The Impact of Russia's Refinery Upgrade Plans on Global Fuel Oil Markets

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WPM 48

July 2012

♣ The authors would like to thank Christopher Allsopp, Peter Stewart, and Marcelo Pinelli for their useful comments. All remaining errors are our own.

ISBN

978-1-907555-54-1

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1. Introduction

The last three decades have witnessed some radical changes in the dynamics of the fuel oil market. On the demand side, the substitution to coal and gas in power generation and residential heating has resulted in secular decline in fuel oil consumption, reducing its share in the global mix of petroleum products from 25% in 1979 to less than 10% in 2011.[1] Between 1980 and 2011, the year-on-year decline in fuel oil consumption averaged 236,000 b/d, with the trend being much more acute in OECD countries which accounted for more than 98% of the global decline.[2] In contrast, in many emerging economies fuel oil is still used as a backup fuel in the power sector to meet surges in electricity demand, in refineries, and in heavy industry such as glass and cement.[3] For instance, in the Middle East, fuel oil accounts for 25% of the fuel mix in 2011, where it is still widely used in power generation. [4]

However, power generation is not expected to provide a growth outlet in the long-term as substitution away from fuel oil continues in most regions, although other sources of fuel oil use such as for the production of asphalt and for marine vessels (bunkers) are still growing at a fairly robust pace. Marine bunker demand for fuel oil has continued to grow over the past decade notwithstanding the short-lived drop following the 2008 financial crisis. Between 1998 and 2008, consumption of residual fuel oil for bunkering increased from 2.23 million b/d to 2.90 million b/d i.e. at an average compounded annual growth rate of 2.6%.[5] The growth in demand for bunker fuel[6] has been driven by the continued expansion of the world shipping fleet and global trade. Maritime transport accounts for over 80 % of the volume of global trade and over 70% of value traded.[7] Since 1970, global seaborne trade has expanded on average by 3.1% annually. Assuming no major upheaval, the UN estimates that global seaborne trade will have increased by a further 36 per cent in 2020 and will have doubled by 2033 driven in large part by trade liberalization, increase in vertical specialization of production, and rapid improvement in incomes in emerging economies.[8]

Alongside these structural shifts in demand patterns, regulatory changes have also been shaping fuel oil market outcomes. From January 1, 2012, the International Maritime Organization (IMO) has mandated that ships' global sulphur emission cap be reduced from 4.5% to 3.5%. By 2020, the global sulphur cap may be reduced further to 0.50%.[9] In Emission Control Areas (ECAs)[10], the requirements are more stringent. On 1 July 2010, the sulphur cap in ECAs was reduced from 1.50% to 1.00% and by 1 January 2015 it must be reduced further to 0.10%. The implications of such regulatory changes on the fuel oil market

[1] BP (2012) Statistical Review of World Energy. In this report, 'Fuel oil' includes marine bunkers and crude oil used directly as fuel.
[2] BP (2012) Statistical Review of World Energy.
[3] Residual fuel oil is also used as an intermediate feedstock for further processing within the refining system to increase the yields of lighter products.
[4] BP (2012) Statistical Review of World Energy 2012.
[5] EIA Website, International Energy Statistics, accessed in May.
[6] Since fuel oil has limited use outside power generation and marine vessels, it is often referred to as bunker fuel. Bunker fuel accounts for around 45% of residual fuel demand (excluding feedstock), followed by power generation and industry.
[7] UN (2012), 'World Economic Situation and Prospects', Development Policy and the Analysis Division.
[8] IMF(2011), 'Changing Patterns of Global Trade', Prepared by the Strategy, Policy, and Review Department, June.
[9] The date is not set in stone. In 2018, the IMO will assess the refining system's readiness to switch to 0.5% and if the industry is judged not be ready, the implementation date is likely to be delayed to 2025.
[10] ECAs are especially designated sea areas with more stringent mandatory measures for emissions from ships. Currently, ECAs include the Baltic Sea Area and the North Sea Area. The North America Area is expected to enter into effect 1 August 2012.

still remain unclear. Changes in fuel bunker specifications and the extension of ECAs could lower demand for high sulphur fuel oil (HSFO) in favour of low sulphur fuel oil (LSFO). The shipping industry could instead install scrubbing technology, allowing vessels to continue using HSFO in some basins. The shipping industry could also respond to more stringent regulations by shifting to distillate fuels such as Marine Gas Oil (MGO) and Marine Diesel Oil (MDO)[11] as it is very costly to change fuel oil from 3.5% to 0.1%.[12] Some predict that LNG could also make serious inroads into the bunker market, as emission legislation becomes more stringent and as high oil prices make LNG more cost effective. Such shifts in fuel bunker specifications and the response of the shipping and refining industries to such changes will play an important role in determining the supply-demand dynamics of fuel oil, refining margins, and price relationships including between HSFO and LSFO and between fuel oil and distillates.

In addition to structural trends, the fuel oil market is subject to occasional shocks. Given that oil can replace other types of fuel in all the uses including power generation, any disruption to energy flows can usually have a big impact on fuel oil market balances. The closure of nuclear reactors in Japan following the Fukushima disaster resulted in a massive increase in demand for LNG, but also for crude oil and fuel oil. In Q1 2012, the year-on-year increase in Japanese fuel oil demand averaged 141,000 b/d, reaching almost 600,000 b/d in February 2012.[13] For countries with no LNG infrastructure, there is little choice but to rely on liquid fuels in case of disruptions. For instance, the disruption of pipeline gas from Egypt has forced Israel and Jordan to increase their imports of crude oil and fuel oil to supply their power plants. Crude oil supply shocks can also have large impact on fuel oil markets. The Libyan disruption in 2011 resulted in the removal of a large volume of low-sulphur crude oil in Europe, which had to be replaced from other regions. This caused the differential between HSFO and LSFO and between sweet and sour crudes to widen considerably.

The structural changes in petroleum product demand patterns over the last three decades have transformed the refining industry. During the last decade, global refining capacity expanded at a rapid pace: between 2000 and 2011, world distillation capacity increased by an average of 968,000 b/d per year with most of this new refining capacity being built in non-OECD economies.[14] The largest additions were made from 2006 onwards, as the widening of differentials between HSFO and LSFO and between sweet and sour crudes in 2004 and 2005 triggered a wave of new refining projects. Based on firm project plans, KBC estimates that world net crude distillation capacity will increase by 1.55 million b/d per year through 2015, in line with projections of global demand growth during this period.[15] The change in demand patterns has also meant that refineries have had to respond by producing higher-value products such as gasoline and diesel to compensate for the lower-value fuel oil which is a residual product that often trades at a discount to the cost of crude. The widening of the spread between gasoline and diesel and fuel oil in the last few years has provided refineries with the incentive to invest in new conversion capacity with investment in hydrocracking and coking units consistently being the preferred choice of upgrading.[16] The combination of higher specifications and the negative demand outlook for fuel oil will only consolidate this trend of investment in upgrading units. It is expected that by 2015 catalytic cracking will

[11] MGO is pure distillate oil while MDO is made up of distillate oil with a trace of residual oil. MDO has lower sulfur content than fuel oil but has higher sulfur content than MGO.

[12] Fuel oil with 0.1% sulphur is a distillate specification and it would better to take it from the gasoil cut rather than try to get the sulphur out of the fuel oil.

[13] Energy Intelligence Database.

[14] BP (2012) Statistical Review of World Energy 2012.

[15] KBC, Outlook for the World Refining Industry, April 2011.

[16] KBC, Outlook for the World Refining Industry, April 2011.

account for almost 50% of crude distillation capacity compared to less than 25% in the early 1980s.[17] These transformations in the refining industry are likely to change the supply balances of various fuels with impacts on key price relationships.

It is against this background that current plans to restructure Russia's refining industry assume a special importance. Russia currently exports around 55 million tons (mt) of fuel oil a year out of a globally traded market of close to 105 mt.[18] Russian fuel oil exports are destined for both Western Europe and Southeast Asia, making Russia an important player in both basins. As a result, the introduction of new tax rules in October 2011 that aim to transform Russia's outdated refining landscape by providing refineries with the incentive to invest in more advanced refining processes, will have a significant impact on fuel oil supplies to Europe and to the rest of the world.

The main objectives of this paper are to analyse the changing dynamics in the Russian refining industry and their potential implications on fuel oil supplies and key price spreads. Section 2 outlines the major changes in Russia's tax system and their impact on Russia's refineries. Section 3 analyses the implications of such changes on the supply and export of fuel oil to Europe and Asia. Section 4 reviews the historical evolution of key spreads and analyses whether the projected changes in supply-demand balances will induce a break in these dynamics. The last section concludes.

2. Changes in the Russian Oil Tax System and their Impact on Russia's Refining System

The Russian refining system is the third largest in the world, ranking only behind the US and China with approximately 275mt of total capacity and 2011 throughput of 257mt. However, despite this high output and capacity utilisation, the majority of Russia's refineries are of significantly lower quality than their global peers, with an average Nelson complexity index of just over 5 compared to a European average of 6.5 and a US average of 9.6.[19] The fundamental reason for this difference is that all but one of the refineries in Russia were built during the Soviet era to service the USSR's enormous military and industrial complex, with more than 75% being constructed before 1970 and with a focus as much on producing fuel oil to power tanks and other military equipment as on producing light products for other transport needs. Indeed by the end of the Soviet era approximately 45% of Russia's output of major oil products[20] was accounted for by fuel oil, with 98mt being produced in 1991.[21]

The trends in Russia's refining sector during the 1990s mirrored the overall collapse in the country's oil industry, with product output falling by more than 40% between 1991 and 1998 in line with the country's economic decline. Almost no investment was made in upgrading refining capacity during this time, and therefore fuel oil output, although significantly reduced (to a low of 48mt by 2000), continued to account for approximately 40% of the product mix. This continuing preponderance of lower quality products did not have a major impact on the economy, however, as the country's vehicle fleet continued to be relatively small and largely made up of Soviet-era vehicles using low-octane gasoline. The key problem

[17] KBC, Outlook for the World Refining Industry, April 2011.
[18] Barclays (2012), Fuel oil: Saudi demand and Iranian supplies, April 24. Fuel oil volumes are often measured in million tons. For conversion from tons to barrels, we use the BP conversion rate of 6.7.
[19] Data sourced from Oil & Gas Journal, Company data and Bank of America Merrill Lynch Research
[20] Major oil products defined as Fuel Oil (Mazut), Diesel, Gasoline and Jet Kerosene
[21] Data from EIG database

was felt in the oil sector itself, where refinery utilisation fell to below 50% (and in some remoter refineries to much lower levels),[22] meaning that the industry was running at a significant loss.

The economic problems for the refining industry were exacerbated in 1999 by the introduction of an export tax on oil products that was in line with the crude oil export tax introduced at the same time. The level of the tax was set on a relatively ad hoc basis until it was formalised in 2003 at 90% of the level of the crude export tax.[23] This essentially meant that exports of fuel oil were loss-making, given the lower price that they could generate compared to other oil products. This commercial issue for Russian refiners, combined with growing domestic demand for oil products as the Russian economy rebounded from the 1998/99 economic crisis, then highlighted for the first time a growing problem of product imbalance in the sector. With the military and industrial complex in continuing decline, demand for fuel oil had also continued to fall, while at the same time demand for lighter products, in particular gasoline, had started to rise. Indeed, the biggest challenge was meeting the demand for high octane gasoline, which was emphasized by the fact that Russia was exporting lower quality 92 Research Octane Number (RON) gasoline while importing higher RON products. Furthermore, given the lack of investment in the Russian refining system, every extra tonne of gasoline or other light product produced domestically necessitated the additional production of a tonne of fuel oil, for which there was a declining market. This fuel oil could not be sold domestically and was loss-making on the export market due to the high export tax, leaving refiners with a dilemma – satisfy domestic demand for light products but incur losses on fuel oil exports, or reduce refinery throughput to lower the output of fuel oil but then fail to meet domestic demand for light products.

The debate between the oil industry and the Russian State over this issue lasted for two years, with the government making an initial concession to reduce the export tax on products to 65% of the crude oil levy in July 2004, before finally introducing a formal export duty scale for refined products based on the price of crude oil.[24] The formula was set as:

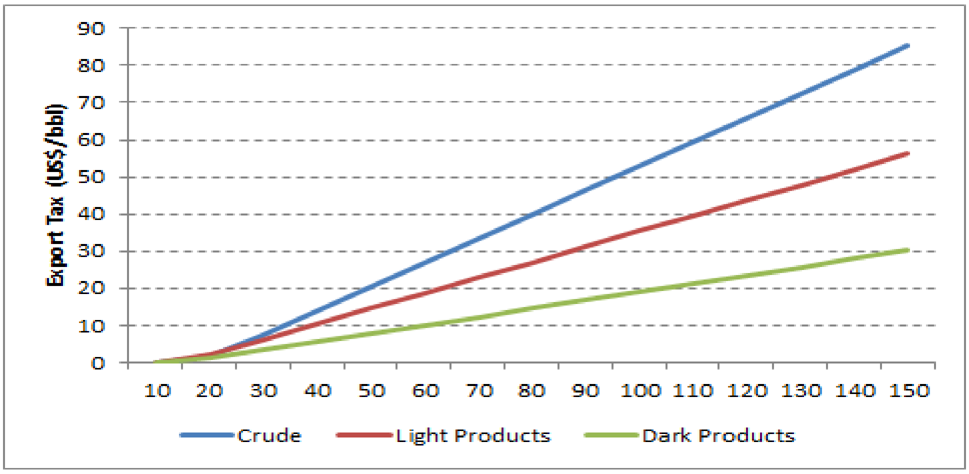
EP = ((PC-15) x 0.32 x 7.33) x 0.7 (for dirty products) ***or*** *x 1.3 (for light products)*

where PC is the price per barrel of Urals Blend crude and EP is the export tax per tonne of products.

In a similar fashion to crude exports, the tax did not start until the oil price exceeded $15 per barrel, with a tax rate of 32% then being set on any revenue over this level (and multiplied by 7.33 to convert into tonnes). Further multipliers then provided a differentiated tax rate for fuel oil compared to lighter products such as gasoline and diesel, although all oil products were taxed at a lower rate than crude oil which suffered a 65% marginal export tax at any oil price above $25 per barrel. Figure 1 clearly demonstrates the discounted export tax rate for oil products versus crude oil, which offered a relatively small incentive to export products rather than crude oil at the oil prices prevailing in 2004/05 (around $30-40 per barrel) but a much more significant discount at the higher oil prices from 2006 onwards.

[22] The Almanac of Russian Petroleum, 2000, Energy Intelligence Group
[23] Burgansky, A., Russia Oil and Gas Yearbook 2010, Renaissance Capital Research, Moscow
[24] Burgansky, A, "Oil and Gas Yearbook, 2010: Stand and Deliver", pp190-191, Renaissance Capital, Moscow

Figure 1: Comparison of export tax rates for Crude Oil, Dirty Products and Light Products following tax changes in 2005



Source: Author's calculations based on data from Russian Tax Authorities

This change to the tax rules in favour of product exports was catalysed not only by the need to provide a profitable outlet for Russian fuel oil but also by the intention of the Russian Administration to see the extra profits generated then reinvested in the upgrading of the country's refining system. From his earliest days in office President Putin had stated his desire to see Russia exporting less raw materials and more finished goods,[25] and in the oil sector this was meant to be reflected in increased oil product sales as opposed to crude. A further implication of the lower product export tax was to reduce the pressure on domestic product prices, with light products now effectively being priced on an export netback basis. As a result a lower export tax meant a lower netback and a lower wholesale price in Russia.

Post 2005, the Russian oil tax regime therefore saw crude oil exports being taxed at a marginal rate of around 65% if the oil price was above $25 per barrel, while light products were taxed at approximately 67% of this level and dirty products at around 35-40% of the crude export tax (depending on the oil price). However, this change of affairs did not produce quite the impact that the Russian government had been expecting. The profitability of the Russian refining system certainly improved, as was clearly demonstrated in the financial results of the major Russian oil companies. For example Rosneft, the state-controlled Russian major, reported that the netbacks received by its Russian refineries (reflecting a combination of domestic and export prices) often exceeded the netback for crude oil exports,[26] while LUKOIL would regularly emphasize the strong margins that could be generated in its domestic downstream business.[27]

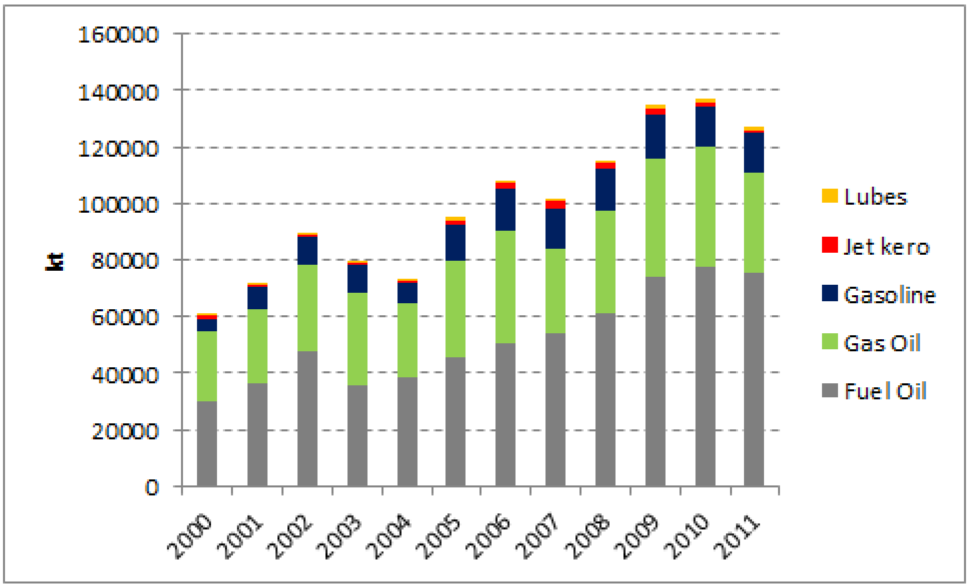
Economic activity in the refining sector was therefore encouraged, with a particular impact on export sales but with benefits to the domestic fuel economy too. Refinery utilisation increased sharply from 72% in 2004 to a post-Soviet high of 93% in 2011 as Russian oil companies diverted as much crude oil as possible towards the lower tax environment enjoyed by product sales, with many of the major companies seeing close to 100% refinery utilisation in 2011. As a result the availability of lighter products for the domestic market increased, while surplus fuel oil could be exported profitably. Domestic product prices rose to export netback levels due to the tight supply-demand balance caused both by growing domestic

[25] Russia Journal, 17 Jan 2000, "Putin urges export of finished goods", Petrozavodsk
[26] Rosneft presentation to investors, 8 April 2007, Q4 and FY 2007 results, slide 12
[27] For example LUKOIL presentation to Investors, April 2008, 2007 Financial Results, slide 8

demand and the increased incentive to export oil products, meaning that in 2009 and 2010 Russian refining margins reached levels of $10-15 per barrel compared to the much lower $0-5 per barrel seen in Europe,[28] although prices at domestic retail sites were kept under control by a combination of government coercion and oil company restraint.

However, one of the major failings of the new oil product tax regime was that, although oil companies were incentivised to produce more products and increase refinery activity, there was no real incentive to invest in upgrading capacity. Indeed the major commercial incentive over the period since 2004 has been to exploit the tax break to its fullest extent, and as can be seen in Figure 2 this has meant a sharp increase in oil product exports from 71mt in 2004 to around 130mt in 2009-2011, with a particular emphasis on fuel oil exports. However, the sharp growth in the latter may mask another trend, namely the desire to exploit the lower export tax by exaggerating export sales of fuel oil as opposed to crude. Indeed it is widely believed that the level of fuel oil exports is significantly below the 76mt shown in Figure 2 (by as much as 15-20mt) with the difference being made up of crude oil that has been passed through a refinery gate and sold on as fuel oil in order to minimise tax payments.

Figure 2: Russian Oil Product Exports 2000-2011



Source: Interfax

Whatever the truth of this suspicion, it remains the case that fuel oil, and indeed all oil product, exports have risen over the past seven years, but it is also clear that little of the profits earned have been reinvested in improving the quality of Russia's refining system. Although there are isolated examples of upgrading work being carried out,[29] the overall complexity of Russia's refining sector has remained remarkably stable. The average Nelson Complexity Index of a Russian refinery has only risen from 4.4 in 2004 to 5.1 in 2011, while the share of fuel oil as part of the output of major oil products has actually increased from 38% to 40% on the same timescale.[30]

[28] For example as shown by LUKOIL in the presentation of its 2009 and 2010 Financial Results, March 2011, slide 6

[29] For example at LUKOIL's Nizhny Novgorod plant, TNK-BP's Ryazan refinery and currently at GazpromNeft's Moscow refinery

[30] Data from EIG database

This lack of upgrading investment has been in direct contrast with the demands of the Russian domestic market, where a combination of increasing car ownership and an upgrading of the car fleet, as more international models have displaced older Russian brands, has led to a sharp increase in demand for higher quality oil products, in particular high octane gasoline. This trend is set to continue, as highlighted by LUKOIL CEO Vagit Alekperov in a recent strategy presentation,[31] with vehicle ownership in Russia forecast to increase by 4% p.a. to 2021 while demand for gasoline is expected rise by 3.5% p.a. (the lower rate reflecting increasing vehicle efficiency), with premium gasoline accounting for the majority of this growth. The Russian government is encouraging this trend by mandating a gradual shift towards European standards for gasoline and diesel, with Euro 5 standards currently anticipated by 2015 (see Appendix 1 for details). However, the lack of response in the refining sector to this changing demand pattern combined with the continued incentive to export oil products at beneficial tax rates resulted in a significant shortage of gasoline in the spring of 2011.[32] In response to this situation, then Prime Minister (now President) Putin responded by temporarily increasing the gasoline export tax and more fundamentally calling a meeting of the leaders of Russia's major oil companies to discuss the strategic priorities for the country's refining industry.

This meeting, held in Kirishi near St Petersburg in July 2011, saw Prime Minster Putin express his dissatisfaction with the progress being made in the Russian refining sector and demand improvements catalysed by a further change in the tax regime.[33] He pointed out the fact that in the period 2006-2011 gasoline consumption had risen by 23% but gasoline output at Russia's refineries had increased by only 13%, while conversely fuel oil demand had fallen by 20% while production had increased by 29% in the same period. As a result of this imbalance and the negative impacts on Russian consumers Putin demanded an increase in secondary processing, with a focus on the isomerisation, reforming and cracking processes, and called for all the companies to formally commit to upgrading plans and capital expenditures which would be monitored by the Federal Anti-Monopolies Service and Rostekhnadzhor.[34] While the exact details of the commitments made by the companies have not been made public, Putin made clear that he wanted to see the implementation of the main targets of the Russian Energy Strategy to 2030 (published in 2009), which involved raising Russia's overall refining capacity to 285mt, increasing overall refining depth from 72% to 85% by 2015 and decreasing fuel oil production by at least 17%.

In order to catalyse progress from the Russian oil companies two spurs to action have been created. The first is an implicit threat that if the formal upgrading commitments are not met then the Federal Anti-Monopolies Service (FAS) will not allow oil companies to profit at the expense of Russian consumers, and will, in President Putin's words, "respond with appropriate measures, including the appropriation of windfall profits."[35] A further incentive for oil companies to complete their refinery modernisation plans has been provided by the implementation of the new "60/66" tax regulation, which has increased the export tax on oil products while reducing the burden on crude oil exports. While one of the drivers of this move has been to increase investment in the upstream sector, where concerns over a potential

[31] Alekperov, V., March 2012, "Third Decade of Evolution: New Challenges, New Opportunities", slide 28
[32] Nefte Compass, 5 May 2011, "Russia tackles gasoline shortage", Moscow
[33] www.government.ru/eng, "Prime Minister Vladimir Putin holds a meeting in Kirishi on Russia's refining industry and petroleum products market", July 2011, accessed 10 May 2012
[34] Rostekhnadzor is a Russian Agency with responsibility for the certification of technical and industrial safety documentation
[35] www.government.ru/eng, "Prime Minister Vladimir Putin holds a meeting in Kirishi on Russia's refining industry and petroleum products market", July 2011, accessed 10 May 2012

production decline have been gathering, the impact on the downstream sector is intended to be a reduction in the incentive to export low quality products such as fuel oil combined with the goal to increase the availability of higher quality products on the domestic market.

Essentially the new rules, introduced in October 2011,[36] have increased the export tax on fuel oil to 66% of the level of the crude export tax, have formalised the export tax on diesel at the same level and have increased the export tax on gasoline to 90% of the crude export tax. Furthermore, it has been proposed that the tax on fuel oil exports should rise gradually to a level of 90%,[37] and perhaps even 100%,[38] of the crude oil export tax by 2015, thus completely changing the commercial incentives for Russian refiners within four years. Figure 3 demonstrates how the export tax burden on the three main oil products has changed under the new system. The tax on gasoline has risen by 25% while the rate for diesel has actually fallen by 8%, due to the fact that the effective rate is now 66% of a crude export tax that has itself been reduced, as opposed to an effective 67% of a higher tax previously. Most dramatically, though, the export tax on fuel oil has increased by 71%, which has transformed the economics of fuel oil production in Russia. Prior to the current changes the export tax on fuel oil was $21 per barrel (assuming a $110 crude export price), equivalent to 22.5% of the residual fuel oil price in Rotterdam in June 2012.[39] Under the new tax rules the export tax now accounts for 38% of the export price, underlining the incentive for Russian refiners to start to reduce their fuel oil output, especially as at lower oil prices there is a significant risk that product exports could now become unprofitable.[40]

However, the impact of the tax changes over the first six months of their implementation has been mixed. On the one hand, the Energy Ministry has complained that it has yet to see any significant change in the depth of the Russian refining industry, while on the other a number of Russian oil companies have bemoaned the fact that refining has become less profitable. Indeed some have suggested that the incentive for the Russian refining system is not to increase gasoline production, exports of which will now be taxed highly, but to produce more diesel, which is mainly for export and therefore will have little impact on the domestic market. However, what remains clear is that the incentive to reduce fuel oil production and exports remains intact, with the Federal Anti-Monopoly Service announcing in May 2012 that it would be reviewing and re-affirming the refinery upgrade commitments of the Russian oil companies "in regard to deadlines for the purchase and delivery of equipment, and implementation of plans for construction, installation and start-up."[41]

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36 Ernst and Young Oil & Gas Tax Alert, Sept 2011, "Russian Federation oil tax reform", London

37 Interfax, 16 March 2012, "Ministry proposes to raise fuel oil export duty to 90%", Moscow

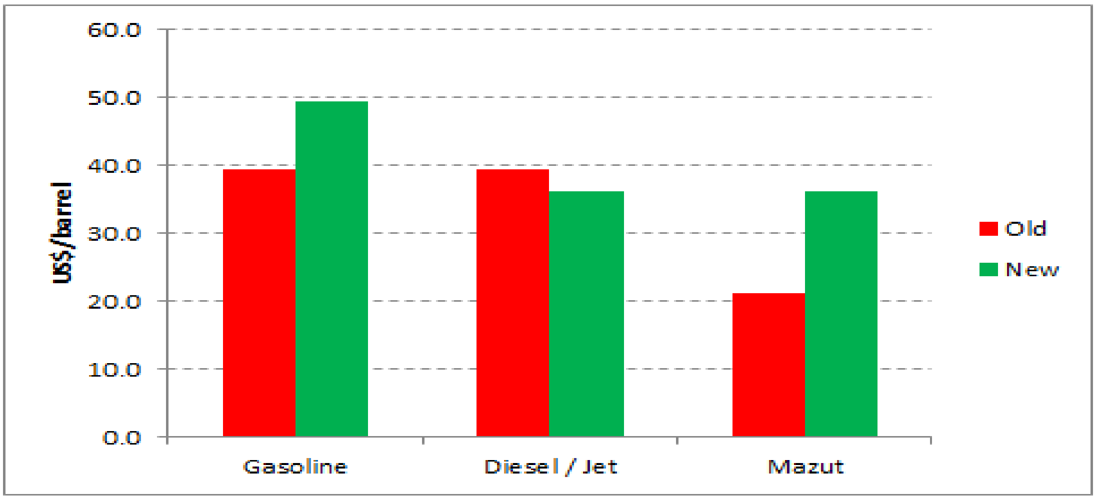
38 Interfax, 19 March 2012, "Sharp change in export duties for fuel oil could indicate inconsistency in state policy – ministry", Moscow

39 The price of residual fuel oil on 5th June 2012 was $634.50 per tonne, equivalent to $94.60 per barrel

40 Interfax, 25 Jan 2012, "Russian oil refining would be unprofitable at oil price below $85 per barrel – expert", Moscow

41 Interfax, 31 May 2012, "Agreements with oil companies to upgrade refineries to be adjusted in June – FAS", Moscow

Figure 3: Change in export tax rates for Russian oil products under new tax regime



Source: Author's calculations based on announcement from Russian Federal Anti-Monopoly Service

3. Planned Upgrading of the Russian Refining Sector and the Likely Impact on Fuel Oil Exports

The specific details of agreement between the FAS and the oil companies remain secret, but an analysis of the upgrading plans announced by individual companies over the past six months can provide some significant indications of the investment that is set to transform the Russian refining industry over the next 4-6 years. Indeed as the Deputy Head of the FAS Anatoly Golomolzin has recently noted, "For the first time in many years Russian companies have begun to seriously attend to oil refining."[42]

Of all the Russian oil companies it is LUKOIL that has been at the forefront of improvements in the Russian refining sector over the past few years, in particular with the investment in its NORSI refinery at Nizhny Novgorod where Russia's largest catalytic cracking complex was completed in 2010 at a cost of $975mm.[43] The company is now embarking on further upgrading work at the refinery with a plan to spend an additional $3.8 billion by 2018 on residue hydrocracking and catalytic cracking of VGO facilities. LUKOIL's other two main Russian refineries at Volgograd and Perm will also receive significant investment, with a VGO hydrocracking facility being built at the former and coking complex being installed at the latter by 2015/16. Overall the company plans to increase its refining depth to 99% by 2015 and to potentially stop producing any fuel oil at that date,[44] with all its refineries also set to produce Euro-5 standard gasoline on the same timescale to meet the new Russian government requirements.[45]

Perhaps not surprisingly, Rosneft, the Russian oil NOC which is 75% owned by the Russian state, has also announced major upgrading plans in line with government policy. The company plans to invest $4.5 billion per year to 2015 to ensure not only that all its domestic

[42] Ibid
[43] LUKOIL Databook 2010, p.55
[44] According to LUKOIL CEO Vagit Alekperov at the company's recent Strategy Day in London, March 2012
[45] Based on comments from Vagit Alekperov, CEO of LUKOIL, and Thomas Mueller, Refining Director, at the LUKOIL Strategy Day for Investors on 14 March 2012

refineries meet Euro-5 standards but also to increase its overall refining capacity by 7mt to 58mt through the expansion of its Tuapse facility in Southern Russia. All of the company's 7 major refineries will see upgrading work taking place, with the overall goal being to lift the average Nelson complexity of its refining system from 4 to 7 while reducing fuel oil production from the 36% of total output seen in 2011 to 11% by 2015.[46] Rosneft CEO Igor Sechin has also announced in June 2012 that the company plans to build a new 12mt refinery near Moscow, although full details have not yet been released.[47]

GazpromNeft is another state-controlled company[48] with significant upgrading plans for its two refineries that together make the company Russia's third largest by refining capacity. GazpromNeft's Omsk refinery is already one of Russia's most sophisticated plants, with a Nelson complexity of 6.4, but $1.1 billion of investment by 2015 should see this rise further with the construction of gasoline and diesel hydrotreaters. Meanwhile a major upgrading programme is underway at the 12mt Moscow refinery, where an isomerisation unit and a gasoline hydrotreater are under construction. The company's overall plan is to spend a combined $4-5 billion on its refineries by 2020 and to increase the Nelson complexity of both to 12, effectively ending the production of fuel oil over the next 5-7 years.[49]

Bashneft, a company based in the Russian republic of Bashkortostan that has always had a major focus on the downstream business, also plans to see a dramatic drop in fuel output at its 3 refineries, with the ultimate goal of ensuring that only 4% of its product mix is "dirty product" by 2016. The company plans to spend approximately $2bn by 2016 on its upgrading plans, with a target to achieve a Nelson complexity of 9.6 across its system within 4 years.[50] Another regional oil company, Tatneft, also has major plans for its refining business, as it has just brought onstream Russia's first new refinery for 30 years, the TANECO plant in Tatarstan. Output from the plant reached its full capacity of 7mt in May 2012 and the completion of a hydrocracker in 2013 followed by further upgrading investment totalling $2.5 billion should see the plant achieve a Nelson complexity of 12 by 2016, with zero fuel oil output.[51]

Two other major oil companies should also be mentioned in this brief review of Russia's refinery upgrading schedule. Surgutneftegas has long planned to improve its huge plant at Kirishi near St Petersburg, where the 21mt capacity refinery produced as much as 53% fuel oil in 2011. The introduction of the new tax regime and the commitments made to the FAS have finally catalysed significant investment, and the company plans to spend approximately $7 billion on the installation of a new hydrocracker and a catalytic cracking facility by 2017 in an attempt to reduce fuel oil output to 5% of the total product mix by 2020.[52] TNK-BP, with its 3 major refineries and 24mt of overall capacity, has less specific plans but will be investing in isomerization units at both its Ryazan and Saratov plants as well as hydrotreaters, hydrocrackers and visbreakers over the next few years in order to manage a gradual decline in fuel oil output from the 41% level seen in 2011.[53]

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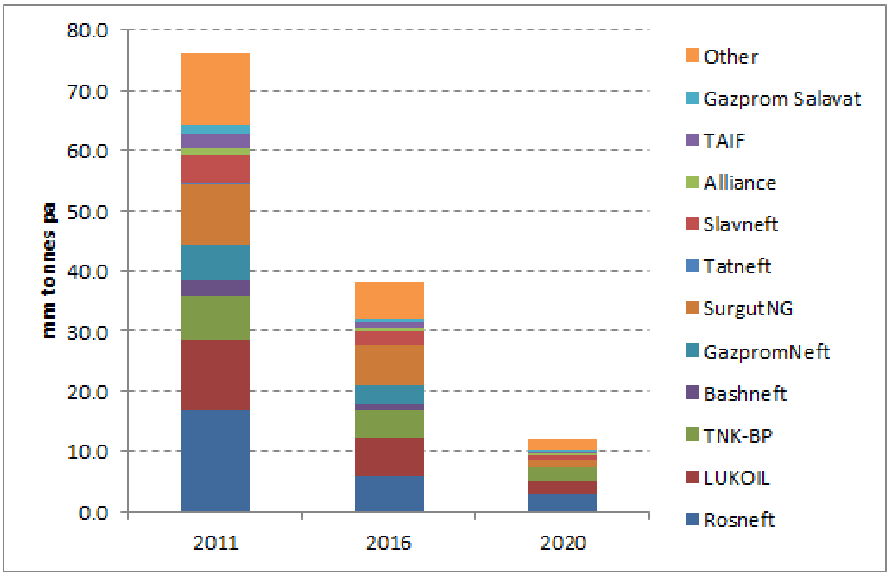
[46] Rosneft presentation "Rosneft – The Leader of the Russian Oil Industry", April 2012, slide 13
[47] Statement made at St Petersburg Economic Forum and reported in Vedomosti, 22 June 2012
[48] GazpromNeft is a 96% subsidiary of Gazprom, which in turn is 51% owned by the Russian State
[49] GazpromNeft presentation to investors, April 2012, slide 25
[50] Bashneft Investor Presentation made by A. Korsik (Bashneft CEO) in May 2012, slide 12
[51] Tatneft Presentation to Investors, April 2012, slides 8-9
[52] Interfax, 14 Feb 2012, "Surgutneftegas postpones completing construction of oil deep processing plant in Kirishi", St Petersburg
[53] http://tnk-bp.ru/en/company/strategy/, accessed 12 June 2012

Across the remainder of Russia's refining sector smaller companies are also planning to contribute to meeting the government's upgrading targets. The most significant are Alliance Oil's goal of increasing the capacity of its Khabarovsk refinery in the Far East of Russia from 3.3 to 4.5mt while also improving the Nelson complexity of the plant from 3.4 to 9.9 at a cost of $1bn,[54] and Slavneft's $1.2 billion investment to install residual hydrocracking and MTBE facilities at its Yaroslavl plant in European Russia. Overall, though, as noted by new Rosneft CEO and former Deputy Prime Minister Igor Sechin, Russian oil companies plan to spend up $50 billion in the construction of at least 100 new refining units by 2020.[55] Although the exact timing of this investment is somewhat uncertain, being dependent on the development of government policy as well as the Russian product market, it nevertheless now seems inevitable that a significant upgrading of the Russian refining system will have occurred by the end of this decade. The details of this upgrading, and the expenditure it will require, are summarised in Appendix 2, but the overall conclusion is that fuel oil output is set to decline sharply while production of gasoline, diesel and jet kerosene will increase to meet the changing needs of the Russian economy.

Figure 4 summarises just how dramatic the decline in Russian fuel oil production could be, showing an estimate based on individual company forecasts but adjusted in an attempt to reflect a likely outcome given the potential for delays and missed targets. Nevertheless, the overall conclusion is that fuel oil output could fall from 76mt in 2011 to 38mt in 2016 and to only 12mt by 2020, with the potential for the latter number to be brought forward if all the companies meet their most aggressive targets. In adjusting some of the company forecasts an element of subjectivity is clearly involved, but essentially an attempt has been made to rationalise the statements and targets announced by all the companies. For example, LUKOIL CEO Vagit Alekperov announced at a recent presentation to investors that fuel oil output would be zero by the middle of this decade, while a more detailed analysis of the company's upgrading plans by refinery would suggest that a target of fuel oil output being reduced from 12mt to 2mt by 2020 is a more likely result. Figure 4 reflects this more gradual decline.

Figure 4: Forecast of Russian Fuel Oil Output by Company to 2020



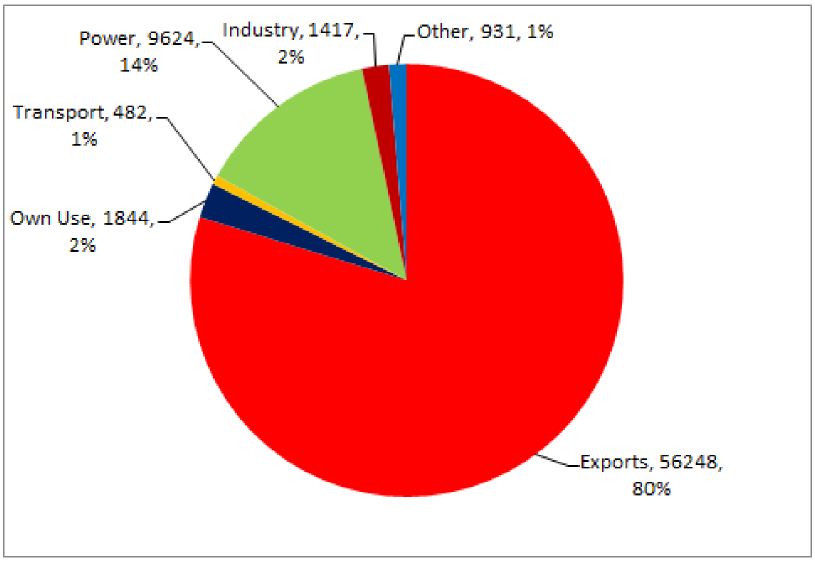
Source: Company Data and Forecasts

[54] Alliance Operational Update 4Q and Outlook for 2011, 18 Jan 2011, slide 10
[55] Interfax, 18 April 2012, "Investments in development of oil production in Russia to total $400-500 bn until 2020 – Sechin", Moscow

Based on a similar type of analysis, the following assumptions have been made concerning the major Russian oil companies. Bashneft will ultimately reduce fuel oil output to 1% of its total fuel mix, but will achieve this by 2020 rather than 2016, reflecting the analysis of the company's economic department[56] rather than the more optimistic views of senior management when presenting to investors. Rosneft's fuel oil output will fall to 10% of its total product mix by 2016, before halving to 5% by 2020 as the company's extensive upgrading and new capacity plans are completed. As for GazpromNeft, although its ultimate target is to reduce the share of fuel oil output to zero (from the current 19%), the upgrading timetable at the Moscow and Omsk refineries suggests that this is more likely by 2020 than 2016, when it is estimated that the share will have fallen to 10%. Improvements at Surgutneftegas' Kirishi refinery will also be most dramatic post 2016 when a catalytic cracker has been installed, which should see fuel oil output reduced to 5% by 2020 from 53% in 2011 and 32% in 2016. Meanwhile TNK-BP will show a gradual decline in fuel oil output as it upgrades all its major refineries, achieving an estimated 10% share by 2020 from 41% at present. Perhaps the most impressive of the major companies, though, will be Tatneft, which has built a new refinery and will be completing significant further upgrading work by 2016 to increase the plant's complexity and to reduce fuel oil output to zero. Finally, the general assumption for the smaller companies is that they will all ultimately meet their individual fuel oil reduction targets, but at a somewhat slower pace than planned.

As noted above, the information on fuel oil exports appears to be somewhat confused by a lack of reliable data due to the possibility of some crude exports being accounted for as fuel oil in order to reduce the export tax liability. Also the data for domestic fuel oil consumption is rather scarce, but the latest figures that encapsulate the entire picture were published by the IEA for 2009 and are shown in Figure 5. It is clear that the majority of Russia's fuel oil is exported, with 80% of the country's 70mt of production leaving for European and Asian markets in 2009. Of the remaining 14mt of domestic demand, two thirds was consumed in the power sector, with industry, transport and own use making up the bulk of the remaining demand.

Figure 5: Russian Fuel Oil Exports and Domestic Consumption (figures in 000 tonnes for 2009)



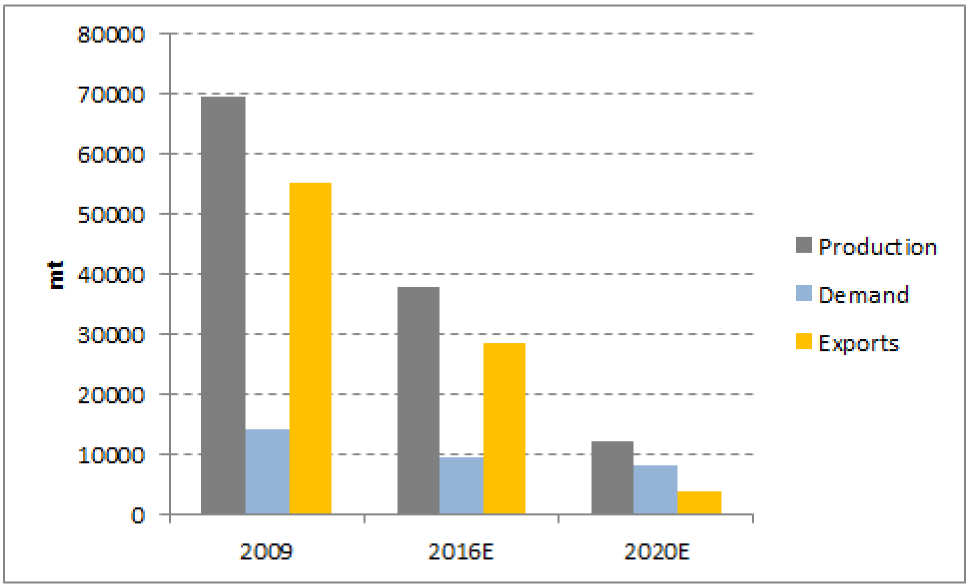
Source: IEA Energy Statistics, Oil in Russian Federation in 2009

[56] Bashneft Presentation, May 2012, "JSOC Bashneft", slide 12

Although 2009 was clearly something of an anomalous year due to the impact of the financial crisis, it is nevertheless interesting to note that fuel oil's share in the power market was only 2% of electricity generated, down from 5% in 2005,[57] underlining both the fact that it is used as substitute fuel and that its use is also in general decline. Indeed the Russian Energy Strategy, itself published in 2009, confirms this trend as it sees fuel oil use in the power sector falling from the 9.5mt seen in 2009 to a range of 3.5-5mt per annum by 2015, with final consumption in other sectors showing a more modest, but definite, decline.

On the assumption that this target is met and that fuel oil consumption in the power sector falls to 5mt in 2016 and 4mt in 2020, while other domestic fuel oil demand also continues a gradual decline (assumed to be 1% per annum to 2020), it is possible to estimate Russian fuel oil demand of 9.5mt in 2016 and 8.2mt in 2020. While these forecasts are inevitably somewhat speculative given the quality of the base data, they do give an indication of the demand trend, and when this is combined with the sharp anticipated fall in fuel oil production the impact on the potential decline in fuel oil exports becomes clear, as is shown in Figure 6. Despite an estimated 5mt fall in domestic demand by 2016, the current upgrading plans for Russia's refineries mean that supply could fall by more than 30mt compared to 2009 levels (and more than 35mt compared to the higher production in 2011 shown in Figure 4 above), meaning that fuel oil exports could fall below 30mt by 2016. These trends are then set to continue to 2020, with the gradual decline in domestic demand swamped by the continued fall in fuel oil output to an estimated 12mt, meaning that fuel oil exports could collapse to as low as 4mt.

Figure 6: Estimated Supply, Demand and Exports of Russian Fuel Oil to 2020



Source: IEA Data, Author's Estimates

In short, the Russian government has provided a clear fiscal incentive to encourage its domestic oil industry to upgrade the country's refining complex and reduce fuel oil production. The key lever has been the export tax on fuel oil, which has already been increased by 71% and is set to rise further if plans to make it equivalent to the crude export tax by 2015 are implemented. At this point the economics of fuel oil exports would become very marginal at best, and would be likely to be loss-making, suggesting that the upgrading

[57] IEA Energy Statistics for the Russian Federation

plans outlined above have strong economic rationale and that their implementation is very probable, if not guaranteed. If anything, this analysis has understated the potential for the fall in fuel oil production because it has taken into account the possibility of construction delays and uncertainty about the ability of all the Russian oil companies to implement their plans within such a short time period. Furthermore, the potential exists for unintended consequences to undermine the speed of the overall shift in the shape of the refining industry in Russia. One example would be the concern expressed by a number of companies that if all the targeted increase in refinery complexity is achieved on the current timescale, there could well be a 4-7mt gasoline surplus in Russia by 2016, a possibility confirmed by former Energy Minister Sergei Shmatko in April 2012 when he noted that gasoline consumption in 2015 could reach 39mt compared with targeted output of 44mt.[58] Clearly such an oversupply would not be attractive for Russian refiners, especially as the profitability of gasoline exports has been undermined by the new higher export tax, and this potential scenario could cause some companies to attempt to delay upgrading investment. Nevertheless, the Russian government's firmly stated commitment to the regeneration of its country's refining industry and its determination to ensure that domestic demand for higher quality products is met would suggest that, although the exact timing of a reduction in fuel oil production may be unclear, a sharp decline in exports by 2016 seems inevitable, while by 2020 Russian fuel oil may have almost disappeared from global markets.

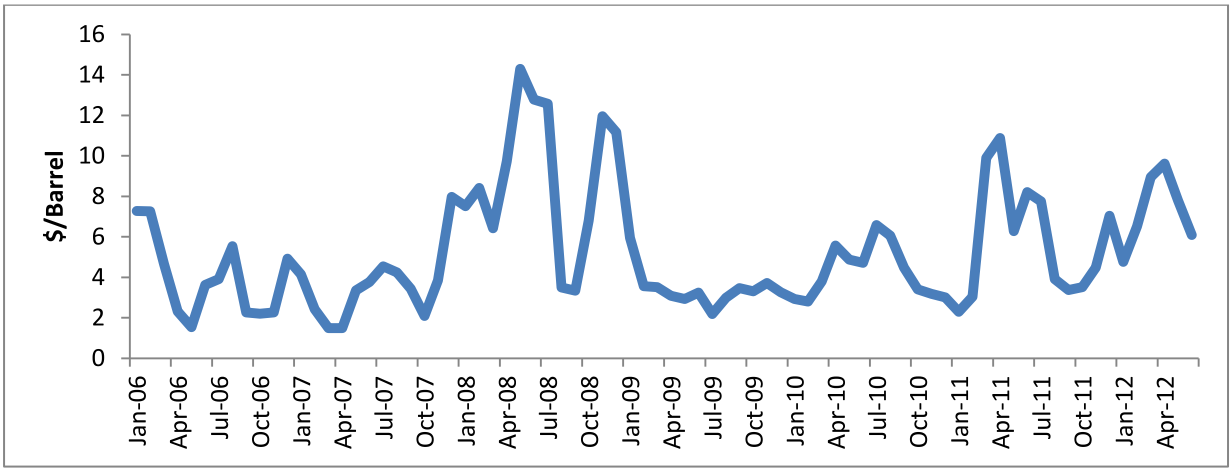
4. Cut in Fuel Oil Exports and Price Relationships

How will changes in the Russian refining scene influence the future dynamics of the fuel oil market? To answer this question, we study the past behaviour of price spreads and then analyse whether the expected decline in Russian fuel oil exports is likely to alter these price relationships. We focus on the time series dynamics of the following three price differentials: the differential between LSFO (1%) and HSFO (3.5%); the differential between North Sea Dated and HSFO; and the differential between Gasoil (0.1) and HSFO. We focus on European prices (barges, FOB) in North West Europe (NWE). The frequency of data is monthly from January 2006 to June 2012. Monthly data were obtained by averaging daily prices over the entire month. All the data were obtained from Bloomberg.

Figure 7 below plots the monthly price differential ($/barrel) between LSFO and HSFO. As seen from this figure, the spread is quite volatile, especially in the first half of the sample, but with no obvious trend. There appears to be a structural break in the price differential dynamics towards early 2009 when the series started to fluctuate within narrower bands. From the third quarter of 2007, the price differential started widening and in July 2008, the differential between LSFO and HSFO reached historically high levels of above $14/barrel reflecting a combination of refining constraints and the introduction of more stringent fuel standards during that time. The widening of the differential did not persist and following the collapse of the oil price and oil demand in the second half of 2008, the differential between LSFO and HSFO narrowed considerably and continued to fluctuate but within narrower band, especially when compared to 2008. Following the Libyan output disruption in February 2011, the differential between LSFO and HSFO widened again, but then declined towards the end of the sample.

[58] Interfax, 19 April 2012, "Russia to boost gasoline production 20% by 2015", Moscow

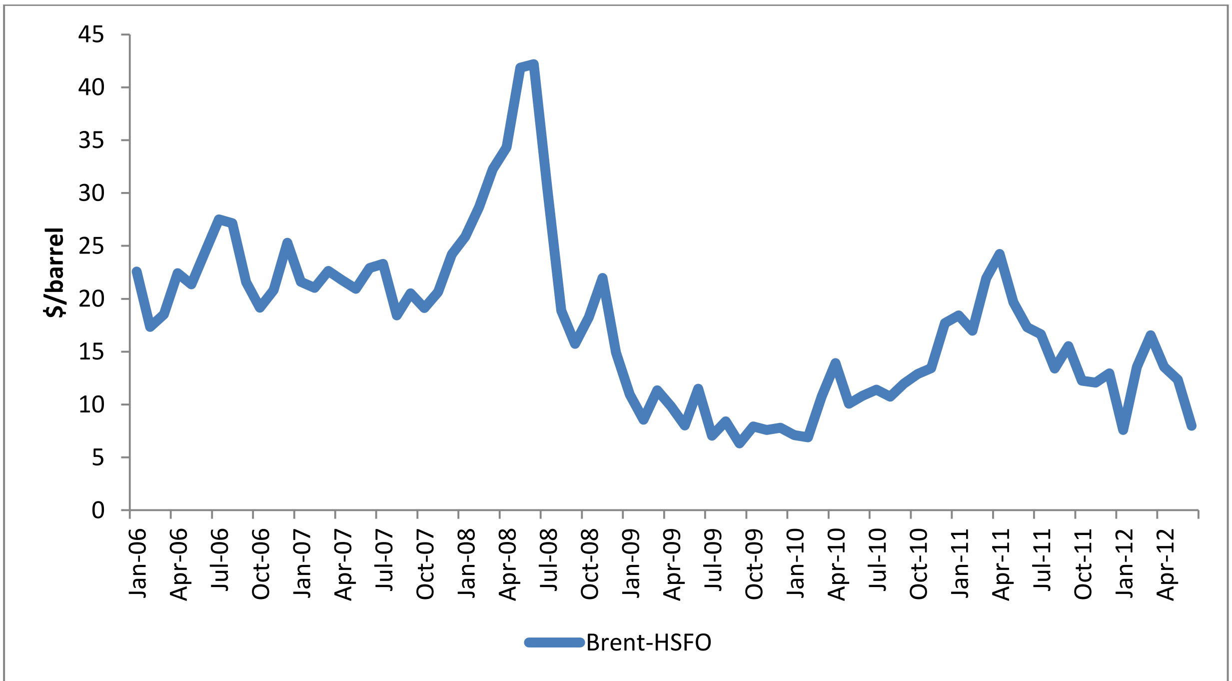
Figure 7: Spread between LSFO (1%) and HSFO (5%) (January 2006-June 2012, $/Barrel)



Source: Bloomberg

Figure 8 plots the monthly price differential between Dated Brent and HSFO. As in the case of LSFO-HSFO, in mid 2008 the relationship between fuel oil and crude prices became unstable, with the spread between Dated Brent and HSFO widening to over $42/barrel in June 2008. These wide differentials did not last long and by the second quarter of 2009, they narrowed as oil demand fell and as new refining capacity was brought on stream. In the first few months of 2011, the spread widened, especially following the Libyan output disruption. But by January 2012, spreads narrowed again to similar levels seen in 2009 and 2010.

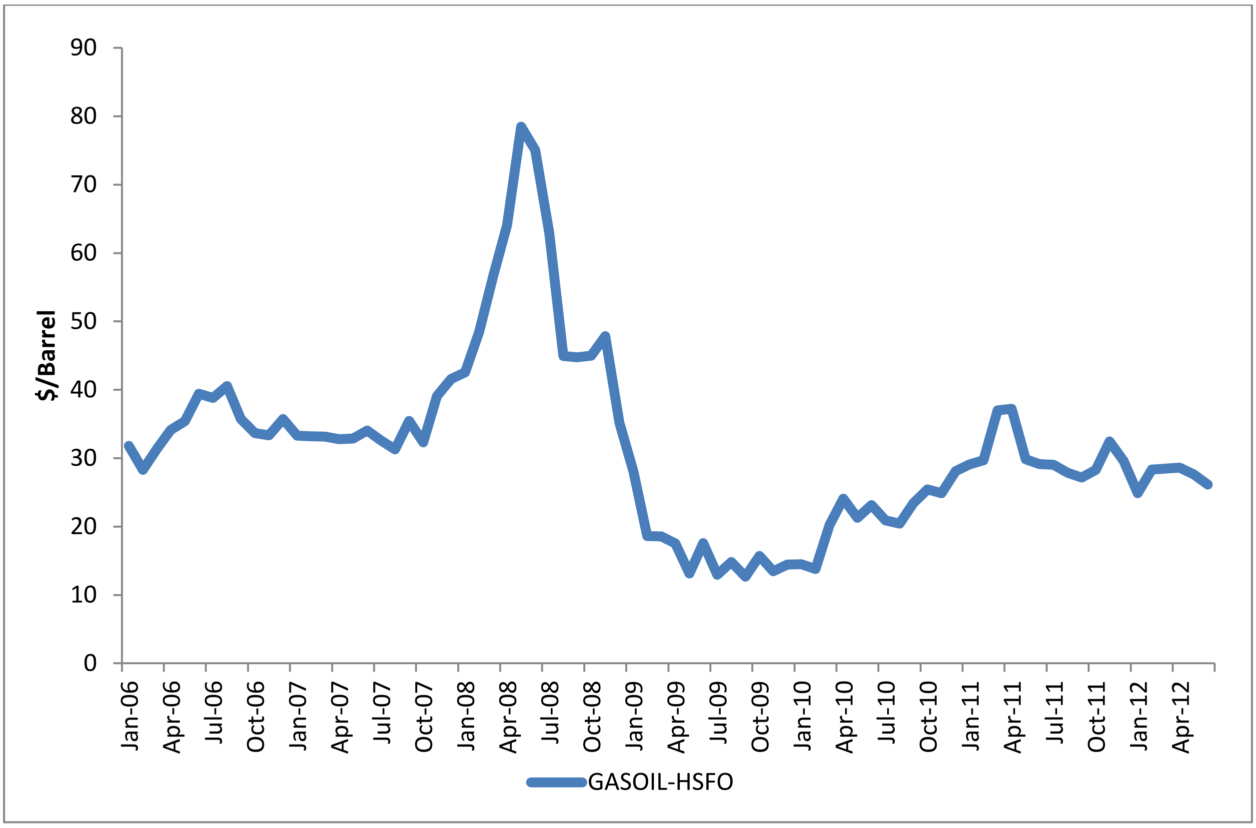
Figure 8: Spread between Dated Brent and HSFO in NWE (Monthly, January 2006-June 2012, $/Barrel)



Source: Bloomberg

Figure 9 below plots the monthly price differential between Gasoil and HSFO. As seen from this figure, there appears to be a structural break in the dynamics of the series in late 2008 or early 2009. In June 2008, the differential widened to almost $80/barrel, a historical high. This sharp widening can be explained by refining constraints and the increase in demand for low sulphur products caused by more stringent requirements and higher demand for diesel, especially from China. The wide differential did not persist and by May 2009 the spread narrowed to around $13/barrel and remained at low levels for most of 2009. In 2010, the spread started to widen again reaching $37/barrel in April 2011 in the aftermath of the Libyan disruption, which caused the loss of supplies of diesel rich crude oil that were difficult to replace. Since then, the differential weakened slightly and has been trading within a narrow range between $27 and $29/barrel.

Figure 9: Spread between Gasoil and HSFO in NWE (Monthly, January 2006-June 2012, $/Barrel)



Source: Bloomberg

Table 1 below provides some basic statistics for the three price differential series. For the period between 2006 and mid 2012, the mean of the LSFO-HSFO price differential was $5.20/barrel. It is interesting to note though the wide range between the minimum and maximum values of around $14/barrel. The mean of the Brent-HSFO price differential was $17.52/barrel, but with relatively high standard error and wide range between the maximum and minimum values reaching more than $27/barrel. For the differential between Gasoil and HSFO, the mean stood at $31.60/barrel, with a standard error of $13/barrel and wide range between the minimum and maximum values exceeding $65/barrel. All the series are positively skewed indicating a longer right side tail of the distribution.

Table 1: Basic Statistics

	Mean	Standard Error	Skewness	Min	Max
LSFO-HSFO	5.20	2.93	1.18	1.49	14.30
BRENT-HSFO	17.52	7.72	0.87	6.32	42.19
GASOIL-HSFO	31.60	13.00	1.33	12.66	78.47

Notes: LSFO-HSFO is the price differential between Low Sulphur and High Sulphur Fuel Oil; BRENT-HSFO is the price differential between North Sea Dated Brent and High Sulphur Fuel Oil; GASOIL-HSFO is the price differential between Gasoil and HSFO. All the series are expressed in $/barrel. Data frequency is monthly from January 2006 to June 2012 based on averages of daily data.

Figures 7, 8 and 9 suggest that the price differential follows a stationary process but with the possibility of structural break in 2008 or early 2009. If the series is stationary, then there exist adjustment mechanisms that prevent the price differential from increasing or decreasing without bound. These adjustment mechanisms are likely to be stronger at times when constraints on refining ease either as a result of decrease in oil demand, the bringing of new refining capacity on stream and/or upgrading in refining units. On the other hand, if the price differential has a unit root, then its mean and variance are changing over time. We test formally for unit root using the augmented Dickey-Fuller[59] (ADF), the Philips-Perron (PP)[60], the Perron (1997) [61] and the Zivot-Andrews tests (1992)[62]. Given that the above figures indicate that the series may have been subject to structural changes, we attach more weight to the latter two tests, which allow for an endogenous structural time break in the time series.

The results are presented in Table 2 below.[63] As seen from this table, the ADF and PP unit root tests suggest that we can't reject the null of unit root except for LSFO-HSFO where the null hypothesis can be rejected at the 1% level based both on the ADF and PP tests. These tests however are known to have low power in the presence of a structural break and hence the results should be treated with caution. Interestingly, the Perron and Zivot-Andrews tests indicate that there has been a structural break in the various series though the dates of the break are slightly different across the two tests. Based on the Perron and the Zivot-Andrews tests, we can reject the null of unit root at the 1% level for LSFO-HSFO confirming the earlier results obtained on the basis of ADF and PP tests. The date of structural break is April 2009 based on the Perron test, while slightly earlier in February 2009 based on the Zivot-Andrews test. Interestingly, for Brent-HSFO we can reject the null of unit root based on the Perron and the Zivot-Andrews tests, indicating the importance of accounting for structural breaks when testing for unit roots. The Perron test dates the structural break in April 2009 while the Zivot-Andrews test dates the break in February 2009. We obtain similar results for GASOIL-HSFO, where the null of unit root can now be rejected at the 1% level based on both tests. The Perron test dates the structural break in April 2009 while the Zivot-Andrews test dates the break few months earlier in November 2008.

[59] Dickey, D.A., Fuller, W.A., 1979. Distribution of the estimators for autoregressive time series with a unit root. Journal of the American Statistical Association 74, 427–431.
[60] Phillips, P., Perron, P., 1988. Testing for a unit root in time series regressions. Biometrica 75, 335–346.
[61] Perron, Pierre, 1997. "Further evidence on breaking trend functions in macroeconomic variables," Journal of Econometrics, 80(2): 355-385.
[62] Zivot, E., Andrews, D. (1992), Further Evidence of the Great Crash, the Oil-Price Shock and the Unit-Root Hypothesis. Journal of Business and Economic Statistics 10, 251-270.
[63] For the unit root tests, the price differentials are computed by taking the log difference of prices. The log is more appropriate as it reflects the price differential in proportion to the fuel price.

Table 2: Unit Root Tests

	ADF	PP	Perron	Zivot-Andrews
LSFO-HSFO	-3.87***(2)	-3.74***	-5.26** (April 2009)	-8.25*** (February 2009)
BRENT-HSFO	-1.39 (2)	-1.67	-5.806** (April 2009)	-6.21** (February 2009)
GASOIL-HSFO	-1.81 (2)	-1.71	-6.71*** (April 2009)	-6.87*** (November 2008)

Notes: ADF refers to Augmented Dickey and Fuller (1979) test. The lag number is in parenthesis and was selected based on the AIC criterion. Critical values: 1%= -3.520; 5%= -2.900; 10%= -2.587. PP refers to Philips and Perron (1988) test statistics. The lag number is in parenthesis. Critical values for Philips–Perron tests: 1%= -3.517; 5%= -2.899; 10%= -2.587. Perron test for unit root with endogenous structural break. The date of structural break is in parenthesis. Critical values: 1%= -5.92; 5%= -5.23; 10%=-4.92. Zivot-Andrews test for unit root with one endogenous structural break. The date of structural break is in parenthesis. Critical values: 1%= -5.34; 5%= -4.80; 10%=-4.42. *** Significance at the 1% level; ** Significance at the 5% level; * Significance at the 10% level.

In short, the above results suggest the price differential between LSFO and HSFO has been subject to structural break. The series however is stationary which implies that the differential does not increase or decrease without bound and tends to fluctuate around a mean value. This is to be expected as HSFO can always be blended down to LSFO by adding in sufficient amounts of diesel or gasoil.[64] The same conclusion also applies to the price differential between Dated Brent and HSFO and between Gasoil and HSFO, which have also been subject to structural breaks. The easing of refining constraints following the collapse in the oil demand towards the end of 2008 and the additional refining capacity brought on stream in the last few years provided enough flexibility in the global refining system to help the differentials fluctuate within relatively narrow bounds.

Looking beyond 2016, our analysis indicates that Russian fuel oil supply will have fallen sharply by then. The key question is: how would this impact the price relationship between heavy fuel oil and the other products? It is very difficult to provide an answer to this question given the large array of factors that influence the movements in the spreads, some of which are temporary in nature (a supply shock to a certain type of crude oil) while others are structural (such as underinvestment in refining capacity or changes in the quality of crude oil arriving to the market). However, it is possible to make the following two observations:

- There are two structural trends in the fuel oil market that are working in the opposite direction. On the one hand, the implementation of more stringent regulations will result in lower fuel oil demand. On the other hand, the expansion in conversion capacity and the upgrading of Russian refineries will tighten the supply of fuel oil. Other things being equal, this will continue to provide support for heavy fuel oil prices, preventing steep declines in the crack spread for both HSFO and LSFO. Given that Brent-HSFO and Gasoil-HSFO already exhibit a stationary behaviour and given the current plans to expand and upgrade refining capacity, there is no reason why the nature of these dynamics will change and these differentials are likely to continue to fluctuate within narrow bounds and around a long-term mean value. The mean value may be subject to a sudden structural break or be subject to gradual adjustment around an identifiable trend depending on a number of factors such as the pace of

[64] As sulphur blends linearly, it is possible to calculate the maximum limit to the spread based on the diesel fuel spread. The key thing to bear in mind that this is not like a refining constraint and it is always possible to blend as long as there are suitable terminals to do so. The main issue is the cost of blending.

expansion in the refining capacity, the size and timing of cuts in heavy fuel oil exports, and the time frame in which regulatory changes are implemented.

- Structural transformation in demand patterns and changes in the regulatory environment will continue to exert a downward pressure on the demand for HSFO. However, the reduction in the supply of HSFO, the possibility for blending, and the potential decline in demand for LSFO as the bunker market shifts to middle distillates is likely to keep the differential between LSFO and HSFO within narrow bounds and in line with historical averages.

5. Conclusion

While higher fuel specifications and regulatory changes in the bunkers market are most likely to have a big impact on long-term fuel oil demand, a structural shift of a similar magnitude on the supply side is already taking place, particularly in Russia, the largest exporter of fuel oil. The Russian government's firmly stated commitment to the regeneration of its country's refining industry and its determination to ensure that domestic demand for higher quality products is met would suggest that, although the exact timing of a reduction in fuel oil production may be unclear, a sharp decline in fuel oil exports by 2016 seems inevitable, while by 2020 Russian fuel oil may have almost disappeared from global markets. We show that in the past, price relationships between high sulphur and low sulphur fuel oil and between heavy fuel oil and crude oil and diesel have been subject to structural breaks, but price movement did not increase or decrease without bounds as the refining industry continued to adjust to increasing demand for petroleum products and changing global demand patterns towards cleaner products. Looking ahead, as investment in refining capacity expands and as upgrading of refining units accelerates in Russia and elsewhere, price spreads are likely to exhibit similar behaviour to that in the past few years. This does not imply that structural breaks in the price relationships will not occur. For instance, governments' desire to implement more stringent requirements without ensuring that the refining infrastructure is ready for such a shift or delays in refinery projects will most likely destabilise the behaviour of price differentials, though the timing and the nature of such potential breaks (abrupt of gradual) remain highly uncertain.

Appendices

Appendix 1 – Russian Government Targets for Gasoline and Diesel Quality

	2009-10	2011	2012	2015
Gasoline				
Standard	Euro 2	Euro 3	Euro 4	Euro 5
Max Sulphur, ppm	500	150	50	10
Maz benzene, %	5	1	1	1
Maz aromatics, %	no limit	42	35	35
Min octane rating	92	95	95	95
Diesel				
Standard	Euro 2/3	Euro 2/3	Euro 4	Euro 5
Max Sulphur, ppm	500/350	500/350	50	10
Maz density	860/845	860/845	845	845
Min cetane rating	45/51	45/51	51	51

Source: LUKOIL

Appendix 2 – Refinery upgrading and capital expenditure plans of Russian Oil companies to 2020

Company	Refinery	Upgrading Plans	Est. Capex	Comment
			US$bn	
LUKOIL	Nizhny Novgorod	Catalytic Cracking, Hydro Cracking	4.8	Upgrade to complete 2016-18
	Perm	Coking Complex	0.7	Completion in 2015
	Volgograd	VGO Hydrocracking	1.8	Completion in 2016
	Other		3.0	Overall goal to increase LUKOIL Nelson Complexity to 8.8
Rosneft	Angarsk	Isomerization, Hydrotreater, MTBE and Alkylate Units	18.0	Increase overall light product yield to 80% and reduce fuel oil output from 36% to 10% by 2015. Overall Nelson Complexity to rise from 4 to 7
	Syzran	Catalytic cracker, Hydrotreater		
	Novo-Kuibyshev	Catalytic reforming unit, hydrocrwacker, isomerization unit		
	Kuibyshev	Catalytic cracker		
	Komsomolsk	Coking plant		
	Achinsk	Coker, hydrocracker, isomerization unit		
	Tuapse	Refinery expansion and upgrade		
TNK-BP	Ryazan	Hydrocracker, Visbreaker, Hydrotreater	0.9	Gradual improvement to product slate and gasoline quality by 2015
	Saratov	Visbreaker, Hydrotreater, Isomerization	0.4	
SurgutNG	Kirishi	Hydrocracker in 2012, Catalytic cracker by 2015/17	7.0	Major upgrade to improve conversion rate to 95% by 2017
GazpromNeft	Omsk	Catalytic cracking unit, hydrotreaters	1.0	Completed in 2012/13
	Moscow	Isomerization, hydrotreater, catalytic cracker	5.2	Plan to increase Nelson Index to 12 and cease fuel oil output
Bashneft	Novo-Ufa	Alkylation Unit, Hydrocracker, Hydrogen Plant	1.8	Increase overall Nelson Index from 8.3 to 9.6 and light profuct yeild to 73%
	Ufa	Hydrotreater, Coker		
	Ufaneftekhim	Coker		
Tatneft	TANECO	Hydrocracker in 2013, Catalytic Cracker by 2016	3.0	New plant completed in Dec 2011, with upgrading to take Nelson Complexity to 12 by 2016, with no fuel oil output
Slavneft	Yaroslavl	Residual hydrocracking facility, MTBE	1.2	
Alliance	Khabarovsk	Refinery expansion, Catalytic reformer	1.0	Increase capacity to 4.5mmt and increase Nelson Complexity from 3.4 to 9.9
Total			**49.8**	

Source: Company Data