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# Abstract

We examine the implications of increased unconventional crude oil production in North America. This production increase has been made possible by the existence of alternative oil-recovery technologies and persistently elevated oil prices that make these technologies commercially viable. We first discuss the factors that have enabled the United States to expand production so rapidly and the glut of oil inventory that has accumulated in the Midwest as result of logistical challenges and export restrictions. Next, we assess the extent to which the increase in U.S. domestic production will affect global supply conditions and whether the U.S. experience can be repeated in other countries with rich unconventional oil sources. The evidence suggests that even in the best-case scenario, the increase in U.S. production will not make a large contribution to global production, so its effect on the price of oil is expected to be limited. Furthermore, the United States enjoys unique infrastructural and technological advantages that make it unlikely that similarly rapid increases in unconventional production can be achieved elsewhere.



*JEL classification: Q41, Q43, Q47*
*Bank classification: International topics; Recent economic and financial developments*



# Résumé

Les auteurs examinent les répercussions de l’accroissement de la production de pétrole brut non classique en Amérique du Nord. Si cette production est en hausse, c’est grâce à l’apparition de nouvelles techniques d’extraction, devenues rentables en raison de la vigueur persistante des cours pétroliers. Les auteurs traitent d’abord des facteurs qui ont permis le vif essor de la production aux États-Unis ainsi que du surplus de brut qui s’est accumulé dans le Midwest en raison de contraintes logistiques et de restrictions aux exportations. Ils évaluent ensuite l’incidence de l’augmentation de la production américaine sur l’offre mondiale et cherchent à déterminer s’il serait possible que l’expérience des États-Unis se reproduise dans d’autres pays disposant de réserves de pétrole non classique abondantes. Même dans le scénario le plus optimiste, les données tendent à indiquer que la hausse de la production américaine ne contribuera pas de manière significative à la croissance de l’offre mondiale, ce qui laisse croire que son effet sur le prix de l’or noir sera limité. Par ailleurs, les avantages incomparables sur le plan des infrastructures et des technologies dont bénéficient les États-Unis font qu’il est peu probable que l’expansion rapide de la production de pétrole non classique qu’a connue ce pays se répète ailleurs.

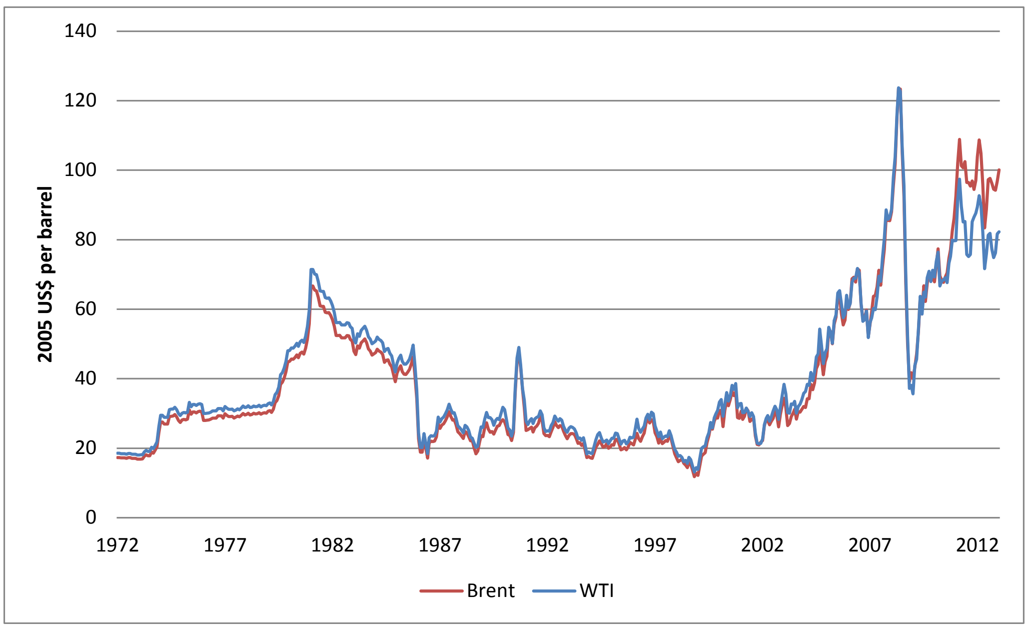


*Classification JEL : Q41, Q43, Q47*
*Classification de la Banque : Questions internationales; Évolution économique et financière récente*

## 1 Introduction

In recent years, high crude oil prices have been a source of discontent for U.S. consumers. Although the price of oil declined sharply in the fall of 2008, it quickly returned to a level almost as high as the one that prevailed before the crisis (Figure 1). This sharp rebound in the price of oil has led some observers to argue that high oil prices have impeded the U.S. economic recovery by hurting consumer sentiment and slowing consumer spending (Hamilton 2012).

**Figure 1. Real Crude Oil Prices**




Note: WTI = West Texas Intermediate
Source: Haver Analytics

At the same time, however, these persistently high prices have stimulated investment in the production of unconventional oil, in particular "tight" oil from oil-bearing shale formations. Tight oil wells require different extraction technology from conventional wells and are drilled horizontally rather than vertically. High prices and the development of alternative oil-recovery technologies have made the extraction of some types of unconventional oil commercially viable.

The presence of these unconventional sources of oil throughout the world and the ability to recover them makes a large expansion in the physical production of oil a possibility. Recent estimates suggest that about 3.2 trillion barrels of unconventional crude oil, including up to 240 billion barrels of tight oil, are available worldwide (IEA 2012a). By 2035, about 14 per cent of oil production will consist of unconventional oil, an increase of 9 percentage points. The potential for unconventional oil extraction around the world has led some oil industry analysts to describe scenarios in which the world experiences an oil glut and a decline in oil prices over the medium term (Maugeri 2012).

Nowhere are the repercussions of these changes more evident than in the United States, where the unanticipated and rapid increase in oil production has had dramatic consequences for domestic supply conditions. U.S. domestic liquids production has expanded by nearly 30 per cent since 2005 and is expected to continue to increase (IEA 2013). The International Energy Agency (IEA 2012b) projects that the U.S. total petroleum supply will increase from 9.7 million barrels per day in 2012 to a peak level of 11.1 million barrels per day in 2020.

In this paper, we examine the implications of the increase in unconventional crude oil production in North America. To put these developments into perspective, we begin by discussing the supply and demand shocks that have driven global oil prices in recent years. We then discuss the factors that have enabled the United States to expand production so rapidly and the glut of oil inventory that has accumulated in the Midwest as a result of logistical challenges and export restrictions. Finally, we assess the extent to which the increase in U.S. oil production will affect global supply conditions and whether the U.S. experience can be emulated in other countries with abundant unconventional reserves over the medium term.

Even in the best-case scenario, the increase in U.S. oil production will mostly be devoted to offsetting the decline in oil production in conventional oil fields and, possibly, OPEC production cuts in response to the expansion in North American supply. Thus, the effect of increased production on global prices will likely be limited. Furthermore, the United States enjoys unique infrastructural and technological advantages that make it unlikely that similarly rapid increases in unconventional production can be achieved elsewhere. Thus, high oil prices are a blessing in disguise for the United States. By simultaneously encouraging growth in oil production and reduced oil consumption, elevated oil prices have put the long-standing goal of U.S. energy independence within reach.

## 2 Structural Drivers of Global Oil Prices

Before turning to conditions in the North American energy market, it is important to examine recent developments in the global crude oil market. A precondition for the commercial viability of the extraction of tight oil from shale is a price level above about $50 per barrel.[1] An understanding of the broader forces that have driven the price of oil above this threshold is therefore critical for putting these regional developments into a global perspective.

[1] In the International Energy Agency's 2012 *World Energy Outlook*, the average cost of production for tight liquids ranged between $50 and $80. According to Goldman Sachs, the bulk of liquid-rich shale finds in the United States break even at about $80 per barrel (Della Vigna et al. 2012).

## 2.1 Oil demand

During the past decade, demand conditions have played an important role in the evolution of the price of oil. Major sources of demand are related to strong economic growth in emerging Asia, especially China, with much of the new demand linked to urbanization and growth in personal transportation associated with rising incomes.[2] Despite the rapid growth in Chinese oil consumption already observed, there remains considerable scope for additional growth in the future (Dargay et al. 2007). By contrast, OECD consumption of crude oil has entered a period of structural decline because of improvements in fuel efficiency, changes in demographics, and, in the United States in particular, fuel switching toward lower-cost natural gas. The net effect of these factors is that new demand for oil comes from non-OECD countries, such as China, rather than the developed countries. Indeed, Kilian and Hicks (2012) document that news about global growth prospects, which is driven primarily by revisions to GDP growth in emerging Asia, accounts for much of the surge in the price of oil between 2003 and 2008.

## 2.2 Oil supply

Since 2005, the global production of oil has experienced weaker growth rates as a result of several factors.[3] First, stagnant and declining production rates are consequences of the decline in oil investment from the mid-1980s until the late 1990s (IMF 2011). While investment in new production has since increased, the long lead times between the initial development of oil fields and the point at which they are ready for production imply that the new projects will not come online for several more years. In addition, weak production growth is related to the maturation of oil fields in several important oil-producing countries (e.g., Russia).[4] Finally, spare capacity in OPEC countries has diminished in recent years due to persistent demand growth, the need to offset production declines in Libya and Iran, and the inherent difficulties in expanding supply capacity (Blanch et al. 2013). Spare capacity outside of Saudi Arabia, an important indicator of supply tightness in the global oil market, remains low by historical standards (Büyükşahin and Robe 2011).[5]

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[2] China has not only become the largest importer of crude oil, but between 2000 and 2010 almost doubled its per capita consumption of oil (IMF 2011).

[3] Hamilton (2009) documents that, since 2005, the production of oil has exhibited below-trend growth, such that the level of output has been essentially flat (Alquist and Gervais forthcoming).

[4] Although this development has primarily affected non-OPEC producers, Saudi Arabia also reportedly faces similar constraints (Sorrel et al. 2010).

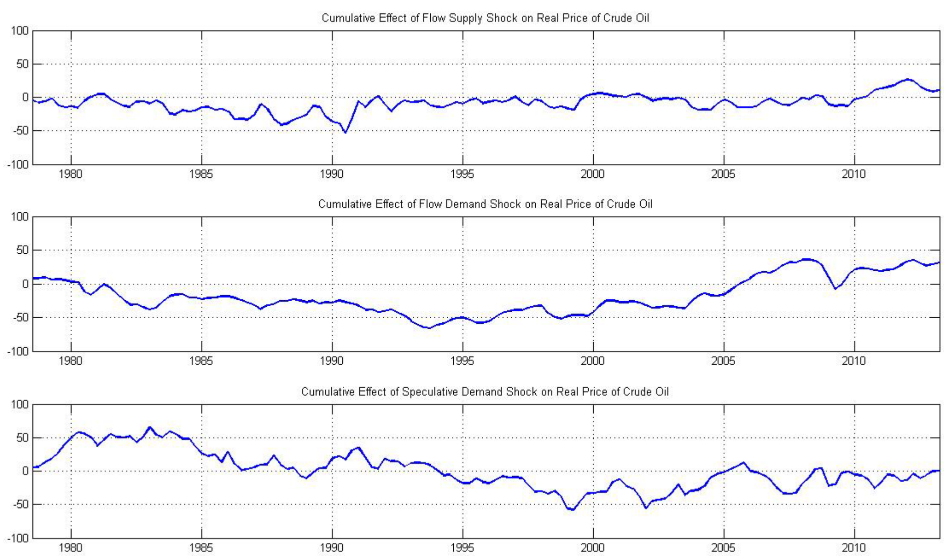
[5] Although most of the global market's spare capacity is found in Saudi Arabia, this capacity has not been verified and, as such, can be considered to be theoretical (Büyükşahin et al. forthcoming).

## 2.3 Putting the pieces together: a structural model of the global crude oil market

The economic significance of these different forces can be quantified in structural models of the global crude oil market. These models have been used to identify oil demand and supply shocks and to decompose fluctuations in the real price of oil into components related to the structural shocks (Kilian 2009; Lippi and Nobili 2012; Baumeister and Peersman forthcoming; and Kilian and Murphy forthcoming). A broad insight from these models is that the recent behaviour of the real price of oil is related to the cumulative effect of unexpected increases in the demand for oil.

Figure 2 shows the results from an example of this type of model. The model is quarterly and relates movements in the real price of Brent to unexpected changes in the global supply of crude oil, global demand (proxied by global GDP growth), and crude oil inventories.[6] As is evident in the figure, the predominant driver of oil prices since 2003 has been changes in global demand related to economic growth. In addition, although oil supply shocks have had some effect on the real price of oil, the historical decomposition indicates that they have not been the most important driver of the increase in the price of oil in recent years. This evidence confirms the importance of demand as a driver of global oil prices in general and over the 2003–08 period in particular.

**Figure 2. Cumulative Structural Shocks from Global Oil Market Model**




Sources: Bank of Canada; International Energy Agency; Haver Analytics; authors' calculations

[6] The model code is available from the authors.

## 3 Developments in the North American Crude Oil Market

Alongside these demand-driven oil price increases, the North American oil market has undergone two related changes: a rapid expansion of its production of crude oil from unconventional sources and the accumulation of an oil surplus in the U.S. Midwest. In this section, we discuss each of these developments.

### 3.1 Increased unconventional production

Before discussing the causes of the increase in the unconventional crude oil production, it is important to provide some technical background on unconventional oil. This paper focuses on tight oil from oil-bearing shale formations. The geological characteristics of these formations make extraction difficult; oil companies must use alternative extraction methods.[7] Most unconventional wells are drilled horizontally to access as much of the tight oil formation as possible. Although drilling horizontally increases the area of typical wells, a technique known as "fracking" is required to access the oil. In the fracking process, fluids are pumped down the well under high pressure, creating cracks in the surrounding rock through which tight oil can flow (National Energy Board 2011). Shale formations produce several types of petroleum liquids, from dry natural gas to light crude oils, and all of these liquids are accessed using the same extraction methods described above. Thus, the tight oil extraction process has greatly benefited from technological developments in the extraction of shale gas sources.

In the United States, the extraction of crude oil from unconventional tight oil sources found in oil-bearing shale formations has increased rapidly. In 2012Q4, U.S. petroleum production averaged 9.7 million barrels per day for the first time since 1988, and since 2008 supply has been growing, on average, at about 5 per cent per year, reaching 9 per cent per year in the past two years. This development, coupled with the associated boom in natural gas production from shale, has led some observers to predict that the United States will be energy independent by the end of the decade (Morse et al. 2013). The production of oil from Canadian sources has added to the supply of oil in North America.[8]

[7] Conventional crude oil is found in reservoirs composed of porous material such as sandstone and limestone. The oil in the reservoir flows through the sandstone pores and tends to accumulate in areas above water-bearing rock. By contrast, unconventional oil refers to oil found in geological formations with levels of porosity that are too low for conventional extraction methods.

[8] The source of Canada's unconventional oil is called oil sand, which contains a heavy form of crude known as bitumen. It is extracted using surface mining and in-situ methods. The production costs for surface mining are about $85 to $95 per barrel, while those for in-situ methods are in the range of $50 to $60 per barrel according to the National Energy Board (IEA 2012a). Canadian production of heavy oil and upgraded light crude from this source averaged 1.8 million barrels per day in 2012, and is projected to reach 3.2 million barrels per day by 2020 (Canadian Association of Petroleum Producers 2012).

Three factors have enabled the United States to expand its domestic oil supply: a history of shale gas exploitation, legal incentives for landowners and an advanced oil production infrastructure.

Domestic shale gas exploitation predates the modern oil industry, with the first well drilled in the early 19th century (Shirley 2001). In the 1970s, concerns about future gas shortages caused the U.S. Department of Energy to invest heavily in shale research and to work closely with energy companies to develop the technological and geological expertise necessary to exploit shale gas commercially (U.S. DOE 2011). An important step toward commercial viability was taken in 1981 when Mitchel Energy combined extraction techniques known as horizontal drilling and fracking to increase the flow rate of the Barnett Shale in Texas (Boyer et al. 2011). It is not, however, enough simply to drill horizontally and produce fractures. Substantial geological expertise, aided by tools such as seismic mapping and electromagnetic measurement-while-drilling, has been needed to increase well flow rates sufficiently to make shale projects profitable (Alexander et al. 2011). As a result of this geological and technological knowledge, U.S. mid-sized exploration and production firms have developed the expertise necessary to replicate their initial shale successes throughout the country. The combination of historical and modern developments made the unconventional oil boom possible (King 2010).

Second, the United States possesses legal and institutional features that make the economic environment attractive for the extraction of unconventional oil. U.S. land-use rights facilitate drilling and exploration by providing landowners financial incentives in return for their mineral rights (Kefferputz 2010). Furthermore, the structure of land leases associated with the exploitation of shale resources requires continuous drilling activity, thus providing an impetus to increase production above levels warranted by the current economic climate.[9] The structure of the U.S. market has also played a role in encouraging the increase in unconventional production. The independent exploration and production firms responsible for the boom have benefited from decentralized corporate structures, a competitive environment, and access to global capital market funding through partnerships and joint ventures (Carr et al. 2011).

Third, the United States possesses a large number of state-of-the-art drilling rigs, an extensive pipeline network that spans the country and associated refineries to produce final-demand products (Rae et al. 2012), all of which ensure that it is well-placed to expand production levels quickly. For example, the U.S. Midwest region, where unconventional oil supplies have accumulated, possesses substantial refinery capacity capable of absorbing much of the recent increase in local production.[10] The mature infrastructure that the United States has in place to

[9] According to Bentek, an energy market analytics company, more than 1,000 shale gas wells drilled in 2012 have yet to be brought online (http://www.forbes.com/sites/peterdetwiler/2012/12/03/driven-by-oil-shale-economics-natural-gas-prices-primed-for-slow-and-steady-rise).

[10] As of 2012, the U.S. Midwest region had a total operable refinery capacity of about 3.7 million barrels per day. This compares to an average regional crude oil production rate of about 1.2 million barrels per day during the same period.

satisfy domestic demand can distribute the new supply, despite confronting some challenges related to the recent increase in production, as we discuss in section 3.2.

The advantages discussed above are expected to support the growth of North America's unconventional oil supply through the end of the decade. Although crude prices in the mid-continent remain low, U.S. producers can profitably exploit tight oil finds at WTI prices below $90 per barrel (Della Vigna et al. 2012). Initial successes in the major tight oil plays, including the Bakken (Montana, North Dakota and Saskatchewan), the Permian Basin (Texas), and Eagle Ford (Texas), have been followed by steady improvements in flow rates and a reduction in decline rates (Della Vigna et al. 2012).

While the foregoing evidence suggests that U.S. oil production should be able to meet the projections made by forecasters such as the Energy Information Administration and the International Energy Agency, there are limits to the ability to replicate in the long run the initial success in extracting the tight oil. Oil-rich shale formations are uncommon compared to their natural gas counterparts and, as a result, emerging U.S. shale finds are increasingly disadvantaged in terms of oil content (Della Vigna et al. 2012). Existing reservoirs have a limited number of locations where the oil can be extracted from the shale at low cost. As these locations are gradually exhausted, production costs will likely increase and flow rates decrease (IEA 2012a). Similarly, encouraging initial production rates in new finds are often higher than the reservoir's medium-term production potential (IEA 2012a). Moreover, although natural gas liquids from shale gas finds are often equated with petroleum, only a specific, and less common, type of natural gas liquid known as natural gasoline can be considered a direct substitute for light crude oil in the production of petroleum products (Della Vigna et al. 2012). All of these factors caution against relying too heavily on these forecasts for planning purposes and extrapolating from recent trends.

## 3.2 The crude oil inventory surplus

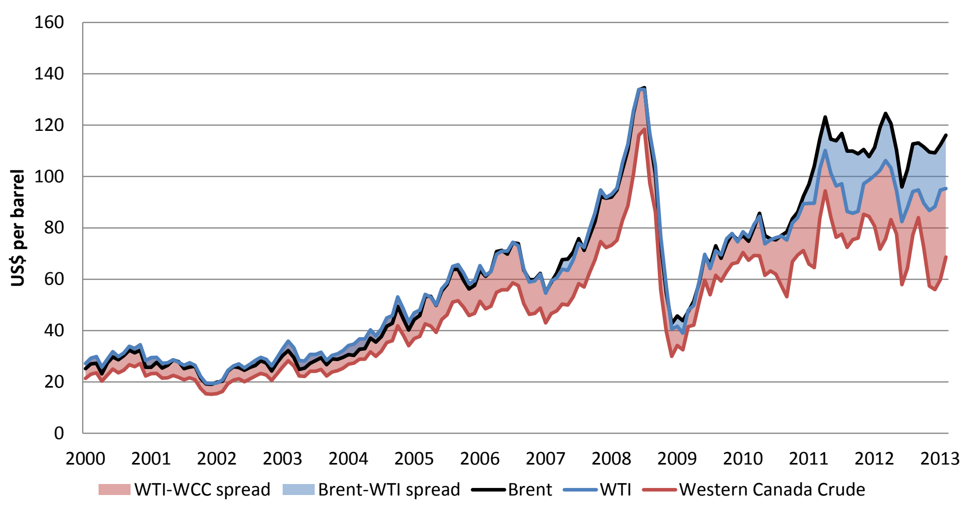
Logistical constraints imposed by a lack of optimized transport infrastructure, combined with legal restrictions on the export and shipping of domestically produced crude oil, have, to some extent, segmented the North American crude oil market from the global market. This segmentation has contributed to the divergence between continental benchmark crudes such as WTI and Western Canada Select (WCS) and seaborne benchmark crudes such as Brent (Figure 3).[11] In this subsection, we discuss each of these factors.

[11] WCS is a heavy sour oil blend representative of the crude streams produced in Alberta. It has traditionally traded at a discount of about $15 to WTI due to its inferior quality and high sulphur content. Brent is a combination of crude streams produced in the North Sea and is heavier than WTI. It is considered a global light sweet benchmark due to its unfettered access to tidal markets. Historically, WTI has traded at a slight premium to competing international counterparts such as Brent due to the cost of seaborne shipping.

### *3.2.1 Logistical constraints*

Pipelines are the most widely used and efficient means of transportation for liquid hydrocarbons, including natural gas, crude oil and petroleum products. What pipelines gain in efficiency, however, they lose in flexibility. Crude oil, natural gas and petroleum products cannot be mixed and each requires its own pipeline network. Moreover, each pipeline flows in only one direction. Reconfiguring a pipeline to accept a different product and reversing its direction of flow is costly and time-consuming.[12] In the United States, the existing petroleum pipeline network was designed along the lines of the Petroleum Administration for Defense Districts (PADDs) framework introduced in 1942 to aid in wartime gasoline rationing (Figure 4). The flow of crude oil is relatively unconstrained within the five districts, but it is constrained across them (Borenstein and Kellogg forthcoming).[13]

**Figure 3. North American and Global Crude Oil Prices**



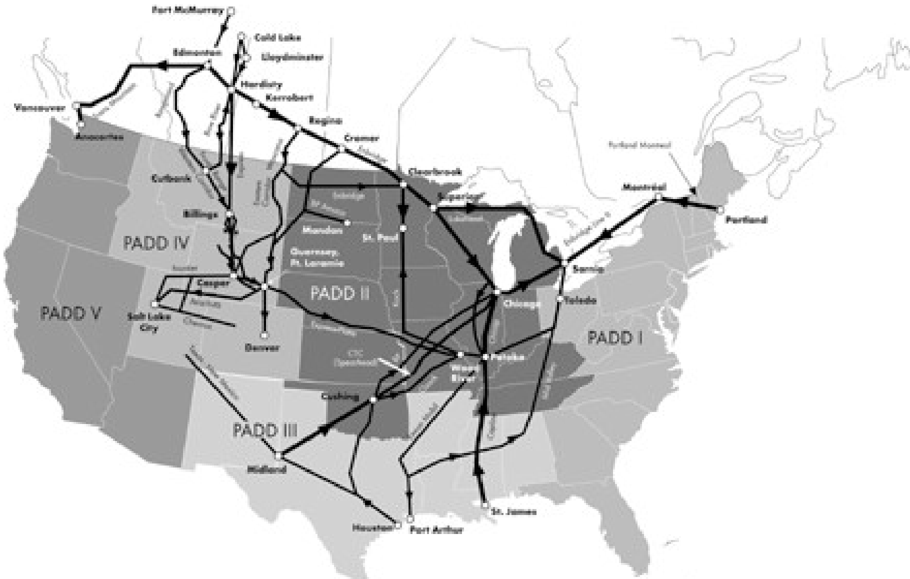

Source: Bloomberg, Haver Analytics

Notes: The Western Canada Crude Index is based on the Canadian Heavy Crude Oil (Net Energy) Index that is traded on the Chicago Mercantile Exchange. The data for the indices are unavailable before October 2010, so the historical series is backcast using historical spot prices for Western Canada Select and the historical growth rate of the WTI benchmark (see Bank of Canada 2012).

[12] For example, the proposed oil conversion and flow reversal of the 770-mile-long Energy Partners trunk line linking the U.S. Midwest to the Gulf Coast is expected to cost about $1.5 billion and to take up to one year to complete (Platts 2013).

[13] It is important to recognize the differences between the logistical constraints facing the U.S. crude oil and petroleum product markets. U.S. refined products face fewer logistical constraints across PADDs.

**Figure 4. North American Oil Pipelines and Directions of Flow**




Source: National Energy Board of Canada (2006)

This segmentation is one of the causes of the accumulation of excess crude oil supplies in the American Midwest. Starting in late 2010, an oil glut emerged in Cushing, Oklahoma, the centre of the PADD 2 pipeline network (Figure 4).[14] The hub at Cushing receives and stores oil from domestic and foreign sources and distributes it to population centres in the Midwest and on the East Coast. Growing exports from Canada, the tight oil finds in North Dakota and weak PADD 2 gasoline demand have impeded the hub's ability to distribute crude oil to end-user markets (EIA 2013a). The subsequent increase in crude oil inventories at Cushing (Figure 5) has contributed to the depressed level of WTI spot and futures prices relative to those of other benchmark crudes such as Brent (Figure 6).

[14] Smaller, temporary supply gluts associated with logistical constraints also occurred in the autumn of 2008 and the winter of 2009 (Büyükşahin et al. forthcoming).

**Figure 5. The Divergence of Inventory Levels between PADD 2 and PADD 3**

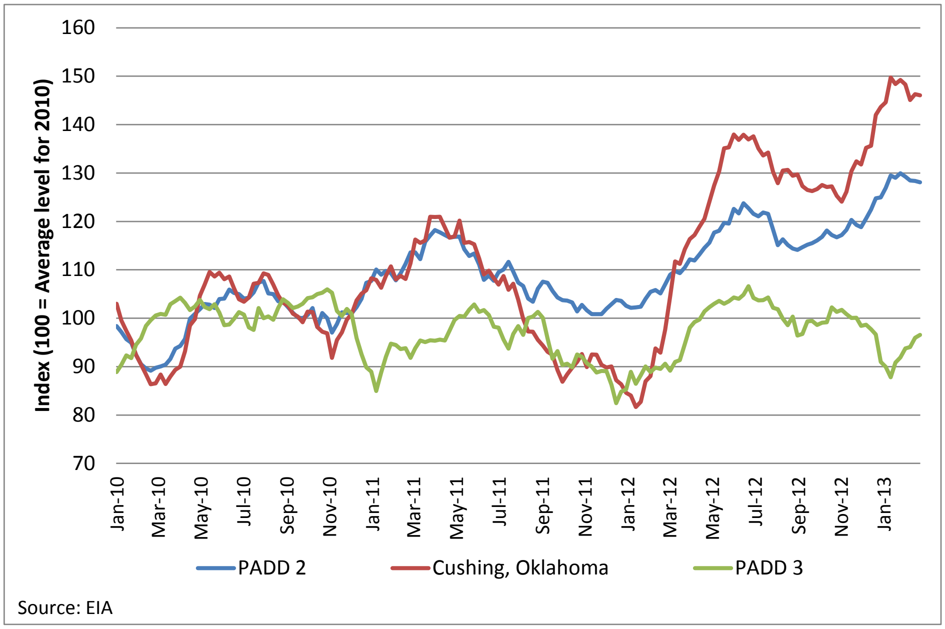
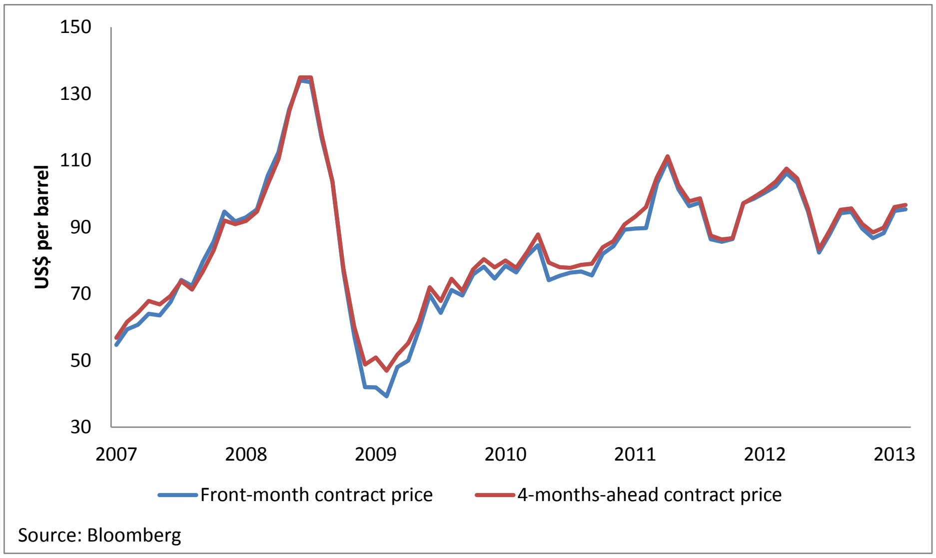



**Figure 6. Front-Month and 4-Months-Ahead WTI Futures Contracts**




Note: In the case of WTI, the front-month futures contract for delivery at Cushing, Oklahoma is considered a proxy for the spot physical price.

The persistence of the WTI and WCS discounts relative to Brent highlights some of the difficulties in finding alternative modes of transportation such as rail and, more importantly, building new pipeline infrastructure to overcome the logistical constraints. Attempts to overcome these difficulties are exemplified by the Keystone XL proposal that would link the Canadian heavy oil production directly to global tidal markets via the Gulf Coast (Figure 7). By connecting Canadian crude oil exports to the Gulf, Keystone XL would be a departure from the import-centric PADD pipeline structure and would represent an effort to adapt to North America's new domestic supply-driven crude oil market. But the Keystone project faces well-organized political opposition from environmentalists and landowners that has delayed its approval and made the ultimate outcome uncertain (Hoberg et al. 2012; Morse et al. 2013; Blanch et al. 2013). Thus, the infrastructure constraints in the North American market are expected to linger over the medium term. As of February 2013, the planned increase in takeaway capacity from Cushing by mid-2014 is unlikely to be sufficient to normalize the oversupply conditions in PADD 2 (EIA 2013a).

**Figure 7. Current and Proposed Canadian and U.S. Crude Oil Pipelines**


Source: Canadian Association of Petroleum Producers (2006)

Moreover, political resistance is likely to delay the approval and completion of other pipeline links to tidal markets that are vital to the ongoing infrastructure transition. Northern Gateway, another pipeline project linking Canadian crude oil directly to tidal markets in the Pacific Basin, may not be completed due to the combined opposition of rival pipeline operators, aboriginal groups and Canadian provincial governments (Hoberg et al. 2012).[15] Such opposition complicates the North American market's transition from a system geared to meeting growing U.S. domestic demand to an alternative one that integrates regional PADD markets with the tidal crude oil market and reduces the segmentation between the North American market and the global market.

### *3.2.2 Legal restrictions*

Adjusting U.S. infrastructure to serve these changed market conditions will require not only addressing the challenges discussed above but also relaxing restrictions on exporting and transporting domestically produced crude oil. The Energy Policy and Conservation Act of 1975 restricts the export of domestically produced crude oil to global markets, and the U.S. Merchant Marine Act of 1920 (the Jones Act) restricts the naval transportation of domestically produced petroleum to domestically built vessels (Morse et al. 2013). The latter substantially increases the costs of using maritime routes to circumvent land-based infrastructure constraints.

These legal obstacles limit the demand for oil from the Gulf Coast. Moreover, Gulf Coast refiners are optimized to process medium and heavy crudes. These refineries consequently have a lower willingness to pay for the light sweet crudes, which further depresses oil prices in the continental market.[16] The portion of the Brent-WTI spread attributable to these legal restrictions and Gulf refinery demand can be approximated by the spread between Brent and Louisiana Light Sweet (LLS), an offshore U.S. crude benchmark unaffected by transportation constraints. After controlling for transportation costs, the recent 2012 average Brent-LLS gap of $7 per barrel explains about a third of the $17.50 Brent-WTI spread over this period.[17] The political sensitivity of these legal restrictions suggests that they may not be lifted in the medium term. As of March 2013, the question of export restrictions had not yet been addressed by the Obama administration (Morse et al. 2013).

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[15] Alternative proposals that involve existing infrastructure may materialize in the near future, but they will not be sufficient to reduce the North American market's internal segmentation related to logistical capacity. These proposals include linking Western Canadian supplies to consumers in Eastern Canada by reversing the flow of pipelines and converting natural gas pipelines to transport crude oil.

[16] Over three-quarters of the refinery capacity in PADD 3 (Gulf Coast) is optimized to process heavy crude oils. Replacing preferred heavy oils with light sweet oils could reduce refinery throughput by between 20 and 50 per cent (Blanch et al. 2013).

[17] Historically, Brent has averaged $1 to $2 per barrel more than U.S. benchmarks. This reflects the marginal cost of transporting foreign crudes to the U.S. Gulf Coast. As for quality, the LLS and Brent can be considered roughly equivalent, since Brent's higher American Petroleum Institute gravity roughly offsets LLS's lower sulphur content.

### *3.2.3 Implications for the future*

Overall, the presence of physical and legal restrictions favours the growing use of rail as an alternative means of transportation to link rapidly growing production with demand centres along the U.S. coast. For this reason, it is unsurprising that rail has become an increasingly important element of the North American energy transportation system, with rail loading capacity in the Bakken region alone expected to reach 1.1 million barrels per day in 2013 (Platts 2013).

The greater reliance on rail as the main means of transportation for additional barrels of oil implies that rail shipping costs will play an important role in the medium-term discount between landlocked crudes and their seaborne equivalents. These costs range from $4 per barrel from Cushing, Oklahoma to the Gulf Coast up to $15 per barrel for bitumen from Hardisty, Alberta to the Gulf Coast (Fenton et al. 2012; Platts 2013). Long-dated futures prices of Brent and WTI suggest a convergence of the Brent-WTI spread to about $10 per barrel by the end of 2015, which reflects both the transportation costs and the effect of the legal restrictions.[18] That said, one needs to be careful in relying on oil futures prices as predictors of future spot prices (Baumeister and Kilian 2012; Alquist et al. forthcoming).

Finally, it is also important to recognize that the benefits to the United States of having large-scale transportation infrastructure in place far outweigh the logistical distortions imposed by its inflexible nature. For example, the exploitation of tight oil resources in the Permian Basin has been aided by the infrastructure that has been in place since commercial drilling began in 1921. Eagle Ford has also benefited from its proximity to the U.S. Gulf Coast refining complex. Even the relatively isolated Bakken volumes are finding an outlet via existing rail and transnational pipeline networks. However, if the increase in U.S. tight oil production highlights the advantages of having a mature infrastructure, it also underscores the problems that can arise even with a well-developed oil distribution system.

## 4 Implications for the Global Crude Market

### 4.1 Effects of increased U.S. production

When set alongside the nearly 90 million barrels of petroleum produced every day, the increased oil production in North America is unlikely to make a large contribution to the global supply of oil. The ability of the United States to displace nearly 3 million barrels per day of foreign crude oil imports between 2006 and 2013 must be measured against the increase of 11 million barrels

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[18] The Brent-WTI spread has also been affected by demand and supply conditions in Europe. On the supply side, several production outages as well as declining rates of production have applied upward price pressure to Brent (Büyükşahin et al. forthcoming). Weak European demand for light sweet crude associated with depressed economic activity and refinery maintenance has lowered Brent prices relative to other light sweet benchmarks (Longson et al. 2013).

per day in non-OECD oil demand over the same period (EIA 2013b). Similarly, the Energy Information Administration's projected increase in tight oil production, from 2 million barrels per day in 2012 to 2.8 million barrels per day by 2020, is insufficient to meet domestic demand (EIA 2012). Even an optimistic scenario in which U.S. oil production increases by 1.9 million barrels per day by 2020 implies a net global supply addition of less than 3 per cent (Maugeri 2012). It is also unclear whether U.S. refiners can provide a sustainable source of demand for light sweet oils due to their preference for heavy crude oil.

Growing Canadian volumes from the oil sands have contributed to the large increase in the production of oil in North America. The existing North American transportation infrastructure that was designed to carry Canadian and other foreign oil imports to U.S. markets has transported Canadian crudes to the Midwest and exacerbated local excess-supply conditions. As discussed above, it will take time to complete the reorientation of the transportation network and the liberalization of the export and shipping of domestically produced oil required to integrate the North American crude market more fully with global markets. These factors alone caution against making strong predictions about the quantitative importance of new North American supplies on the global oil market. According to the model discussed in section 2, a scenario in which North American production adds a net 3.4 million barrels per day to global supply over the next three years would, all else equal, result in only a 13 per cent reduction in real global oil prices by the end of 2015. The limited effect on prices of such a large and rapid increase in U.S. unconventional production is consistent with the results obtained from similar models (Baumeister and Kilian 2012; Alquist et al. forthcoming). Moreover, this projected reduction in prices assumes no unexpected demand shocks, no offsetting OPEC response and continued production growth. For example, the emergence of infrastructure constraints in Canada and their consequences for Canada's ability to continue exporting at the same rate suggest that this scenario is less likely.[19]

### 4.2 Can the U.S. experience be replicated?

It may seem that the developments in the United States are a harbinger of developments in other markets. Extensive geological research indicates that tight oil and gas resource plays are broadly dispersed throughout the world, even if they will take time to develop (McGlade 2012; EIA 2011; Price Waterhouse Coopers 2013). Potentially massive shale gas and oil finds have been located in Argentina, Poland and China. Furthermore, as a result of the global demand pressures discussed earlier, oil prices are now above the $90 per barrel hurdle rate necessary to make the exploitation of shale on a global scale profitable (Della Vigna et al. 2012).

[19] The heightened volatility of oil prices in Western Canada caused by infrastructure constraints has made investment in the Canadian oil sector less attractive (Bank of Canada 2013).

All of these factors indicate that other countries will be able to replicate the U.S. experience over the medium run, but the uniqueness of the U.S. technological and infrastructural endowments make such projections unlikely to materialize. Argentina, Poland and China provide specific cases that illustrate the challenges associated with the large-scale exploitation of non-conventional oil and gas resources outside of North America. The Neuquén Basin in Argentina contains large reserves, with initial finds of about one billion barrels of unconventional oil and gas equivalents. The Argentine government's shifting regulatory environment, coupled with its decision to nationalize the country's major oil finds, has introduced substantial political risk into the exploitation of these resources and, as a consequence, increased exploration and processing costs. These decisions have reduced the attractiveness of the Argentine oil and gas sector to foreign investors and have prevented it from accessing international capital markets. In Poland, the combination of challenging geology, regulatory uncertainty and a lack of available infrastructure have dimmed its prospects for developing a large-scale oil and gas industry (Johnson and Boersma 2013).[20] Even in China, where the central government has made the development of its vast shale wealth a priority, plans for a rapid increase in extraction have been complicated by difficult geology, an unfavourable market structure dominated by national oil companies, and a lack of infrastructure and supply chain services (Wood Mackenzie 2012; Wang et al. 2012). Thus, the ability of other countries that possess rich shale oil resources to reproduce the U.S. unconventional oil boom is more limited than some recent accounts suggest.

These limitations have important implications for global oil prices. U.S. unconventional crude oil production cannot be relied upon to provide a large source of additional supply in the global market for crude oil in the near term. As a result, unconventional oil production outside of North America will need to expand in the coming years to meet emerging-market demand. Despite substantial technical expertise in unconventional crude oil extraction, achieving this goal will be challenging. For example, unconventional sources of oil located offshore seem promising, but they are not without complications. The initial optimism about Brazil's pre-salt deepwater finds ignores rapid well production decline rates and sizable environmental risks, as exemplified by the 2010 BP oil spill in the Gulf of Mexico (IEA 2008).

In any case, these unconventional sources have to offset the decline in conventional crude oil production. Recent studies suggest that decline rates in giant oil fields, the world's principal sources for conventional crude oil, are currently high and expected to increase despite the application of new technology. In fact, the decline rate of giant fields could reach 10 per cent by 2030 (Hook et al. 2009). Increasing decline rates, in turn, have been a major driver of growing oil extraction costs, as well as of the rapid expansion in global upstream investment, which has increased five-fold since 2000 to more than $600 billion in 2012 (IEA 2012a).

[20] Despite the large shale potential in Poland identified by the Energy Information Administration, Exxon Mobil ended its exploratory drilling activities in June 2012 due to disappointing initial results (Johnson and Boersma 2013).

All of this evidence suggests that a concerted effort to expand global supply will be needed to make up for accelerating decline rates, with a large portion of U.S. unconventional production growth offsetting declines in conventional oil fields. Given the growth in demand for crude oil in emerging markets, the global oil market is expected to remain tight for some years to come.

The foregoing arguments imply that the current price levels in the North American continental market are not necessarily reliable indicators of global price levels. Oil prices must remain sufficiently high that an increase in unconventional supply growth will balance the effects of increasing decline rates and strong demand from emerging markets. This view of oil prices runs counter to other assessments of global oil prices, with financial institutions such as Citibank predicting a ceiling of $90 for Brent, and some oil industry analysts expecting a global oil boom to lead to prices of $70 (Morse et al 2013; Maugeri 2012). These price projections hinge on the ability of other countries to duplicate the U.S. experience with unconventional hydrocarbon resources. The lack of technology and infrastructure outside of the United States that would enable the rapid development of unconventional oil resources, coupled with accelerating decline rates in the world's conventional oil fields, are likely to keep oil prices at elevated levels over the medium term.

## 5 Conclusion

Over the past decade, strong demand for crude oil from emerging-market economies has pushed oil prices above their historical inflation-adjusted average. These elevated price levels have been a blessing in disguise for the United States. While high oil prices may have adversely affected the recovery of the United States from the Great Recession, they have also made the extraction of its tight oil resources commercially viable. Although producing oil from these sources presents challenges, there has been a large and rapid supply response, suggesting that elevated prices have helped to facilitate the adjustment to a new equilibrium in which unconventional oil sources are profitable.

The foundations of the expansion of U.S. production include technological developments and a mature distribution network. Based on the recent U.S. unconventional oil boom, some oil industry analysts have forecast large increases in unconventional oil production in other countries. We find these forecasts implausibly optimistic because of the unique circumstances that prevail in the United States. As a result, we expect the expansion in global supply from unconventional sources to be relatively modest. The slow dissemination of technology, the lack of mature infrastructure in the relevant countries and geopolitical risk all make the extraction of unconventional oil in other countries a greater challenge than is often claimed. Moreover, global unconventional oil projects currently have hurdle rates as high as $140 a barrel, which makes high prices a necessary precondition for exploiting these sources of oil.

## References


Alexander, T., Baihly, J., Boyer, C., Clark, B., Waters, G., Jochen, V., Le Calvez, J., Lewis, R., Miller, C., Thaeler, J., and Toelle, B., 2011. Shale gas revolution. Schlumberger Oilfield Review, 23, 40–55.

Alquist, R., and Gervais, O., forthcoming. The role of financial speculation in driving the price of crude oil. Energy Journal.

Alquist, R., Kilian, L., and Vigfusson, R., forthcoming. Forecasting the price of oil, in: Elliott, G. and Timmermann, A. (Eds.), Handbook of Economic Forecasting, 2, Amsterdam: North-Holland.

Bank of Canada, 2012. Monetary policy report. July. Available at http://www.bankofcanada.ca/2012/07/periodicals/mpr/mpr-july-2012/.

———, 2013. Monetary policy report. April. Available at http://www.bankofcanada.ca/2013/04/periodicals/mpr/mpr-2013-04-17/.

Baumeister, C., and Kilian, L., 2012. Real-time forecasts of the real price of oil. Journal of Business and Economic Statistics, 30, 326–336.

Baumeister, C., and Peersman, G., forthcoming. Time-varying effects of oil supply shocks on the U.S. economy. American Economic Journal: Macroeconomics.

Blanch, F., Schels, S., Kim, S., Helles, P., and Widmer, M., 2013. Global energy paper: Medium-term oil outlook. Bank of America Merrill Lynch Commodities, February.

Borenstein, S., and Kellogg, R., forthcoming. The incidence of an oil glut: who benefits from cheap crude oil in the midwest? Energy Journal.

Boyer, C., Clark, B., Jochen, V., and Lewis, R., 2011. Shale gas: a global resource. Schlumberger Oilfield Review, 23, 28–39.

Büyükşahin, B., Lee, T., Moser, J., and Robe, M., forthcoming. Physical markets, paper markets and the WTI–Brent spread. Energy Journal.

Büyükşahin, B., and Robe, M., 2011. Does paper oil matter? Working paper, American University, July. SSRN paper No. 1855264.

Canadian Association of Petroleum Producers, 2012. Crude oil forecasts, markets and pipelines, June. Available at http://www.capp.ca/forecast/Pages/default.aspx.

Carr, R., Chakravarthy, C.,and Larrabee, J., 2011. Revolution or evolution? Oilfield Technology. March.

Dargay, J., Dermot, G., and Sommer, M., 2007. Vehicle ownership and income growth, worldwide: 1960–2030. Energy Journal, 28, 143–170.

Della Vigna, M., Murti, A., Morris, H., Singer, B., Mattar, F., Banerjee, N., Mamedov, G., and Hackworth, P., 2012. Global energy: oil under-delivery and technological innovation split the industry. Goldman Sachs Equity Research, October.

Energy Information Administration (EIA), 2011. World shale gas resources: An initial assessment of 14 regions outside the United States. April. Available at http://www.eia.gov/analysis/studies/worldshalegas/.

———, 2012. Annual energy outlook 2013 early release report. December. Available at http://www.eia.gov/forecasts/aeo/er/pdf/0383er%282013%29.pdf.

———, 2013a. This week in petroleum. February. Available at http://www.eia.gov/oog/info/twip/twiparch/2013/130213/twipprint.html.

———, 2013b. Short-term energy outlook database. Available at http://www.eia.gov/forecasts/steo/query/.

Fenton, C., Brown, J., Martin, D., Sullivan, R., Hansen, M., Kabra, U., and Jain, V., 2012. Daily oil note: Shifting rail costs driving Brent-WTI. J.P. Morgan Global Commodities Research, October.

Hamilton, J., 2009. Causes and consequences of the oil shock of 2007–08. Brookings Papers on Economic Activity, Spring, 215–261.

———, 2012. Oil prices, exhaustible resources, and economic growth. Prepared for *Handbook of Energy and Climate Change.* October. Available at http://dss.ucsd.edu/~jhamilto/handbook_climate.pdf.

Hoberg, G., Rivers, A., and Salmons, G., 2012. Comparative pipeline politics: Oil sands pipeline controversies in Canada and the United States. Prepared for Delivery at the American Political Science Association annual meeting, New Orleans, August.

Hook, M., Hirsch, R., and Aleklett, K., 2009. Giant oil field decline rates and their influence on world oil production. Energy Policy, 37, 2262–2272.

International Energy Agency (IEA), 2008. World energy outlook. November.

———, 2012a. Oil medium-term market report 2012. October.

———, 2012b. World energy outlook. November.

———, 2013. Monthly oil data services. May. Available at http://www.iea.org/stats/mods.asp.

International Monetary Fund (IMF), 2011. World economic outlook. April.

Johnson, C., and Boersma, T., 2013. Energy (in)security in Poland the case of shale gas. Energy Policy, 53, 389–399.

Kefferputz, R., 2010. Shale fever: Replicating the U.S. gas revolution in the EU? Center for European Policy Studies Policy Brief, June.

Kilian, L., 2009. Not all oil price shocks are alike: Disentangling demand and supply shocks in the crude oil market. American Economic Review, 99, 1053–1069.

Kilian, L., and Hicks, B., 2012. Did unexpectedly strong economic growth cause the oil price shock of 2003–2008? Journal of Forecasting. Available at http://onlinelibrary.wiley.com/doi/10.1002/for.2243/pdf.

Kilian, L., and Murphy, D., forthcoming. The role of inventories and speculative trading in the global market for crude oil. Journal of Applied Econometrics.

King, G., 2010. Thirty years of gas shale fracturing: What have we learned? Society of Petroleum Engineers Annual Technical Conference and Exhibition, SPE 133456.

Lippi, F., and Nobili, A., 2012. Oil and the macroeconomy: A quantitative structural analysis. Journal of the European Economic Association, 10, 1059–1083.

Longson, A, Corda, C., and Lee, A., 2013. North America crude oil WTI-Brent: Brent not what it seems in U.S. diff equation. Morgan Stanley Research, March.

Maugeri, L., 2012. Oil: The next revolution. Belfer Center for Sciences and International Affairs, Kennedy School, Harvard. June.

McGlade, C. E., 2012. A review of the uncertainties in estimates of global oil resources. Energy Journal, 47, 262–270.

Morse, E., Lee, E., Dray, D., Bond, K., Fordham, T., and Fediuk, S., 2013. Energy 2020 independence day. Citibank GPS: Global Perspectives and Solutions, February.

National Energy Board of Canada, 2006. Canada's oil sands opportunities and challenges to 2015: An update. Available at http://www.neb.gc.ca/clf-nsi/rnrgynfmtn/nrgyrprt/lsnd/pprtntsndchllngs20152006/pprtntsndchllngs20152006-eng.pdf.

———, 2011. Tight oil developments in the Western Canada sedimentary basin. December. Available at http://www.neb-one.gc.ca/clf-nsi/rnrgynfmtn/nrgyrprt/l/tghtdvlpmntwcsb2011/tghtdvlpmntwcsb2011-eng.pdf.

Platts, 2013. Special report: New crudes, new markets. March.

Price Waterhouse Coopers, 2013. Shale oil: the next energy revolution. February.

Rae, M., Della Vigna, M., Singer, B., Syed, W., Murti, A., and Hackworth, P., 2012. Shale oil: Where did it all go so right? Goldman Sachs Equity Research, September.

Shirley, K., 2001. Shale gas exciting again. American Association of Petroleum Geologists Explorer, March.

Sorrel, S., Speirs, J., Bently, R., Brandt, A., and Miller, R., 2010. Global oil depletion: A review of the evidence. Energy Policy, 38, 5290–5295.

U.S. Department of Energy (U.S. DOE), 2011. DOE's early investment in shale gas technology producing results today. Press Release, February. Available at http://fossil.energy.gov/news/techlines/2011/11008-DOE_Shale_Gas_Research_Producing_R.html.

Wang, P., Jiang, R., and Wang, S., 2012. Lessons learned from North American and current status of unconventional gas exploration and exploitation in China. Society of Petroleum Engineers. In preparation for the European Unconventional Resources Conference and Exhibition, March, SPE 153071.

Wood Mackenzie, 2012. China: Shale gas will not satisfy demand, requiring coal-to-gas and additional imports by 2030. Press Release, June. Available at http://www.woodmacresearch.com/cgi-bin/wmprod/portal/corp/corpPressDetail.jsp?oid=10598941.