets are utilised over the period 2012 to 2016 for selected countries including South Africa. Such an investigation is crucial for the on-going evaluations of piped-gas pricing regulation in international gas markets despite fundamental differences in stages of market maturity and demand patterns. The relationship between the South African natural gas price regime and prices of gas in other primary supra- regions of the global gas market is also examined to validate the gas price convergence hypothesis. Quantitative tools of research, mainly descriptive and inferential statistical analysis, are used to assess the relationship between the South African gas price and prices in the Asia Pacific, the European Union, North America and Latin America. Price data are obtained from Eurostat, the International Gas Union (IGU) and NERSA. Findings are that gas prices have persistently declined in most of the countries examined. Evidence is also presented that the gas price convergence hypothesis holds, other factors held constant and that the South African gas price is positively correlated to prices in selected international jurisdictions.

***Key Words**:* South Africa Price convergence Piped-gas Price-correlations Benchmarking Oil-indexation

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INTRODUCTION

Natural gas has the potential to make a significant difference to the South African economic as well as the energy demand and supply environment. Henceforth, understanding the underlying drivers of market evolution is an essential underpinning for identifying both new market trends and shifts in the rate of change of ongoing trends. Natural gas is increasingly becoming a global commodity that is traded between regions. As such, international natural gas markets are undergoing a substantial change in market structure and organisation, as well as in supply and demand patterns. These on-going changes create challenges for modelling and forecasting global natural gas supply, demand, and price (EIA, 2014:1). The Energy Regulator requires such an understanding to continuously check the efficiency and efficacy of the gas price in South Africa for benchmarking purposes.

This paper presents an overview of the global gas markets, possible drivers of the evolution of the global gas market and the position of the South African gas market in the global arena. In the face of assertions that international gas prices are converging, this study presents an opportunity to provide an assessment as to whether the South African GE price is evolving towards such convergence or otherwise. The aim of the study is to benchmark the South African gas prices against the international gas prices. This study seeks to assess the relationship between the South African natural gas price regime and prices of gas in other primary supra-regions of the global gas market for benchmarking purposes. Quantitative tools of research are used as instruments of exploring such a relationship to check for alignment of the natural gas price in South Africa against prices of other regions, despite fundamental differences in stages of market maturity and demand patterns. Price data are obtained from various sources to facilitate a desktop research and analysis.

Over the next 10 to 15 years, the energy environment in South Africa is expected to change (, with gas possibly playing a bigger role. It is therefore imperative for the Energy Regulator to take note of this. From a planning perspective, the Energy Regulator needs to be prepared for such an eventuality. Understanding international gas pricing regimes and global gas price trends is crucial for planning and monitoring purposes by the Energy Regulator.

Understanding the conditions under which potential convergence between global pricing mechanisms and price regimes is fundamental for the Energy Regulator to ensure that the price of natural gas in South Africa is aligned to the global market. Such conditions, according to the World Energy Outlook (2013), include; (i) the impact of LNG export flows from the USA; (ii) the impact of breaking links between oil-price escalations and gas supply contracts; (iii) regulatory changes to the gas sectors of the Asia Pacific significantly influencing global pricing trends and; (iv) the declining costs of erecting liquefaction plants throughout the global market, among other factors.

The paper is organised as follows. Section 2 presents the background information and the history to the gas price evolution process in South Africa. Section 3 is a statement of purpose of the study followed by the discussion of methodology adopted in this study in section 4. Section 5 outlines the limitations and de-limitations of the study while section 6 presents the evolution of the gas energy in South Africa. In section 7, a conceptual overview of the price formation mechanisms is presented. A literature survey of geography of international gas markets and global gas pricing regimes is presented in section 8. Section 9 presents gas pricing data from key markets and various comparative analysis is done against the South African GE price. Conclusive remarks are given in section 10.

HISTORICAL BACKGROUND

Regional gas development scenarios in Southern Africa are revealing that there are five countries with potential gas reserves, namely Mozambique, Angola, South Africa, Botswana and Namibia. According to Transnet (2014), the proven gas reserves total potential of the sub-region is estimated at 221 trillion cubic feet (Tcf) of which approximately, 70% (about 154.5Tcf) of such potential is vested in Mozambique with South Africa as the key market.

South Africa has a history of gas as an energy source dating as far back as 1892. However, in 1966 the South African Gas Distribution Company (now known as Sasol Gas) was formed to market and distribute natural piped-gas in South Africa broadly.

At that time, natural gas was produced from industrial coal-to-gas processes. In 1969, the Superior Group drilled the first offshore well. Before 1970, natural gas deposits were discovered for exploration on the continental shelf of the Southern Cape Coast. The Mossgas complex went operational in 1993 at almost full capacity and in 2004 first natural piped gas arrived at Secunda from Mozambique.

In September 2001 the Government of the Republic of South Africa entered into an agreement with Sasol Limited regarding the regulatory regime of Sasol Limited's activities in piped-gas. The agreement was then known as the 'RSA Regulatory Agreement' with the ministers of Trade & Industry and Minerals & Energy as key signatories.

In terms of the RSA Regulatory Agreement, Sasol Gas was given a Special Regulatory Dispensation which gave it exclusive rights to the pipeline infrastructure for the period 2004 (first gas received by Sasol) to 25 March 2014. In this dispensation, NERSA's regulatory mandate was subject to the RSA Regulatory Agreement which prescribed Sasol's prices until 25 March 2014 as well as certain tariffs, exclusivity conditions and price capping.

The Regulatory Agreement bestowed Sasol Limited ("Sasol") with a special regulatory dispensation until 25 March 2014. The agreement made provisions for Sasol to charge its customers using the Market Value Pricing (MVP) principle. In terms of the Regulatory agreement, Sasol Gas was expected to charge a so-called market price to each customer. This market value price was determined according to the costs of the alternative fuel used by the customer. In other words, Sasol Gas could therefore charge different groups of customers different prices, depending on the alternative to gas that is available to the customer.

The MVP regime legalised a form of price discrimination (since the price was not determined by the cost of supplying gas), as well as cross-subsidisation between customers. In 2013, NERSA started regulating piped-gas prices using the Methodology to Approve Maximum Prices in South Africa (the Methodology). The Methodology prescribes that the maximum price for gas energy shall be determined by reference to energy price indicators. Once the maximum price for gas is determined then all other costs (i.e. trade margins, distribution tariffs, transmission tariffs and levies) shall be included to arrive at the total price to be invoiced by a licensee to its customers.

The Gas Act, 2001 (Act No. 48 of 2001) ("the Gas Act") empowers NERSA to regulate gas prices. According to section 4(g) of the Gas Act, when the licensee holds a licence that contains a condition in terms of section 21(1)(p) of the Gas Act, then such licensee's maximum prices must be approved by the Energy Regulator in the prescribed manner where there is inadequate competition.

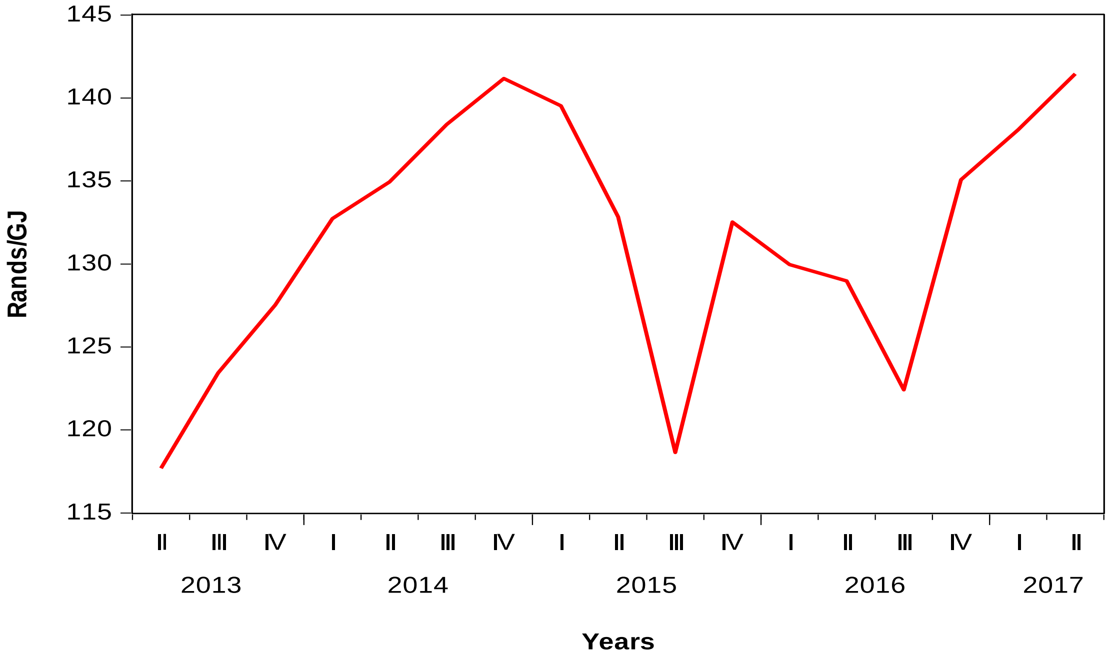
The Piped Gas Regulations, 2007 (published under Government Notice No. R. 321 in *Gazette* No. 29792 on 20 April 2007) ("Piped Gas Regulations") provide further price regulation principles and procedures. Among other provisions, the regulations provide that the Energy Regulator must, when approving the maximum prices in accordance with section 21(1)(p) of the Gas Act, *inter alia* be objective based on a systematic methodology applicable on a consistent and comparable basis.

The objective of this document is to produce a snippet of the gas-pricing framework that is prevalent in the world gas markets. Given that South Africa is planning to introduce Liquefied Natural Gas (LNG) into the market, the global pricing formations and trends will be monitored on an annual basis so as to keep abreast with developments that can potentially have an impact on the local gas pricing landscape. A comparative analysis is thus conducted in this study to see if the evolution of the South African gas market is driven by the same forces as those driving international gas markets and aligned to the global gas market.

Since 2004 to 2013, customers paid a bundled price that included a transmission tariff and other elements in terms of the Market Value Principle (MVP). MVP prices were based on cost of alternative fuels. During this period, NERSA's role was to monitor tariffs as prescribed in the regulatory agreement. Hence, Sasol did not charge tariffs between 2005 to 2013, but only charged MVP. Despite the changes in pricing methodologies in 2014 and new market entrants, competition in the South African gas industry is still inadequate. The industry is characterised by inadequate competition controlled by a single vertically integrated gas supplier, Sasol Gas. The dominant supplier is in control of the existing transmission and distribution infrastructure to a greater extent.

The GE price is driven by prices and volumes of key alternative energy sources in South Africa, namely Coal, Electricity, Diesel, Liquefied Petroleum Gas and Heavy Fuel Oil. Table 2 below shows the evolution of the gas energy price, on a quarterly basis, as presented by both Sasol Gas and NERSA. The GE has been fluctuating over the period ranging between R117.69/GJ to R141.45/GJ over the period 2013 to 2017. Figure 1 below is a graphical presentation of the GE movement according to calculations submitted by Sasol and recognised by NERSA.

Figure 1: Sasol's Gas Energy (GE) Price trend in South Africa, 2013Q2 to 2016Q4



Notably, the GE has fluctuated significantly over the reference period with sharp declines in July 2015 and July 2016 respectively. Figure 1 illustrates that the GE rose consistently for the second quarter of 2013 from R117.69/GJ driven mainly by escalating prices of crude oil, hence diesel prices, HFO and the exchange rate turbulence.The GE price increased from R134.95/GJ to R138.40/GJ in the second to third quarters of 2014. The GE price further increased to R141.18/GJ in the fourth quarter of 2014. This translated to a 5% increase in the Sasol GE price from the date of its first implementation of the maximum GE price to the end of 2014. The increase was mainly due to the increase in the price of electricity, diesel and LPG in the first and second quarters of 2014.

In the first quarter of 2015, the GE price was R139.52/GJ. The GE price decreased from R139.52/GJ to R132.83/GJ in the second quarter of 2015. It further decreased from R132.83/GJ to R118.65/GJ in the third quarter of 2015. This sharp decrease of about 16% in the GE price was due to a decrease in the price of HFO, and consequently the price of diesel and LPG. Diesel has a significant weight in the basket of alternatives formula used to calculate the maximum price. Hence, a decrease in the diesel price had a considerable impact on the final maximum GE price. In the third and fourth quarters of 2015, the GE price increased by 12% to R132.52/GJ. This sharp increase in the GE price was mainly a result of an increase in the price of electricity and diesel.

In the first half of 2016, the GE price slightly decreased again by 3% from R129.97 to R128.98 and continued to further decrease by 5.09% in the second quarter of 2016. The decrease in the GE price in this period was due to a decrease in the prices of electricity and diesel. The GE price increased by 10.33% from R122.42/GJ in the previous quarter ended 30 September 2016 to R135.07 in the quarter ending 31 December 2016. The increase in the GE price of 10.33% in the last quarter of 2016 was due to the increase in the price of electricity and diesel in the second quarter of 2016 (as Sasol Gas' adjustment mechanism uses information from that period to escalate the GE in the last quarter of 2016).

From December 2016 to 31 March 2017 the GE price increased by 2.23% from R135.07/GJ in the quarter ended 31 December 2016 to R138.08/GJ in the quarter ending 31 March 2017. The increase in the GE is attributed to the increase in prices of thermal coal, diesel and electricity. For the second quarter of 2017 ending 30th of June, the GE price stands at 141.45/GJ pronouncing a 2.44% increase from the R138.08/GJ of the first quarter based on historical information at Sasol's disposal. Electricity and diesel prices are once again the main drivers of such an increase.

LITERATURE REVIEW : THEORETICAL CONSIDERATIONS, CONCEPTUAL ISSUES AND APPLICATIONS IN INTERNATIONAL GAS MARKETS.

Natural gas pricing is based on the energy or heating value of the gas. Ordinarily, the natural gas heating value is dependent on composition and is defined as 1000 British thermal units per standard cubic foot (BTU/scf). Thus, the global metric for gas price is quoted as $US per million Btu (alternatively written as $/mmBtu or $/MBtu).

Therefore, the price quote is then understood as the heating value of natural gas for a $/1000scf. It implies that the direct scientific translation of such a heating value for pricing purposes can be defined as 1000Btu/scf as equal to 37,3 mega joules per standard cubic meter (MJ/sm^3). From that argument, in the South African context, natural gas prices are expressed in Rands per Gigajoule (R/GJ) from which 1GJ is directly equivalent to 0.94718mmBtu. Hence, 1GJ can be approximated as 1mmBtu and this concept is adopted for a comparative analysis in this study.

The world gas market is dominated by the gas-on-gas competition pricing formation mechanism, driven by forces of natural gas demand and supply particularly in Europe and American markets. However, other price formation mechanisms are pronounced in the Asian-Pacific markets. The spectrum of natural gas price formation mechanisms embraces at least nine distinct mechanisms namely; Oil Price Escalation (OPE), Gas-on-Gas Competition (GOG), Bilateral Monopoly (BIM), Netback for Final Product (NET), Regulation: Cost of Service (RCS), Regulation: Social and Political (RSP); Regulation: Below Cost (RBC); No Price (NP) and the Not Known (NK). In the OPE regime, the price is linked through a base price and an escalation clause, to competing fuels, typically crude oil, gas oil and/or fuel oil, coal and electricity prices.

The GOG regime is based on the interaction of forces of supply and demand forces in the respective gas markets. The GOG characterises trading at hubs such as the Henry hub in the United States and the National Balancing Point (NBP) of the United Kingdom and other hubs particularly in North West Europe. Under this pricing regime, gas is bought through short term and long term fixed contracts supported by gas price indices rather than competing fuel indices to determine monthly prices. The GOG regime embraces spot LNG and any pricing linked to hub or spot prices. Typically, bilateral agreements in markets dominated by numerous buyers and sellers reflect a GOG regime.

The BIM is a price determined through bilateral discussions and agreements between a large seller and a large buyer. The agreements lead to a fixed gas price that usually has a lifespan up to a year. There may be a written contract in place but often the arrangement is at the Government or state-owned company level. As opposed to the GOG regime, the BIM is between a single dominant buyer or seller, at least, as one party to the transaction (IGU, 2015:7)[2]. Under the NET, the gas price paid to the supplier is a function of the price paid on the final product on which gas would have been used as an input. This is mostly relevant in circumstances where gas is a major variable cost in producing the product. For instance, in production processes where gas is used as a feedstock in chemical plants producing ammonia or ethanol.

The regulation based pricing regimes are either, RCS; RSP or RBC as defined in paragraph 7.2 above. The RCS is a pricing regime approved by a regulatory authority or a responsible authority such as a Ministry, such that it is set to recoup the cost of service and recovery of invested funds inclusive of a reasonable return. The RSP regime sets the natural gas price based on social or political factors on an irregular basis as deemed necessary by a responsible authority with an objective of ensuring that escalating costs are recovered or possibly as a revenue boosting strategy. As such, the RSP is a hybrid between the RCS and RBC. The RBC is therefore a price setting approach with an intention to put it below the average cost of producing and transporting the gas as a way by a government to subsidise the trading of gas in the economy.

The NP and NK regimes are meant to provide gas as a ‘free good’ to the populace and industry, strategically to boost output in targeted sectors of the economy. Usually, such gas is a by-product of other production value chains such as oil refinery or coal extraction activities. Thus, gas pricing regimes that are functional in international gas markets are a resemblance of the above conceptualised price formation mechanisms or hybrid combinations depending on circumstances in such

Two competing pricing regimes have dominated regional gas markets internationally, i.e. the oil-indexed pricing (the OPE) and gas-on-gas (GOG) based pricing. The oil-indexation pricing regime, largely dominating the Asian markets and the Oceania, is driven by the price of crude oil. The gas –to – gas (competition) pricing regime is largely dominant in North American and some European hubs. The share of gas on gas competition stands at 44.4% of total world gas consumption and is the leading pricing regime while the oil-indexed pricing regime is the second at 17%. Other

[2] IGU(2015). News, Views and Knowledge on gas – worldwide: A global review of price formation mechanisms, 2005 – 2014. Wholesale Gas Price Survey – 2015 Edition.

mechanisms are contributing to international pricing of natural gas with remaining proportions.

These competing pricing structures caused divergence among natural gas prices in different regional markets in conjunction with market circumstances that accentuated pricing regime differentials since 2009 until early 2015. Researchers have pointed that since 2016, there are signs indicating that international gas prices are likely to converge in the outlook period up to 2021. The global natural gas market is comprised of regional markets that are often grouped based on either the historical patterns of transoceanic shipping (i.e., the Atlantic and Pacific Basins), or the primary supra-regions for natural gas trades (i.e., North America, Europe, and Asia). The primary supra-regions for natural gas trades are considered in this analysis to understand the global stature of the international gas market with unique characteristics namely; (i) OECD Europe, with Western Europe importing mainly from Norway, Russia and Algeria; (ii) North America, importing from Canada and Mexico while production of shale gas in the USA is contributing about 50% to total gas consumed; (iii) Latin America – with Brazil and Argentina as key consumers of natural gas although Venezuela is the biggest producer and; (iv) Asia – with China, Japan and South Korea as the major consumers and importers of gas in that market.

The North American gas market is highly dynamic and deregulated with gas prices at key hubs, such as Henry hub, determined through gas-to-gas competition. This directly implies that the gas price is set through the interaction of market forces of supply and demand. The natural gas price is highly elastic due to the substitution effect caused by competing sources of energy.Dry gas production has been on a trajectory from 2004 to 2013 with output increasing by at least 25% over that period. This led to increased domestic consumption and changed the United States from an importer to an exporter of natural gas to other markets. Due to the abundance of shale gas in North America, the price of natural gas has been low since 2004. Such a low pricing regime has been aggravated by declining drilling costs and technological advancements that led to efficiency improvements. Low gas prices, at most US$3 per million British thermal units (MMBtu) orchestrated coal-to-gas switching in the electricity generation sector of the United States. However, consumption of gas in the power sector of the United States due to decreasing demand of electricity is increasing at a decreasing rate, with the decline in the consumption rate to a mere 0.5% by 2021.Exportation of gas is expected to drive a steady increase in natural gas prices despite sluggish growth in gas consumption in both industrial and household activities.

The Latin American market is largely dominated by Brazil and Argentina as giant consumers of natural gas although Venezuela is taking the lead in terms of domestic production. By 2016, three countries (Argentina, Brazil and Chile) were importing LNG. Brazil, by far the largest country, represents about half of total energy demand in Latin America. The bulk of natural gas consumption goes towards power generation projects. Imports of natural piped gas from Bolivia to Brazil were sold at prices between US$8.50/MMBtu and US$5.90/MMBtu over the period 2012 to end of 2015 in a declining fashion. Natural piped-gas imported into Argentina over the same period costed between US$10.50/MMBtu to US$6.00/MMBtu. In March 2016, Brazilian industrial customers paid between US$11.05/MMBtu and US$13.10/MMBtu depending on volumes consumed, whereas residential consumers paid US$23.69/MMBtu and commercial consumers paid US$18.9/MMBtu. Power producing plants paid US$3.8/MMBtu (Honore, 2016:109[3]).

In Brazil, import prices from Bolivia (indexed on oil prices) are expected to decline supported by lower LNG prices until 2020. Nonetheless, piped natural gas is approximately 80% of total gas supply with a contribution of the outstanding 20% as LNG. Argentina is the second largest producer of natural gas from its shale gas deposits. Gas demand is driven by variations in temperature during the year and it is volatile. In contrast to the other regional markets, Argentina has a gas-intensive economy that has evolved since 1960s. Approximately 49% of total primary energy demand is covered by natural gas. Argentina imports LNG from the spot markets such as the Henry Hub at a fixed price based on the developments in the short-term markets plus a premium in US dollars. Before 2015, the natural gas prices have been above US$10/mmBtu and thereafter prices of LNG have subsided. Notably, the natural gas market of Argentina is the largest in South America representing 36% of total regional demand.

[3] Honore (2016). South American Gas Markets and the role of LNG, *The Oxford Institute of Energy Studies.*

The European gas market is characterised by a strong link between the gas price and the oil price, although the price formation mechanism has evolved displaying a paradigm shift from oil price linked gas pricing regime to gas-to-gas competition based pricing. The most developed part of Europe in terms of liberalised gas hubs is the North-Western region comprising of the National Balancing Point (NBP) of the United Kingdom as the most developed hub amongst other hubs in countries like Belgium, Denmark, France, Germany, Ireland, Luxembourg, the Netherlands and Sweden. In terms of market development, it is a diverse market depicting the most disparity between 'mature', 'poor' and 'illiquid' hubs. With the NBP as the leading hub, the Dutch TTF of the Netherlands comes second and very strong. The Dutch TTF has been modelled against the NBP and as a result the prices of these two hubs are nearly perfectly positively correlation. Belgium, France and German hubs are middling. In this study, the British NBP, the Netherlands TTF and the Belgian Zeebrugge (ZEE) are selected to represent natural gas price evolution in this block.

The Belgian Zeebrugge (ZEE) started trading in 2000 and has remained a mid-range hub as compared to its counterparts in the region. In the near future, there is an expectation that the ZEE will merge with its counterpart in Luxermbourg in a horizontal market integration. The French market is mainly saved by two hubs, namely the PEG Nord and the TRS. The PEG Nord is well connected to pipeline gas supplies and imported LNG. The PEG Sud is largely dependent on LNG imports and supplemented by PEG Nord pipeline supplies. Central Eastern Europe comprises of Austria, Bulgaria, Croatia, Czech Republic, Germany, Hungary, Poland, Romania, Slovakia and Slovenia. In Austria, the Baumgarten is the most active trading hub handling LNG supplies from Russia for distribution to Western European destinations especially Germany, Italy, Slovenia and Hungary. The market for Germany is understood mainly through the Gaspool (GPL) and NetConnect Germany (NCG). Spot/prompt trades have dominated the GPL and NCG hubs

Mediterranean Europe is defined by countries namely; Portugal, Spain, Italy, Greece, Turkey. The Italian PSV and the Spanish AOC are leading hubs in Mediterranean Europe. Prices of natural gas are essentially higher than those in the North-Western region and low price correlation against either the NBP or TTF prices has been attributed to poor infrastructure connectivity between these regional markets. Notably the Italian PSV and the Spanish AOC are driven by the regulated price formation mechanism. In the North-Western region, the NBP is the benchmark and the most liberalised and mature market with the Dutch TTF seconding. However, significant price convergence has been observed in four key trading hubs of North-Western Europe, that is the Netherlands TTF, the Germany GPL & NCG hubs and the Belgian ZEE over the period January 2012 until January 2015. The key driver of such a price convergence is the linkage in natural gas infrastructure among these four hubs which has improved substantially over the period in question.

Russia is Europe's largest producer of gas. It acts as a 'shock absorber' to the global gas system, in the sense that the excess of LNG that does not go to Asia ends up in Europe, with Russia plugging the shortage of supply (AER, 2017:2). Norway and the Netherlands are the leading gas producers in Western Europe. A substantial decline in gas production has been noted in the Netherlands due to seismic activity in its drilling areas. However, Norway has expanded gas production and supply by up to 8.6% over the period 2013 to 2015 although forecasts are predicting a decline from 2018 to 2021. Northern and North East Europe (Denmark, Sweden, Finland and the Baltic States and Central Eastern & South Eastern Europe (Ukraine, the Balkans, Romania, Bulgaria and Greece) have visible hubs in different maturity stages in that continent.

Prior to 2009, oil-linked prices provided a reference price for the European gas market, but this progressively weakened in the competitive markets of North-West Europe as hubs began to take over as the main price formation mechanism (OIES, 2014:73). In the period 2011 to end of 2013, European hub pricing was influenced by the price needed to attract into the market the marginal tranche of flexible supply, namely Russian pipeline gas contract volumes above the take-or-pay levels, which came to be viewed as a price 'benchmark' by market players. In the first half of 2014, a mild winter (reducing European demand by 51Bcm compared to that of 2012/2013) and consequent high Spring 2014 storage levels , combined with a redirection of LNG cargoes into Europe and away from Asia (as Asian LNG spot prices softened) led to a dramatic fall in European hub price levels.

Three key forces acting on European hub prices are noted as: (i) the supply and price policies of existing European suppliers – especially Russia, Qatar and possibly, but to a lesser extent, Norway; (ii) the availability of flexible supplies of pipeline gas (principally from Russia) but particularly LNG (especially from Qatar, new suppliers in North America and Asia) and; (iii) the development of Asian LNG demand, particularly from China. Overall, by the end of 2014, evidence revealed that the European market has gradually shifted away from oil price indexation to a market pricing regime. The share of market pricing across Europe as a whole stood at 61% by end of 2014 although the market remains variegated. The greatest challenge that Europe has faced in its market liberalisation process is the inability by Algeria to move out of its traditional oil-indexed contracts.

By end of 2016, Europe has significantly moved away from oil indexation to Gas – on – Gas pricing. In the North-Western region, hub-pricing is dominating with over 88% of transactions reflecting such while oil indexation in long-term contracts is still visible with a least 12% of transactions reflecting so. North-Western Europe takes 50% of total European natural gas demand. In Central Europe, gas-to-gas competition drives 53% of overall price formation while 32% of prices in the market are oil-indexed and 15% of prices are regulated prices through social and political factors. In Mediterranean Europe, at least 64% of prices are formed through oil price escalations and at least 30% are established through gas-on-gas competition. South East European prices are largely formed through regulation by cost of service constituting aggregate price formation at 52% and at least 38% of such prices are driven by oil-price escalations. In terms of total continental demand for natural gas South Eastern Europe takes 5% while Mediterranean and Central Europe are taking 30% and 15% respectively. Broadly, British prices are 100% market driven through gas-on-gas competition. Continental Europe balances on both prices based on oil price escalations and gas-on-gas competition at 38% and 54% respectively. Regulated prices takes the least share at 8% prevalent in Central and South Eastern European countries.

According to GIIGNL(2016)[4], the Asia Pacific region continues to dominate world LNG trade with approximately 66% of the world's LNG imports in 2015. Asia Pacific LNG exports stay in the Asia Pacific region, flowing primarily to Japan, South Korea, and China. Traditionally, LNG in Asia Pacific has been bought and sold under long-

[4] International Group of Liquified Natural Gas Importers (GIIGNL)(2016). The LNG Industry: GIIGNL Annual Report 2016 Edition; http://www.giignl.org/sites/default/files/PUBLIC AREA/Publications...pdf.

term contracts, with contract prices indexed to oil prices. In the Asia Pacific region, countries are sparsely located such that hub development has been constrained by geographical distance in between them. Countries such as China, South Korea and Japan are dominant in that market as their consumption of natural gas is above 50% of the total volumes while the other 50% is consumed by Malaysia, Myanmar, Vietnam, Indonesia, Thailand, Philippines and Singapore.

In the Asia Pasific, natural gas end users pay a combination of market-based and regulated prices (EIA, 2017:30)[5]. LNG provides the majority of natural gas supply in all Asia Pacific countries except in China and prices are set in the world market. Domestic prices are on the other hand largely regulated or they are constrained by regulation of the pipeline transmission sector. In the Asia Pacific LNG market, the contract formula utilised extensively is based on the price of crude oil delivered to Japan, called the Japanese Customs- Cleared crude oil price or JCC (alternatively known as the Japanese Crude Cocktail). Buyers and sellers negotiate prices for delivered LNG that usually have three components: a negotiated fixed component, the JCC as published by the Petroleum Association of Japan, and a negotiated fraction used to multiply the JCC. The fraction normally discounts the JCC component. Notably JCC-related prices for LNG have been the norm in Asia Pacific in long-term contracts.

China and India have demonstrated a tendency to move away from the regulated pricing regime for market based pricing regimes in the past five years. China changed from regulated social to a regulated cost of service based pricing regime in 2009. In 2015, the oil price indexation has dictated at least 59% in transactions of the total Chinese natural gas consumption and the outstanding 41% of transactions are through the regulated cost of service pricing regime. China is the leading consumer of LNG in the Asian market seconded by Japan. Notably, China is the biggest producer of LNG in that region followed by Indonesia, Malaysia and Australia. Since 2015, production in China has grown by about 5% and is expected to increase steadily until 2021.

[5] U.S Energy Information AdministrationA(2017). Perspectives on the Development of LNG Market Hubs in the Asia Pacific Region, www.eia.gov

In December 2016, the average price for spot LNG declined to US$7.30/MMBtu in China. However, the spot price was below the average contract price in 2016 which was at US$7.68 over the same period. In India gas demand is currently lower than it was before 2010 due to stagnating domestic production and comparatively higher LNG prices. However, demand for natural gas in India is projected to grow at an average rate of 5.6% since 2015 until 2021. The Indian LNG import price has declined from around US$14/MMBtu in April 2014 to US$6.90 in October 2016. India's price formation mechanism is based on the ratio between international gas prices in hubs such as the Henry hub, the Netherlands TTF and the Belgian ZEE.

Japan is the second largest LNG consumer in the Asian market. However, demand for gas in Japan has declined since 2013 due to high LNG prices that have led to a significant substitution effect in favour of nuclear energy in their electricity generation projects. Japan is entirely dependent on LNG imports with a small significant contribution of its total consumption volumes generated from domestic sources. The JCC LNG pricing formula has long set gas prices across Asia Pacific. In 2015, the Platts JKM price, which represents LNG trades in Japan and South Korea, has provided indication of spot market prices for the region. The average price of LNG imported by Japan stood at US$7.50/MMBtu as of January 2017, a decline of about 4% as compared to the February 2016 prices. Despite the noted declines in demand over the period 2013 to 2016, the prices of gas are expected to increase swiftly from US$6.99 up to US$7.8 between 2017 and 2020 (Interfax, 2017:12)[6].

Overall, spot LNG prices have been declining over the period under review. So far in 2017, at the end of the first quarter, prices in the Asian markets have ranged between US$5.50 and US$6.00. Changes in weather conditions are expected to significantly boost demand for gas in the remaining quarters of 2017, thereby driving prices upwards. In this study, the Asia Pacific region is represented by Japan, China, India and South Korea with special consideration that lack of geographic proximity and expansive waters in between countries are prohibitive factors towards the development of effective hubs

METHODOLOGY AND DATA COLLECTION

[6] Interfax (2017). Global Gas Analytics, Issue 54, Interfax energy.com/analytics.

The study was a desktop research using data collected from secondary sources regarding natural gas prices in selected countries that are deemed as fairly representative of identified regional markets in the world. Three data sets were utilised. The first data set consisted of 13 countries representing the global gas market. As such, 13 countries were selected using convenience sampling; including South Africa. The second data set benchmarks the South African gas-pricing regime to its counterparts in the European Union. The third data set is meant to investigate the alignment and patterns of class-based gas prices per customer categories for five countries including South Africa.

In the first data set, countries selected to represent various markets and regions are chosen on the basis of information availability. They are deemed representative of regions of their origin. In the second data set all European Union countries were considered in the sample for benchmarking purposes. In the third data set, only five countries were considered where Spain is representing Mediterranean Europe, with Belgium, United Kingdom and the Netherlands representing North West Europe. These countries have more advanced markets compared to South Africa. Hence, they were considered for benchmarking purposes.

Data were collected from sources such as the Waterborne Energy and the International Gas Union (IGU) wholesale price survey, the BP Statistical Review of World Energy, the International Energy Agency and Eurostat. Natural gas prices considered excluded taxies and levies. Appropriate data transformations were done to establish a common basis of comparison between natural gas prices among countries selected in the study. For instance, all prices are quoted in US dollars. Since, 1 gigajoule is equated to 1.055million British thermal units (IGU,2012)[7], this study considered these two standard metric measurements of natural gas as directly equivalent and directly comparable.

Comparative analysis was done through summary statistics, descriptive analysis through graphs, measures of central tendency & dispersion and a correlation-covariance matrix. Cross tabulations were done to view the distribution of natural gas prices in each respective country. Cross tabulations were also done to check for

[7] IGU(2012). Natural Gas Conversion Pocketbook.

alignment patterns of class-based gas price caps in South Africa against four European countries, namely United Kingdom, Spain, Netherlands and Belgium. Graphs are presented to observe trends in natural gas prices in the selected countries. They facilitate comparisons of the price time series among the selected countries. They are, in this study, a useful tool to facilitate the inspection process considerably (Asteriou & Hall, 2016:17[8]) particularly in giving an overview of the trends in natural gas prices in selected countries for benchmarking purposes against the South African GE price.

Summary statistics, in the form of tables and graphs are easier to understand than inferential statistics. Relevant summary statistics are extensively considered as adequate input for policy making (Agung, 2009:10[9]). Measures of central tendency are presented to understand average prices of natural gas in countries included in the sample for a comparison. A correlation-covariance matrix is then presented to understand linear association and patterns of co-movement in the gas prices using the first data set to check for global convergence. The correlation-covariance matrix is symmetrical since the correlation or covariance between A and B are also the same as those between B and A.

Theoretically, covariance is a measure of joint variability of two random variables. In this study, covariance coefficients are computed to observe the joint variability of international natural gas prices in different markets. If greater values of one variable mainly correspond to the lesser values of the other variable, and the same is true for their corresponding lesser values, it can be deduced that there is a positive covariance between them. The two variables are moving in the same direction, with or without a possibility that they will converge in future. If greater values are corresponding to lesser values of the respective variables under investigation, there is negative covariance indicating movement of variables in the opposite direction. The sign of the covariance shows positive or negative covariance. The size of the covariance coefficient is not easy to interpret but instead it is useful in the determination of the correlation coefficient[10]. Hence, that is meant to provide

[8] Asteriou, D & Hall, S.G (2016). Applied Econometrics 3rd Edition. China:Palgrave Macmillan

[9] Agung, I.G.N (2009). Time Series Data Analysis using Eviews, Singapore: John Wiley & Sons.

[10] By definition the covariance between two jointly distributed real-valued random variables is the expected product of their deviations from their individual expected values;

preliminary evidence on whether natural gas prices are converging or diverging overtime.

By contrast, correlation coefficients, which depend on the covariance, are a dimensionless measure of linear dependence. As such, correlation coefficients are a normalised version of covariance to the products of the respective standard deviations of the variables. The magnitude of correlations ranges between -1 and 1. Ordinarily, correlation coefficients are statistical measures of dependence or linear association between two variables. Correlations are useful because they can indicate a predictive linear relationship that can be exploited in practice. In this study, simple correlation coefficients depict bivariate linear relationships between paired international gas prices .e.g. between the South African GE price and those in North America, European or Asian Pacific hubs.

The Pearson's product-moment coefficient is utilised in this study and parameter estimates are generated in Eviews software. The Pearson correlation is +1 in the case of a perfect positive (increasing) linear relationship and -1 in the case of perfect negative (decreasing) linear relationship. Between 0 and -1 , the negative Pearson correlation shows an inverse linear relationship which can be taken as preliminary evidence for divergence. Thus, between 0 and 1, the correlation coefficient shows a direct linear relationship which can be taken as preliminary evidence of convergence pending more advanced investigations.

Price correlation shows whether adjoining markets are reacting to forces of demand and supply in the same manner, although the analysis requires a relatively longer time horizon. However, in itself, price correlation is a necessary but not a sufficient condition for price convergence. Thus, it partially proves market integration but with further analysis called for. Notably, price correlation reflects that natural gas prices in this instance are moving in the same direction, at the same time and by the same amount. Price correlation does not necessarily reflect price convergence, other things being equal (Heather, 2015:26[11]). Under each correlation and covariance coefficient estimate, the respective probability value (p-value) is calculated to show the reliability of that particular coefficient estimate.

Cov(X,Y)=E(X-E[X])(Y-E[Y])]

[11] Heather, P (2015). The Evolution of European Traded Gas Hubs, OIES Paper : NG 104.

DATA ANALYSIS AND DISCUSSION OF FINDINGS

Table 3 below presents a sample of natural gas prices over the period 2012 to 2016 in 12 countries representative of key regional gas markets. Brazil and Argentina are representing the Latin American region while Mexico and the United States of America (USA) have represented the North American region in the sample. The European market is represented by the United Kingdom and Belgium from North Western Europe. Spain is representing Mediterranean Europe. The Asian Pacific region is represented by China, Japan, India and South Korea. The South African GE price is benchmarked against prices of these countries despite notable disparities on the maturity of these variegated natural gas market regions.

To some extent, Table 3 displays longitudinal (panel) data if the countries are regarded as cross-sectional identifiers whose prices as variables have been collected over the period in question. On the other hand, countries are treated as variables as they are showing different price regimes over time and as such the data becomes a time series. The period in question has been restricted to 5years because of data constraints for South Africa, with a view to create a balanced panel data.

Below is summary statistics presenting some measures of dispersion and central tendency. Table 4 below is a summary of descriptive statistics displayed through measures of central tendency and dispersion. The mean shows the average natural gas price per country over the period 2012 to 2016. The median is also an alternative to the mean as an estimate of the average gas price per country. The maximum and minimum depicts the highest and lowest prices of gas, respectively, per country over the period in question. The standard deviation reflects the spread of the natural gas prices around their average values per country.

Table 3: Natural Gas Prices for Selected Countries from 2012 to 2016

	Natural Gas Prices for Selected Countries in $US/MMBtu				
Country/Year	2012	2013	2014	2015	2016

United Kingdom	10.17	9.79	6.60	5.40	6.40
Belgium	10.08	9.83	6.78	5.17	6.18
South Korea	14.95	15.75	10.50	6.79	6.79
Japan	14.95	15.04	16.00	10.4	6.9
China	14.55	15.35	10.10	7.01	6.64
India	14.40	13.95	10.15	7.16	6.55
Spain	11.78	10.25	9.15	6.09	6.79
Brazil	15.11	14.95	9.92	7.16	7.01
Argentina	16.41	15.95	10.20	7.18	7.20
USA	3.79	2.97	3.40	1.98	2.84
Mexico	-	16.50	10.18	7.13	6.99
South Africa	-	13.03	12.72	10.27	8.79

Source : Waterborne Energy (except for South Africa)[12]

Over the period in question, the highest price of natural gas price is recorded in Mexico at US$16.90/mmBtu while the lowest price is noted at the Henry hub at US$1.98/mmBtu. In US dollar terms, the average gas price for South Africa is $11.56 between 2012 and 2016 and is closer to average prices in countries such as Mexico at $11.54 and South Korea at $10.96. Figure 2 below shows graphical trends in natural gas prices for these selected countries.

Table 4: Summary of Descriptive Statistics

y Price	**Statistic (US$/mmBtu)**

[12] South African data points from 2014 to 2016 is obtained from NERSA's archives of the GE price in Rand value converted to $US dollar using the average annual exchange rate KBP5339J obtained from the South African Reserve Bank.

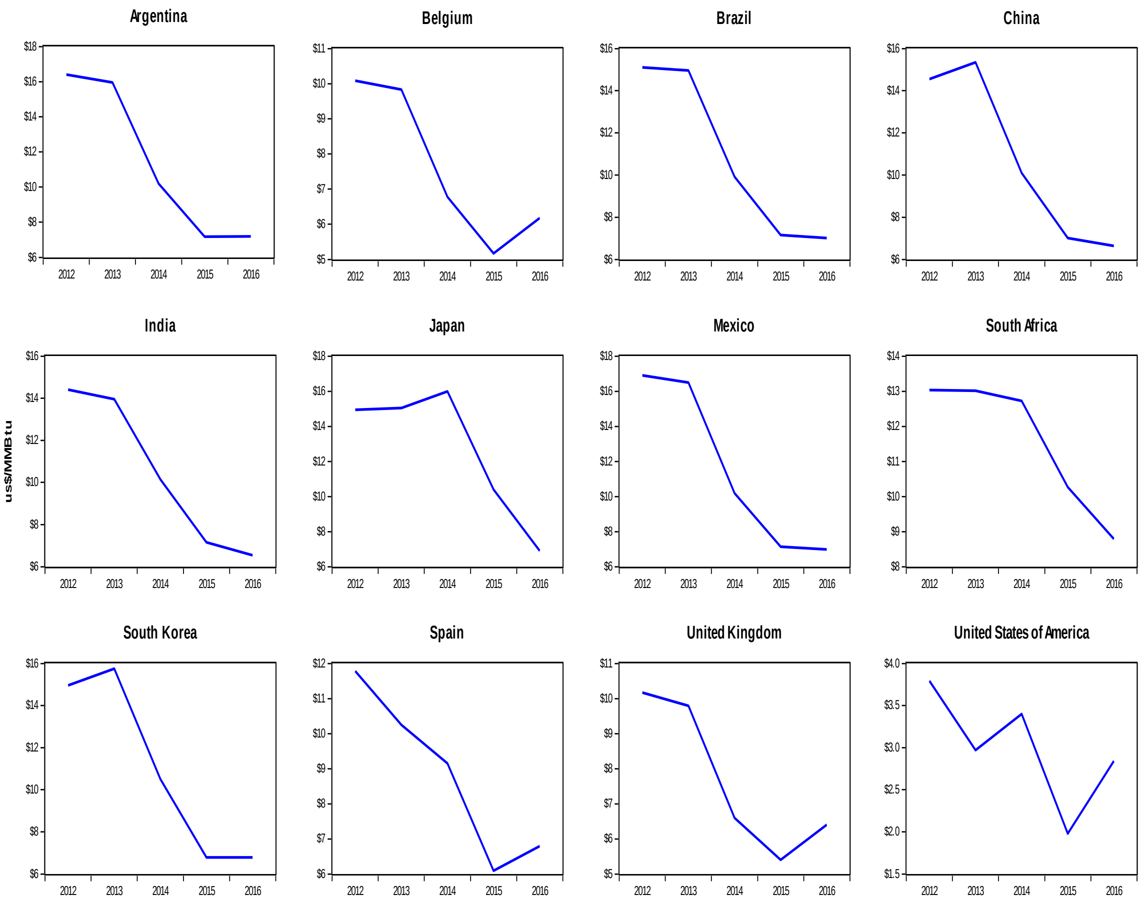
	Mean	Median	Max	Min	Std.Dev
Argentina	11.4	10.2	16.4	7.18	4.55
Belgium	7.6	6.78	10.08	5.17	2.22
Brazil	10.83	9.92	15.11	7.01	4.01
China	10.73	10.1	15.35	6.64	4.09
India	10.44	10.15	14.4	6.55	3.67
Japan	12.66	14.95	16.00	6.9	3.88
Mexico	11.54	10.18	16.9	6.99	4.88
South Africa	11.56	12.72	13.03	8.79	1.93
South Korea	10.96	10.5	15.75	6.79	4.3
Spain	8.81	9.15	11.78	6.09	2.37
United Kingdom	7.67	6.6	10.17	5.4	2.16
United States	3.0	2.97	3.79	1.98	0.68

Source : Authors own calculations in Eviews 8.0

Over the period in question, the highest price of natural gas price is recorded in Mexico at US$16.90/mmBtu while the lowest price is noted at the Henry hub at US$1.98/mmBtu. In US dollar terms, the average gas price for South Africa is $11.56 between 2012 and 2016 and is closer to average prices in countries such as Mexico at $11.54 and South Korea at $10.96. Figure 2 below shows graphical trends in natural gas prices for these selected countries.

The overall trend displayed in the multiple graphs above is that wholesale prices of natural gas have declined since 2013 or earlier in the UK, South Korea, Spain, India, South Africa, Argentina, Belgium and Brazil. In the United States, Henry hub prices have fluctuated. After the decline in prices it emerges that the prices have started to increase swiftly in 2016 with hope of rising further in the outlook period. Countries showing such a price recovery are South Korea, Spain, United Kingdom and Belgium. These countries have liberalised gas markets, except South Korea. Hence, these markets are characterised by more price elastic natural gas prices especially the United Kingdom's NBP and the Belgian ZEE prices.

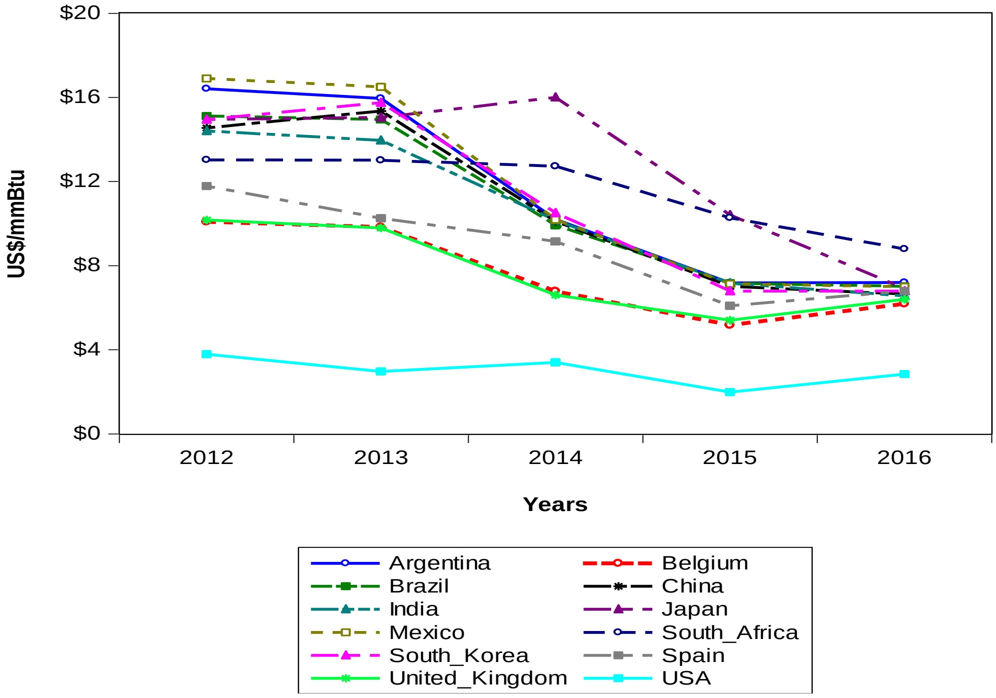
Figure 2: Multiple graphs for natural gas prices in selected countries, 2012-2016



Source : Own estimations in Eviews

However, the gas price in Argentina, Brazil, China, Japan, India, Mexico and South Africa is still showing signs that it may still decline in the outlook period. The first impression is that countries that are showing persisting gas price falls are either under the oil-indexed pricing regimes or regulated pricing regimes, except for Mexico. These gas markets are not liberalised as is the case with countries in the first group outlined in paragraph 11.8. A common feature of such countries is that gas prices have moved together with oil prices over time. Over the sample period oil prices have declined in the international market. Figure 3 below is a presentation of multiple graphs of all the countries to view co-trending, possibilities for price correlations and covariance and any noticeable international price convergence.

Figure 3 : Natural gas prices in selected countries in a single graph



Source: Own analysis in Eviews.

From Figure 3 above, it is evident that the natural gas prices in these countries have moved in a common trend over time, except for the Henry hub prices of the United States. This confirms the trend that has been gazetted by EIA(2017) and arguments that natural gas prices have declined and converged over time, with the price falls since 2014 attributed to lower oil prices. In the EIA(2017) report, evidence suggests that even deregulated markets of natural gas have price regimes influenced by international oil prices despite earlier assertions that such pricing regimes are driven by market forces of supply and demand. South Africa's GE price is co-moving with world prices and thus it can be deduced that it is equally driven by the same factors that have driven world prices over time.

Table 5 below is a correlation-covariance matrix that seeks to explore price correlations among natural gas prices of these selected countries. The correlation-covariance matrix gives evidence beyond the visual relationships displayed in Figures 2 and 3 above. The matrix quantifies the extent of linear association among the natural gas prices in representative countries for the North American, Latin American, European, Asian Pacific and the South African GE price. Whereas linear graphs have presented preliminary evidence that the South African GE price is equally converging with natural gas prices in more mature markets, more quantitative evidence is required to substantiate such claims. Such quantitative evidence, as given in Table 5 below has been found complementary and is supportive of the price convergence hypothesis.

The evidence to support the price convergence hypothesis is seen through highly significant positive price correlations among natural gas prices in countries under review in this study. Covariance coefficients have positive signs as well, showing that natural gas prices in these selected countries are co-moving and driven by the same factors, other things being equal. It is also notable that price correlations from within regional markets are more stronger than across markets. For instance, the Brazilian price is nearly perfectly positively correlated to Argentina's price meaning that such prices are very closely related and are influenced by the same factors over time. The Asian Pacific prices are highly positively correlated to the Latin American prices. However, Japan is an exception to that as it shows positive insignificant correlations with prices of countries in Latin America and European hubs (particularly with the NBP price).

The correlations between North American gas prices against those in the Asia Pacific or Latin American prices are ambiguous. For instance, the Henry hub prices are weakly positively correlated to prices in Japan, Argentina and China while in a strange way, they significantly positively correlated to the Spanish prices yet insignificantly positively correlated to the NBP prices. The South African GE price has positive significant price correlation against prices in North America, Latin America, Mediterranean Europe, North West Europe and the Asian Pacific market, except for the Belgian ZEE price correlation that is positive but statistically insignificant. As shown in Table 5 above, the correlations are ranging between 0.76 to 0.90. Since these correlations are above 0.5 and closer to 1, evidence reflects that the South African GE is positively linearly correlated to world gas prices. Such evidence partially confirms the price convergence hypothesis and it is empirically consistent with EIA (2017) findings. The implication is that the South African GE is converging with the wholesale natural gas prices in the world and it is driven by the same factors that have influenced wholesale gas prices in the world, particularly oil prices.

Table 5 : The Correlation – Covariance Matrix for Natural Gas Prices in Selected Countries.

Correlation Covariance (probability)	Argentina	Belgium	Brazil	China	India	Japan	Mexico	South Africa	South Korea	United Kingdom	Spain	United States
Argentina	**1.00** 16.54 -											
Belgium	**0.98** 7.95 *0.0*	**1.00** 3.94 -										
Brazil	**0.98** 14.56 *0.0*	**0.98** 6.97 *0.0*	**1.0** 12.84 -									
China	**0.99** 14.75 *0.0*	**0.97** 7.02 *0.0*	**0.99** 13.05 *0.0*	**1.0** 13.4 -								
India	**0.99** 13.27 *0.0*	**0.96** 6.27 *0.0*	**0.99** 11.7 *0.0*	**0.99** 11.9 *0.0*	**1.0** 10.8 -							
Japan	**0.74** 10.4 *0.2*	**0.63** 4.38 *0.2*	**0.75** 9.37 *0.14*	**0.78** 9.92 *0.12*	**0.81** 9.25 *0.09*	**1.0** 12.1 -						
Mexico	**0.99** 17.75 *0.0*	**0.99** 8.53 *0.0*	**0.99** 15.6 *0.0*	**0.99** 15.9 *0.0*	**0.99** 14.2 *0.0*	**0.73** 11.1 *0.16*	**1.0** 19.1 -					
South Africa	**0.84** 5.92 *0.07*	**0.76** 2.6 *0.14*	**0.86** 5.3 *0.06*	**0.88** 5.54 *0.05*	**0.90** 5.12 *0.04*	**0.98** 5.91 *0.0*	**0.84** 6.36 *0.07*	**1.0** 2.99 -				
South Korea	**0.99** 15.49 *0.0*	**0.97** 7.4 *0.0*	**0.99** 13.7 *0.0*	**0.99** 14.04 *0.0*	**0.99** 12.53 *0.0*	**0.79** 10.5 *0.11*	**0.99** 16.6 *0.0*	**0.88** 5.84 *0.05*	**1.0** 14.8 -			
United Kingdom	**0.98** 7.67 *0.0*	**0.99** 3.82 *0.0*	**0.97** 6.72 *0.0*	**0.95** 6.73 *0.01*	**0.94** 6.00 *0.01*	**0.58** 3.92 *0.3*	**0.98** 8.23 *0.0*	**0.71** 2.39 *0.17*	**0.95** 7.08 *0.01*	**1.0** 3.73 -		
Spain	**0.95** 8.2 *0.01*	**0.94** 3.96 *0.02*	**0.95** 7.2 *0.01*	**0.93** 7.23 *0.02*	**0.96** 6.69 *0.0*	**0.79** 5.83 *0.11*	**0.94** 8.76 *0.01*	**0.87** 3.19 *0.06*	**0.94** 7.67 *0.02*	**0.92** 3.77 *0.03*	**1.0** 4.49 -	
United States	**0.67** 1.66 *0.2*	**0.70** 0.85 *0.2*	**0.66** 1.45 *0.2*	**0.64** 1.42 *0.25*	**0.68** 1.37 *0.2*	**0.60** 1.26 *0.3*	**0.66** 1.75 *0.22*	**0.64** 0.67 *0.25*	**0.66** 1.55 *0.22*	**0.68** 0.80 *0.2*	**0.86** 1.12 *0.06*	**1.0** 3.87 -

Source : Own calculations in Eviews

In the same vein, the covariance coefficients of the South African GE price against North & Latin American, European and Asian Pacific prices are all positive. This serves as evidence that the South African GE is trending together with wholesale gas prices in the world. These covariance coefficients are supporting the graphical illustrations in Figures 2 and 3 above. The coefficient sizes do not carry much economic meaning but it is a common scientific belief that the bigger the size of such coefficients the stronger the co-movement tendency among variables. If the same principle is applied in this case, it then follows that the South African GE is co-trending with prices in markets considered in this study.

The overall picture is that since gas prices in these selected countries have positive covariance coefficients, additional evidence to support the gas price convergence hypothesis is visible in the correlation-covariance matrix. Table 6 below presents descriptive analysis of natural gas prices per customer category among selected four European countries namely; Belgium, United Kingdom, Spain and Netherlands and compared against South African gas prices per customer category over the reference period.

In Table 6, mean and median prices are presented per customer category from classes 1 to 6 as well as the maximum and minimum gas prices per customer category. The standard deviation is shown to reflect the degree of departure of such gas prices in each class category from their average values. These calculations are based on data presented in Appendix 1. Notably, average gas prices decline with higher consumption volumes in the five jurisdictions presented in Table 6 above. With the aid of data in Appendix 1, such a trend is consistent over the reference period. Hence, the South African gas-pricing regime is proven compatible with other jurisdictions as shown in Table 6 above. For benchmarking purposes, considering class 3 prices as a median class category, the South African average gas price is the lowest at US$9.22 over the period 2012 to 2016. The average British natural gas price stands at US$11.72/GJ, the Dutch at US$9.48/GJ and the Spanish at US$11.81/GJ. For Belgium, the average gas price for the median class category is US$10.22. The South African average maximum price for class 3 stands at $10.64 and is the lowest compared to those of the four countries in Table 6.

In Appendix 3, based on Class 3 prices in the first semester of 2014, the South African gas price at US$10.64/GJ was relatively lower than natural gas prices in South Eastern Europe particularly in jurisdictions such as Slovakia, Slovenia, Hungary, Croatia, Bulgaria and Austria except for Romania. In North Western Europe, the South African gas price was below countries like the UK, Belgium, France, Germany and Ireland except for Denmark whose price stood at US$10.06/GJ. Average gas prices in Mediterranean Europe were higher than the South African average gas price in the first semester of 2014 except for the Turkish average price that stood at US$8.72/GJ.

In the first semester of 2015 the South African average gas price declined by 7.3% to US$9.86/GJ. This was the case throughout the European market with gas prices declining swiftly. In North West Europe, prices in Netherlands, Belgium and Denmark decreased to levels below the South African average gas price while in France, Ireland and the United Kingdom gas prices declined but were still above the average gas price in South Africa. Hence, the South African gas price was aligned to prices in the North West European market in the first half of 2015. Compared to gas prices in Mediterranean Europe over the same period, the average gas price in South Africa was below average prices in countries in this block except for the Turkish average price, that stood at US$8.36/GJ. Compared to South East European countries, gas prices in Austria, Czech and Bulgaria were below the South African average gas price while in other jurisdictions such as Croatia, Slovenia, Slovakia and Bosnia, prices where above the average gas price in South Africa.

As gas prices continued to decline in 2016 in entire Europe, there is evidence that the South African GE price decreased following the same trend as that of Europe. In the first half of 2016, the average GE price in South Africa fell significantly to US$7.13/GJ, hence a decrease of about 27.7% compared to the price in 2014 over the same period. Mediterranean European block had prices below the average South African GE in Greece and Turkey, while in Portugal, Spain and Italy average gas prices were above US7.13/GJ. In North West Europe, countries like Belgium, Denmark and the Netherlands experienced drastic reductions in the average gas price and those prices dropped to levels significantly below the average South African GE as evidenced in Appendix 3. However, in countries like the United Kingdom, Ireland and France, average gas prices declined but remained above the South African average GE.

In the South Eastern block, average gas prices are lower substantially compared to price regimes in either Mediterranean Europe or North West Europe in the first half of 2016. Bulgaria and Romania had average gas prices to the tune of US$6.48 and

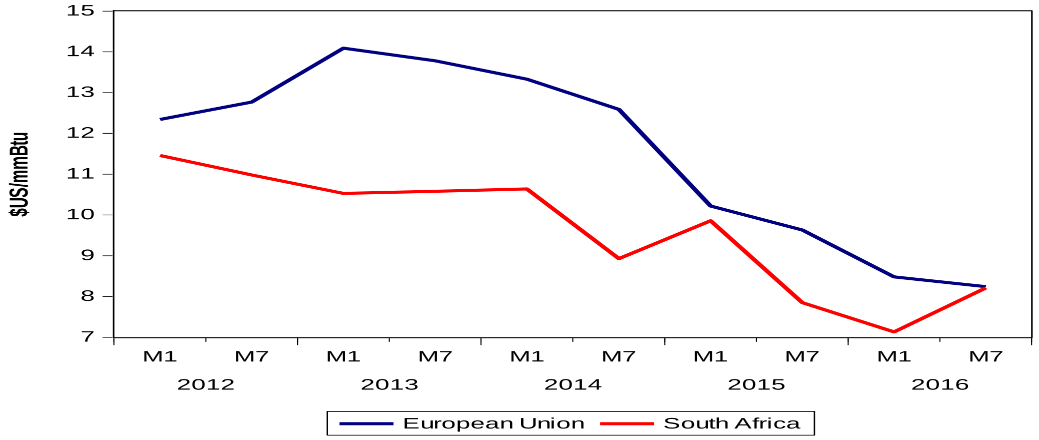
US$5.72 respectively; hence, less than the average South African GE while countries like Czech, Slovenia and Slovakia had prices above the South African GE.

Overall, Appendix 3 shows that in the second half of 2016, the average South African GE price, at US$8.21/GJ, is aligned with European prices in general. The South African GE is above gas prices in Bulgaria, Czech, Greece, Hungary, Belgium, and the United Kingdom. As such, such prices lower than the South African average GE are from both regulated and market driven pricing regimes. However, it is notable average gas prices in other jurisdictions are above the average South African GE, for example in Sweden, Slovakia, Luxembourg, Ireland, France and Germany. Therefore, overall, the average GE price in South Africa is aligned to gas pricing regimes in Mediterranean and Continental Europe and ambiguously related to market driven, oil-indexed and regulated pricing regimes.

Figure 4 below shows the trends in the class 3 average gas energy prices for the entire European Union and the corresponding South African GE price. The trends in these two gas energy prices are depicting that they have a tendency to converge and diverge over time. There is evidence of divergence before the second semester of 2013 and forces of convergence setting in the first semester of 2014 as well as in the first semester of 2015. The South African Class 3 average GE price is more turbulent than the average European Union average Class 3 GE price. Throughout the period under review, the average South African GE is fluctuating below the European Union GE

Table 7 below shows descriptive analysis on the average class 3 energy prices for the European Union and South Africa from calculations based on the fourth data set extracted from Eurostat and NERSA. From Table 7 above, the mean gas energy price for the class 3 customer categories is $9.62/GJ over the reference period and below the corresponding mean price of $11.54/GJ in the European Union.

Figure 4 : The Overall average EU Class price versus the corresponding SA price.



Source: Own computation in Eviews

Table 7: Descriptive Statistics (Class 3 average gas energy prices in the EU & South Africa)

Statistic	Natural Gas Prices in $US/mmBtu	
	European Union	South Africa
Mean	11.54	9.62
Median	12.46	10.19
Maximum	14.09	11.46
Minimum	8.24	7.13
Standard Deviation	2.20	1.48

Source: Own computation in Eviews

Both the mean and median prices for South Africa are below those of the European Union. The maximum and minimum prices for the European market are $14.09/GJ and $8.24/GJ respectively. For the South African market, the maximum and minimum prices converted to US dollars are $11.46/GJ and $7.13 respectively.

CONCLUSION

This study has presented an analysis of the relationship among the South African GE price and natural gas prices in North America, Latin America, North Western Europe, Mediterranean Europe and the Asian Pacific markets for benchmarking purposes, over the period 2012 to 2016. In a quantitative framework, findings are that the South African GE price is highly positively correlated to international prices of natural gas in selected countries that are considered as proxy representatives of the stated regional markets. Findings confirm the gas price convergence hypothesis.

Over the reference period the South African GE ranges between US$8.79/MMBtu to US$13.03/MMBtu (when the MMBtu is construed as equivalent to the gigajoule). Such a range fits in the price ranges for South Korea, India, Japan, Brazil and Argentina over the reference period. Due to the evidence found in this study, the South African GE is driven by factors that are driving price evolutions particularly in oil-indexed pricing regimes and regulated pricing regimes. However, because to some extent market-driven pricing regimes are also driven by oil prices among other factors, the South African GE is thus related to Henry hub and the NBP prices as depicted by the mediocre positive price correlations.

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