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# Economic commentaries

## Increased gas exports, but what about prices?

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Gas exports account for a rising share of Norwegian petroleum revenues. International gas spot prices have traditionally tracked oil prices with a lag. After the financial crisis, international gas prices remained low longer than oil prices. US natural gas prices are still low, while gas prices in Europe and Asia have edged up again. In this commentary we take a closer look at recent years' gas price developments and perform a statistical analysis of whether the link between gas and oil prices has changed. The results of the analysis indicate that there is no longer a relationship between oil and gas prices in the US, but that spot prices for gas in Europe are tracking oil prices as closely as before the financial crisis.

Prices for Norwegian gas have largely been linked to the price of oil in long-term sales contracts, with only a small fraction of gas sold at spot prices. A number of Norwegian gas contracts were renegotiated in 2009-2010 as, at the time, export prices were considerably higher than European gas spot prices. As a result, there was a certain shift away from indexing export prices to oil prices and towards linking them to gas spot prices in Europe. However, we do not find evidence to support a claim that Norwegian gas prices have become substantially less sensitive to changes in oil prices and substantially more sensitive to changes in European gas prices in the past two or three years.

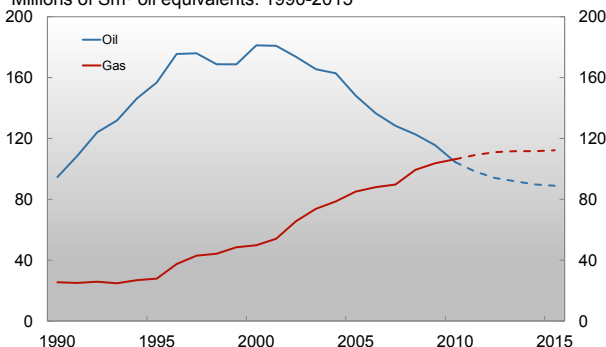
We forecast Norwegian gas prices to be relatively high ahead if oil prices and European gas prices remain high as futures prices currently indicate. At the same time, futures prices suggest that European gas prices will be so high in the coming years that Norwegian gas prices will not be particularly affected if a larger share of exports were to be sold at spot prices.

## Introduction

Natural gas production and gas exports are becoming increasingly important for Norway. Production has more than doubled over the past decade, while oil production has fallen by almost half. Measured in common energy units, gas production and oil production are now at the same level. In 2010, Norway was the world's second largest gas exporter after Russia. At the beginning of the 2000s, Norway was the world's second largest oil exporter, but is now the seventh largest. While oil production will continue to decline in the coming years, gas production is expected to increase somewhat (see Chart 1). For that reason, gas price developments will have a greater bearing on Norway's petroleum revenues ahead.

Chart 1 Oil and gas production on the Norwegian continental shelf

Millions of Sm<sup>3</sup> oil equivalents. 1990-2015<sup>1)</sup>



<sup>1)</sup> Figures for 2011 - 2015 are projections from "The shelf in 2010"

Sources: Norwegian Petroleum Directorate

1 Astrid Stavseng worked on the present article as a student at Norges Bank until summer 2011.

2 We are grateful to colleagues at Norges Bank for helpful comments. We have also received useful input from a number of oil industry experts.

Natural gas prices have traditionally tracked oil prices with a lag.<sup>3</sup> Gas prices thus fell considerably in the period following the sharp decline in oil prices in autumn 2008. While oil prices quickly recovered, international spot prices for gas continued to decline until summer 2009 and remained relatively low (see Chart 2). The US spot price remains at approximately the same level as in mid-2009. The UK spot price, which to a large extent is a price leader for spot prices in the rest of Europe, remained low through 2009 but picked up appreciably through 2010 and the first half of 2011.

Oil and gas price developments in the period 2008-2011 reflect a number of factors. Gas supplies have risen markedly in recent years owing to higher production of unconventional gas (especially shale gas) in the US and a sharp increase in export capacity for liquefied natural gas (LNG) from the Middle East. At the same time, oil supplies have been reduced by the substantial production cuts made by OPEC at the end of 2008. Moreover, demand for oil fell less than demand for gas through the financial crisis, primarily reflecting sustained activity in emerging market economies. These economies are relatively more important for oil demand than for gas demand. Moreover, as the US has become almost self-sufficient in terms of gas and, for the time being, has limited capability to export gas, US and UK gas prices have diverged over the past two years.

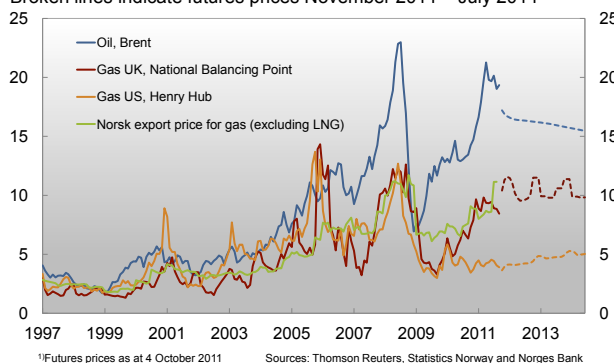
Norwegian gas is primarily exported to European countries through a network of pipelines. In recent years there has been a certain volume of LNG exports (from the Melkøya terminal). While most of the LNG is also exported to Europe, some LNG is sold to the US and some countries in Asia. In 2010, only a half per cent of total gas exports went to countries outside Europe. European markets are therefore far more important for Norwegian gas exports than the US market.

Historically, most Norwegian gas has been sold under long-term contracts where prices have been adjusted in step with oil price developments. Only a small fraction has been sold in spot markets or under contracts where prices have been linked to spot

prices for gas. Through 2009 and the first half of 2010, Norwegian export prices for gas were clearly above UK spot prices (see Chart 2). This prompted gas importers to call for renegotiation or termination of their oil-indexed gas contracts.

**Chart 2 Oil and gas prices**

Monthly figures. USD/MMBtu. January 1997 - September 2011. Broken lines indicate futures prices November 2011 - July 2014<sup>1)</sup>



In 2009-2010, Statoil and the Russian gas producer Gazprom, both major gas exporters, had to renegotiate some of their long-term oil-indexed sales contracts (see Statoil (2011), Financial Times (2010) and Stern and Rogers (2011)). This led to a certain shift away from indexing contract prices to oil prices towards linking them to gas prices on European spot markets. In addition, gas exporters became somewhat more flexible regarding the volume of gas that importers had to take under the contracts. This may have resulted in an increasing share of Norwegian gas being sold in the spot market in recent years.

Gas companies are reluctant to provide detailed information on the content of their gas contracts, how they are renegotiated and the share of gas now being sold at spot prices. Thus, it is unclear whether the concessions from Statoil in 2009-2010 were temporary in nature – and related to the unusual situation in those years – or whether there has been a permanent move towards increased spot-indexing and/or greater volume flexibility in contracts. Another element of uncertainty is whether pressure to renegotiate contracts will continue. It cannot be ruled out that prices for Norwegian gas will become more closely linked to gas spot prices in the period ahead, either because spot prices become more prominent in new and rene-

<sup>3</sup> In this article we use the price of the European benchmark, Brent Blend. The US and Asia have their own oil benchmarks, but in this context they are of less importance.

gotiated contracts or because a larger share of gas is sold on spot markets. This need not result in lower export price as long as US gas market developments continue to have little impact on European spot prices. However, if the US expands its capacity for exporting LNG on a large scale, which is an issue currently being discussed, European spot prices may be more affected by low US gas prices than they have been to date. In that case, the value of Norwegian gas exports may be far lower than previously assumed (Pedersen and Wærness (2010)).

### The historical relationship between oil prices and gas prices

Oil and gas are used as energy sources in many sectors of the economy. While substitutable to a certain degree, oil and gas have seen their potential substitutability diminish over the past 20-30 years. This is because various sectors in the economy use energy solutions that are less capable than previously of short-term switching between oil and gas.<sup>4</sup>

Nevertheless, in the medium to long term, the relative prices of oil and gas – and other types of energy – may influence the choice of energy solution for different purposes.

Since the beginning of the 1980s, gas prices have been 60-70 per cent of oil prices, measured in the same energy unit. A rough explanation of this price difference is that gas is more costly to use than oil because it is far more expensive to transport and store per energy unit (Hannesson (1998)). Moreover, gas cannot be used to any great extent in the transport sector. At the same time, global gas reserves are more ample than oil reserves. Finally, OPEC plays a key role in the oil market, while no similar cartel exists in the gas market.

High transport costs for gas have resulted in more regional markets for gas than for oil (Hannesson (1998)). Historically, gas has been used as an energy source especially in countries relatively close to gas fields. Even so, this has gradually changed over the years. New, large gas deposits have been discovered in countries far from traditional gas consuming countries. In addition, improved technology and lower costs for LNG have helped to make it profit-

<sup>4</sup> In advanced economies, this pertains to power generation in the electricity sector and for industrial uses. In emerging market economies, there is probably still competition in these areas.

able to transport gas over longer distances. This has led to an increasingly globalised gas market.

Approximately a third of all gas is traded on regional spot markets (International Energy Agency (IEA) (2011a)). This includes nearly all gas in the US and the UK, which are by far the largest spot markets. Also a share of gas in continental Europe is sold on spot markets. Around a fifth of gas globally is sold under long-term contracts where gas prices are linked to prices for oil or various oil products. Spot prices for gas and prices for other energy such as coal may also be included in these contracts, but oil prices have been by far the most important to date (Honore (2010)). Contracts of this type are common for gas exports to continental Europe and Asia. Internationally, over a third of gas is sold at regulated prices, which are often well below spot and oil-indexed prices. A small fraction is sold between bilateral monopolies, primarily in the former Soviet Union.

US and UK spot prices for gas are determined by supply and demand in the gas market and are not directly linked to oil prices as is the case for Norwegian and Russian gas. Since there is a degree of demand substitutability between oil and gas and since oil and gas are produced by many of the same companies, spot prices for gas will still be affected by changes in oil prices. A rise in oil prices can shift demand away from oil towards gas. At the same time, higher oil prices may make exploration and production of oil more profitable than gas. Over time, these adjustments will help push up gas prices as well.<sup>5</sup> Prices for oil and gas also tend to be related as they are influenced by common factors, such as increased economic activity, low interest rates and ample global liquidity. Spot prices for oil and gas may also be correlated because spot prices for gas will be affected by oil-indexed gas prices. Major changes in available resources, such as we have seen for gas in recent years, may have a more lasting effect on relative prices.

Finally, other forms of energy may influence spot prices for gas. Coal prices in particular will be of importance as coal competes with gas in the power sector.

<sup>5</sup> For a more detailed discussion of these factors, see IEA (2010), Chapter 10: "Prospects for natural gas pricing".

Norwegian gas prices are primarily determined by long-term sales contracts<sup>6</sup> where the price per quarter is directly linked to the previous months' oil price developments.<sup>7</sup> The time lag in Statoil's traditional contracts is three to nine months (see Statoil (2011)). A share of sales under long-term gas contracts is linked to European spot prices for gas. This proportion increased somewhat following the renegotiations in 2009-2010. In addition, some of the gas is sold directly on the spot market, particularly in the UK. This share may also have increased in recent years.

Oil-indexed gas contracts were introduced in Europe in the 1960s. The rationale for linking gas prices to changes in oil prices in such contracts was that oil and gas were near-substitutes and the absence of spot markets for gas in Europe. Later, substitutability has diminished at the same time as spot markets for gas have developed. However, spot markets in continental Europe are relatively shallow and illiquid. The UK spot market is more mature, but spot prices can show considerable volatility under extraordinary conditions. Therefore, many gas market participants still prefer oil-indexed contracts.

### Oil and gas price developments in recent years

The various gas prices have traditionally tracked oil prices, even though there have been occasional deviations due to temporary disturbances. Recent years have been marked by substantial volatility in oil prices and a surge in gas supplies.

Oil prices increased sharply from 2003 until summer 2008. The main reason for this was high global economic growth, particularly in emerging market economies, higher production costs for new non-OPEC oil and OPEC's drive for higher oil prices (Akram and Winje (2008)). The financial crisis resulted in a sharp drop in oil prices in the second half of 2008. However, they began to recover already in the first months of 2009, largely due to the same factors as before the financial crisis.

Spot prices and Norwegian export prices for gas also rose substantially from 2003 to mid-2008. The sharp rise in gas prices in the UK and US in autumn and winter 2005/2006 was related to extraordinary conditions in the gas markets there.<sup>8</sup> When these conditions were reversed, gas prices in the US and UK fell back again. The subsequent surge in gas prices through 2007 until summer 2008 was fuelled by higher oil prices and robust growth in the global economy. Norwegian gas prices also rose markedly. On average, export prices for Norwegian gas were approximately on a level with UK spot prices in the period 1997-2008 (see Chart 2).

Spot prices for gas in the US and Europe fell sharply towards the end of 2008 and in early 2009. They remained low until the beginning of 2010, even though oil prices began to move up again from spring 2009. There were several reasons for this in addition to the time lag between changes in oil prices and changes in gas prices. Demand for gas, as for oil, fell in the wake of the financial crisis. But unlike oil supplies, global gas supplies rose due in part to an unexpected surge in unconventional gas production in the US and in part to a sharp upturn in export capacity for LNG from the Middle East.<sup>9</sup> The UK became a major outlet of the higher LNG exports, which were redirected from the US to Europe, as US import needs fell.

Norwegian export prices for gas also fell considerably towards the end of 2008 and at the beginning of 2009, but remained well above the UK spot price until summer 2010. This reflects the fact that Norwegian export prices to a large extent were indexed to oil prices and that oil prices rose at a much faster pace than UK gas prices in 2009. In the first half of 2011, Norwegian gas export prices and UK gas prices were approximately equal. In recent months, Norwegian gas export prices have risen in line with the increase in oil prices since the beginning of the year.

The low spot prices for gas in 2009 and into 2010 raised the issue of whether a structural shift had

6 There are considerable differences in the specific formulation of sales contracts, depending on when they were signed, the country and company contractual party, the gas delivery profile, the buyer's flexibility regarding taking of gas and the seller's delivery reliability. See *inter alia* Petroleum Tax Office (2011).

7 It is actually prices for various petroleum products such as heating oil and fuel oil that are included in these contracts. Even so, since prices for these products track oil prices very closely, these contracts are commonly said to be linked to oil prices.

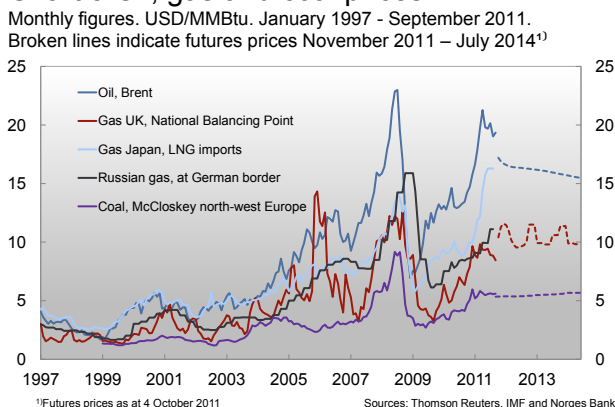
8 In the US this was especially due to the impact on production of the devastation caused by Hurricane Katrina. In the UK the reasons were unusually cold weather, a sharper-than-expected drop in production on the UK continental shelf, low gas stocks, lower imports from the continent and fewer LNG tankers than assumed. See Energy Charter Secretariat (2007).

9 The IEA has repeatedly referred to this as a gas revolution. See *inter alia* IEA (2009), (2010) and (2011a).

taken place in the relationship between oil prices and gas prices owing to increased gas supplies (see for example IEA (2010)). However the picture became more nuanced through the second half of 2010 and into 2011. US and UK spot prices diverged: US prices remained low while UK prices rose markedly. In the US the increased supply of cheap unconventional gas kept gas prices low. The need to import LNG has virtually disappeared, while possibilities for exporting LNG are still limited.<sup>10</sup> Thus, US spot prices may remain low for some time, even through gas prices are high in the rest of the world.

In the UK the situation is different. An increasingly integrated LNG market outside the US means that regional gas prices will gradually converge, even though price differences will persist due to the relatively high costs of producing, transporting and regasifying LNG. High oil prices and strong growth in demand for gas have pushed up LNG prices in Asia, which have also fed through to prices for LNG exports to Europe (see Chart 3). In addition, spot prices for gas in the UK and elsewhere in Europe have been pushed up towards oil-indexed European gas prices. This is because gas customers on the continent are able to temporarily adjust the volume under long-term oil-indexed gas contracts to purchasing cheaper gas on spot markets.<sup>11</sup>

**Chart 3 Oil, gas and coal prices**



<sup>10</sup> In 2010, US gas imports were around 10 per cent of total gas consumption. Imports have fallen by 30 per cent since 2007. LNG imports, which represent 20 per cent of gas imports, have fallen by 50% since 2007. Some LNG imports are re-exported. Since LNG imports are low, the potential for re-exports will also be low. For example, re-exports in January 2011 were record high, but still below 5 per cent of Norwegian gas production the same month.

<sup>11</sup> This is assumed, for example, to be behind the substantial decline in Russian gas exports in 2009. In 2010, Russian gas exports were still lower than in 2008.

Higher UK spot prices since the second half of 2010 must also be viewed in conjunction with higher demand for gas owing to recent years' cold winters in both the UK and the rest of Europe. Demand also rose because economic growth on the continent picked up again in 2010 and into 2011, especially in Germany. Coal prices have nearly doubled since the trough in 2009. In addition, exports of gas from Norway and LNG from the Middle East were lower than usual in spring and summer 2010. Moreover, UK gas production saw an unexpectedly swift decline. Globally, gas prices have also been pushed up as a consequence of cutbacks in several countries in the use of nuclear power following the problems in Japan in spring 2011. In 2011, Libyan gas exports also declined, even though volumes were moderate (IEA (2011a)).

Increased production of unconventional gas in the US has, in recent years, broken the link between oil and gas prices in the US. In econometric equations, we find that a 1 per cent increase in oil prices results in approximately a 1 per cent increase in gas prices when the equations are estimated using data from 1997 up to end-2005. The estimated impact gradually diminishes and markedly so when the estimation period is extended using data up to mid-2011. We find no significant impact from oil prices when the equations are estimated using data from the past five to six years. Others have also found that the relationship between US gas prices and oil prices has weakened from 2005 (De Bock and Gijon (2011)).

UK gas prices remained relatively low for some time after the financial crisis, but have since then rebounded. It is therefore uncertain whether the relationship between oil prices and UK gas prices has been broken. In the case of Norwegian gas prices, contract renegotiations in 2009-2010 would be expected to make export prices less sensitive to changes in oil prices and somewhat more sensitive to changes in European gas prices.

It is, however, uncertain whether these changes are permanent or temporary and whether they are important from an economic viewpoint. In the next section, econometric methods are applied as a means of analysing price formation for UK and Norwegian gas.

## The relationship between oil prices and the prices for UK and Norwegian gas

We have estimated separate equations for UK and Norwegian gas prices based on monthly figures from the second half of the 1990s up to end-August 2011.<sup>12</sup> We have examined the long- and short-term relationship between gas and oil prices and to what extent UK spot prices and Norwegian export prices have been impacted by developments in coal prices and US gas prices. We have also examined how stable the relationships have been over time. The resulting equations are presented in the appendix.

### UK gas prices

The equation for UK gas prices contains the oil price, the price of coal in Northern Europe and US gas prices. It has the following long-term solution:

$$(1) \text{Log}(\text{UK gas price}) = \text{constant} + 0.53 \text{log}(\text{oil price}) + 0.44 \text{log}(\text{coal price})$$

This relationship shows that a 1 per cent increase in the oil price yields a 0.53 per cent increase in the UK gas price in the long run for a given coal price and US gas price. A 1 per cent increase in the coal price results in a 0.44 per cent increase in the UK gas price, if oil prices and US gas prices remain constant.

Changes in coal prices have a strong effect on UK gas prices already after one to two quarters, while changes in oil prices do not feed through until after four quarters. A fall in US gas prices has some negative effect on UK gas prices after three to five quarters, but we find no significant long-term impact of US gas prices on the UK gas price. The estimated short-term effects of US gas prices are significant only after 2005. These effects may capture impacts on UK gas prices of the marked increase in US gas supplies from 2005-06 and the subsequent rise in the supply of LNG to Europe (originally intended for the US).

We used recursive estimates to examine the stability of the equation. Such estimates show changes over time in the estimates when the starting point of the estimation is kept constant and the estimation period is extended by one observation at a time. The recursive estimates showed that the long-term coefficient for the coal price has been relatively stable since 2002. However, the long-term coefficient for the oil

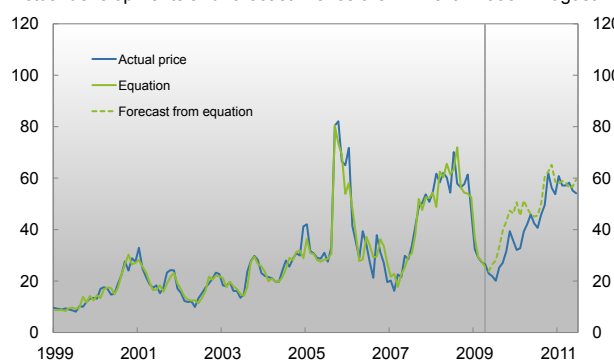
price is 0.75-0.80 when the estimation period ends in the second half of 2005. The shift from 2005 to 2011 is statistically significant. This suggests that the direct effect of oil prices on UK gas prices has become somewhat weaker in recent years. However, changes in oil prices also affect UK gas prices indirectly via coal prices in (1), since coal prices and oil prices are positively correlated. Oil and coal prices have been more closely correlated after 2005 than in the previous years. Consequently, the analysis so far does not provide an unequivocal answer to the question of whether UK gas prices have become more or less sensitive to oil prices than previously.

To examine this further, we estimated an equation for the UK gas price where the only explanatory variable included was the oil price. In such an equation, the effects of oil prices will also capture the effect via coal prices. The estimated long-term coefficient for the oil price was approximately equal to one when using data up to end-2005 and when using data for the period 2006-2011. The deviation from one was far from statistically significant for both periods. We are therefore unable to reject a hypothesis that UK gas prices have tracked oil prices one to one in the long term and that this relationship continues to be valid. This conclusion is in line with the results in Asche et al. (2011). The other coefficients in the model are also stable.

In Chart 4, we have used the estimated equation containing oil and coal prices using data up to mid-2009 in order to project gas prices up to August 2011. The chart shows that gas prices were lower than projected until summer 2010, but that the equation has been on the mark in 2011. This supports the conclusion that price formation for UK gas has not changed substantially in recent years.

Chart 4 UK gas price

Actual developments and forecast. Pence/therm. March 1999 – August 2011



<sup>12</sup> Asche, Osmundsen and Øglend (2011) also estimate a relationship between oil prices and UK gas prices, but they do not look at the relationship between oil prices and Norwegian export prices for gas.

### Export prices for Norwegian gas (excluding LNG)

The equation for Norwegian export prices includes the UK gas price in addition to the oil price. This is because Norwegian export prices are linked to oil prices and European spot prices for gas through long-term contracts and because some Norwegian gas is sold on the spot market. We also know that the UK spot price for gas is very closely correlated with spot prices for gas elsewhere in Europe.<sup>13</sup> We found no significant effects of coal prices or US gas prices on Norwegian export prices.

$$(2) \text{Log}(\text{Norwegian gas price}) = \text{constant} + 0.67 \text{log}(\text{oil price}) + 0.12 \text{log}(\text{UK gas price})$$

Equation (2) states that the Norwegian gas price will rise by 0.67 per cent in the long run if the oil price rises by 1 per cent and the UK gas price is constant. A 1 per cent increase in the UK gas price results in a 0.12 per cent increase in the Norwegian gas price if the oil price remains constant. The estimated long-term coefficient for the oil price is 0.71-0.72 if the estimation ends in the first half of 2009. In that case the effect of the UK gas price is 0.09, i.e. somewhat lower than in (2). The change in the estimates from the first half of 2009 to August 2011 may indicate that the direct effect of oil prices has weakened somewhat and that the effect of UK gas prices has become somewhat stronger in recent years. This is in line with the renegotiation of a number of contracts in 2009-2010 where spot prices for gas were given greater weight. A larger share of Norwegian gas may also have been sold directly on the spot market for gas as a result of the renegotiations in 2009-2010. However, the changes in the coefficients are far from statistically significant. Since the relationship between oil prices and UK gas prices appears to have been relatively stable in recent years, our findings do not indicate that Norwegian gas prices have become significantly less sensitive to oil prices than previously.

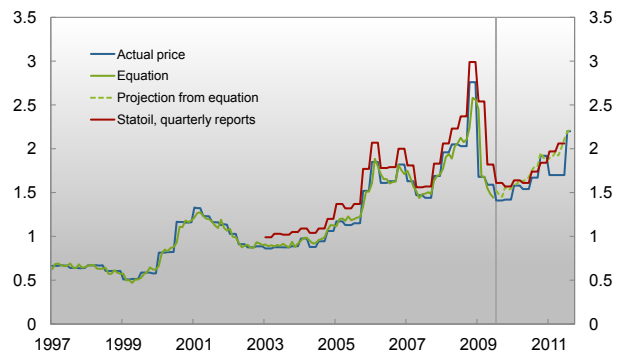
If we posit that UK gas prices track oil prices one-to-one in the long run, according to equation (2) a 1 per cent increase in the oil price will lead to a  $0.67+0.12*1=0.79$  per cent increase in Norwegian gas export prices. Similarly, the long-term coefficient for the oil price is 0.78, if UK gas prices are excluded

<sup>13</sup> The correlation coefficient between the monthly percentage change in the prices of UK and Dutch gas (in same-currency terms) was 0.88 over the period August 2005 to September 2011.

from the equation. This estimate is significantly lower than one, both numerically and statistically. Thus, we find no support for a hypothesis that Norwegian export prices track oil prices one-to-one in the long term.

### Chart 5 Export price for Norwegian gas

Actual developments and forecast. NOK/Sm<sup>3</sup>. January 1997 – August 2011



Sources: Statistics Norway and Norges Bank

In Chart 5 we have used the estimated equation with data up to mid-2009 to project gas prices up to August 2011. The chart shows that gas prices were lower than projected in the first half of 2011, though the equation was accurate in July and August. This supports the conclusion that price formation for Norwegian gas has not changed substantially in the past two to three years. For comparison, the chart also shows the gas price reported by Statoil in its quarterly reports since 2003. As Statoil accounts for a substantial share of Norwegian gas exports, this should be a good proxy. Our projected price correlates well with Statoil's price. On the other hand, there is a distinct deviation from the price in Statistics Norway's external trade statistics for the first half of 2011, although Statoil's price is not always necessarily representative of the overall Norwegian export price.

### Gas prices ahead

In retrospect, the fall in gas prices outside the US appears to have been mostly related to reduced demand in the wake of the financial crisis. Low US natural gas prices reflect regional conditions, i.e. an increase in the supply of gas as of yet largely unexportable. The rise in UK gas prices better reflects global conditions, especially the effect of higher demand in Asia via interregional LNG trading. Various supply-side disturbances, such as lower Russian gas exports, adjustments in LNG exports from the Middle East and temporary shutdowns in



the North Sea have an impact on UK gas prices but not on US gas prices.

Assessments of developments in the gas market have also changed along the way. In autumn 2010, the IEA argued that continued higher supplies and weak demand might keep global prices low for several years ahead (IEA (2010)). However, already in summer 2011, the IEA noted several factors that had helped to restore market balance and boost gas prices in Europe and Asia as described above (see IEA (2011a)).

Nevertheless, the importance of unconventional gas – especially shale gas – for prices should not be underestimated (see for example Deutsch (2011)). Production costs for unconventional gas in the US are estimated to range between USD 3/MMBTu and USD 7/MMBTu (IEA (2011b)), which suggests that US gas prices may remain low for a long time. Growth in US shale gas production over the past five to six years has had a sizeable impact on regional price developments. According to the International Monetary Fund (IMF), unconventional gas may become of major importance, but for this to occur the US would have to start exporting gas on a large scale or other countries would have to start exploiting their own unconventional gas resources (IMF (2011)). Global unconventional gas resources are estimated to be as large as conventional resources (IEA (2011b)). However, the quality of shale resources is uncertain and production requires extensive investment in new infrastructure. Environmental challenges are also considerable – water needs alone may hamper development in arid regions. There is also strong local opposition to shale gas development. Considerations like these have already slowed development in the US and put a stop to further development of shale resources in France.<sup>14</sup>

There is now a record disparity between US and UK natural gas prices. The difference between US and Asian gas prices is even greater. If the US expands its capacity for exporting LNG on a large scale, this may help to smooth out the differences in gas prices between the US, Europe and Asia. According to the Energy Information Agency (EIA) (2011), LNG

<sup>14</sup> The *Economist* (2011) also discusses arguments for and against the view that increased exports of LNG and higher production of unconventional gas may alter the outlook for the role of gas ahead. Stevens (2010) also discusses the challenges posed by unconventional gas.

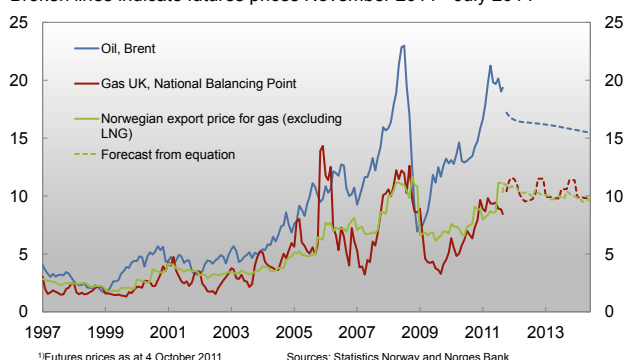
export projects have been proposed, but their profitability is still regarded as uncertain. Projections in the EIA report are not based on the development of such export capacity. In any case, it will likely take time for such capacity to push down gas prices in Europe. UK and US gas futures prices suggest that the price differential will persist for at least the coming years.

Moreover, there are reports that Asian importers are willing to sign new long-term LNG contracts at 80-90 per cent of the oil price, which indicates that they expect gas prices to track oil prices in the longer term (*Financial Times* (2011)). Finally, reduced use of nuclear power in a number of countries following the accident in Japan in March 2011 may contribute to a tighter market balance for gas ahead, especially in Europe and Asia (see Oxford Energy Forum (2011)).

In Chart 6 we project Norwegian gas prices on the basis of the estimated price equation for the Norwegian gas price. We assume that oil prices and UK gas prices will track the respective futures prices ahead as they were at the beginning of October. The projections suggest that the Norwegian gas price will decline somewhat from their July and August levels. Nevertheless, it will be relatively high and approximately equal to the expected UK spot price. This may ease the pressure to renegotiate oil-indexed gas contracts. However, the pressure may rise again in the event of a renewed sharp fall in the UK spot price while oil-indexed gas prices remain steady. There may also be other reasons to reduce oil-indexing, such as developing a more liquid gas market and avoiding a recurrence of a situation where contract prices are far higher than spot prices.

**Chart 6 Oil and gas prices**

Monthly figures. USD/MMBTu. January 1997 - May 2011. Broken lines indicate futures prices November 2011 - July 2014<sup>1)</sup>



<sup>1)</sup>Futures prices as at 4 October 2011

Sources: Statistics Norway and Norges Bank

# Appendix

Table 1: A model for UK gas prices

$$\begin{aligned} \Delta nbp_t = & 0.09 - 0.24 nbp_{t-1} + 0.13 brent_{t-4} + 0.10 coal_{t-1} \\ & (0.10) \quad (0.05) \quad (0.05) \quad (0.06) \\ & + 0.22 \Delta brent_{t-4} + 0.32 \Delta coal_{t-1} + 0.20 \{\Delta hh_{t-3} + \Delta hh_{t-5}\} \\ & (0.13) \quad (0.14) \quad (0.06) \\ & + 0.73 dummy_t + \Omega\{season\}_t \\ & (0.14) \end{aligned}$$

$$R^2 = 0.52, \sigma = 0.133, DW = 2.06$$

Model's long-term solution:

$$nbp = constant + 0.53 brent + 0.44 coal$$

Estimation period: March 1999 – August 2011 (monthly figures)

Estimation technique: Least squares method

Standard error stated in brackets under estimates

$$\Delta x_t = x_t - x_{t-1}$$

Variables are defined as follows:

*nbp* = Logarithm of the UK natural gas price (National Balancing Point)

*brent* = Logarithm of the price of crude oil (Brent Blend)

*coal* = Logarithm of the coal price (McCloskey North West Europe)

*hh* = Logarithm of the US natural gas price (Henry Hub)

*season* = Seasonal dummies

*dummy2005* = Dummy for capturing effect of cold weather in autumn 2005.

Equal to 1 in 2005, otherwise 0

The variables *nbp*, *brent*, *coal* and *hh* are measured in GBP. These variables have been obtained from Thomson Reuters.

Table 2: A model for Norwegian gas prices

$$\Delta norw\ gas_t = -1.58 - 0.37\ norw\ gas_{t-1} + 0.25 \{ \{brent_{t-2} + brent_{t-4} + brent_{t-6}\} / 3 \}$$

(0.21) (0.05) (0.04)

$$+ 0.04\ nbp_{t-2} + 0.06\ \Delta nbp_{t-3} + \Omega\{season\}_t$$

(0.02) (0.03)

$$R^2 = 0.39, \sigma = 0.065, DW = 1.96$$

Model's long-term solution:

$$norw\ gas = constant + 0.67\ brent + 0.12\ nbp$$

Estimation period: December 1996 – August 2011 (monthly figures)

Estimation technique: Least squares method

Standard error stated in brackets under estimates

$$\Delta x_t = x_t - x_{t-1}$$

Variables defined as follows:

- norw gas* = Logarithm of the export price of Norwegian gas excluding LNG
- brent* = Logarithm of the price of crude oil (Brent Blend)
- nbp* = Logarithm of the UK natural gas price (National Balancing Point)
- season* = Seasonal dummies

The variables *norw gas*, *brent* and *nbp* are measured in NOK.

The Norwegian export price is derived as the value of Norwegian gas exports divided by the volume of gas exports. Series for value and volume of exports taken from Statistics Norway's external trade statistics.

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