Forecast of Chinese Investment in US Shale Gas

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Forecast of Chinese Investment in US Shale Gas

A Thesis

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Master of Arts

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Abstract

This thesis will make a forecast of the future growth of Chinese investment in the US shale gas industry in the short term (within the next 5 years) and in the long term (in more than 10 years). The thesis’s purpose is to study the purpose, trend as well as the impact on China itself in China’s recent asset acquisition activities in the US shale gas. Following an introduction to the shale gas development in the US and China, this thesis will make a forecast with the methodology including extrapolation, qualitative analysis, political risk analysis and scenario analysis. The conclusion drawn from the analysis is: in the short term, more Chinese joint ventures will be set up between large Chinese oil and gas companies and small to medium sized US shale gas explorers, with a preference for tight oil and wet gas; in the long run, due to its transitioning nature, the joint venture investment will discontinue, and the Chinese companies’ activities in acquiring US shale gas companies will greatly depend on the US government’s policy and natural gas price.
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Chapter One

Introduction

Though people have been questioning whether the Great Wall of China can be seen from outer space\(^1\), there is one thing in China that has been recently definitively proved to be visible from outer space -- the ominous smog covering the east coast of China. On Dec 7\(^{th}\) 2013, NASA released a picture taken by satellite of smog covering some of the major cities in China including Beijing and Shanghai (Longid, Bloomberg News, 2013). One of main reasons of the smog is China’s heavy reliance on coal, which causes more air pollution than its alternatives such as oil and gas.

One of the possible solutions to China's over consumption of coal is to substitute a large percentage of coal consumption with natural gas -- a cleaner and more efficient energy source than oil and coal. China has one of the largest amounts of shale gas resources, though mostly untapped. The US shale gas boom has shown China how it could be done: Due to the breakthroughs in the drilling technologies including hydraulic fracturing and horizontal drilling, the US has witnessed a quick growth in its shale gas production. In 2012, thanks to the extraction of shale gas, US natural gas consumption

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\(^1\) The Great Wall was said to be one of the few man-made structures visible from orbit, yet it has been proved that it is only visible under specific conditions. 
http://www.scientificamerican.com/article/is-chinas-great-wall-visible-from-space/
rose 4.4% to a record high 25.5 trillion cubic feet and natural gas currently accounts for approximately 30% of electricity production and 50% of home heating (Napach, March 13th, 2013). The shale gas boom has provided a historically unprecedented opportunity to further grow China’s outbound investment in the global energy sector, which accounts for nearly half of the total Chinese overseas investment (Scissors, 2013). According to a merger tracking firm Dealogic, from 2008 to 2012 the Chinese oil and gas companies have spent $44.2 billion to acquire U.S. and Canadian energy firms as well as oil and gas fields (Gold, 2013), with a large amount of the fund invested in shale gas.

Considering the bittersweet US-China relationship, the Chinese investment in US shale gas has raised many questions: Who are the major investors? What is the motivation behind the investment? What will be investment's impact on China's own shale gas development? How will the US government react to such a sensitive investment? This paper will focus on these questions and lift the "smog" on the current Chinese investment in the US shale gas industry. Based on the analysis of the current investment, a forecast of the future investment trend in the near future (next 5 years) and long term future (10 years and above) will be made.
Chapter Two

Literature Review

1. An Overview on Shale Gas Development in the US and Its Impact on China

   Jennifer Turner & Kexing Liu and Erica Downs have conducted an overview on the current shale gas development and Chinese investment. Authors of each article share different perspectives on the same issue. Turner and Liu provide an overview on the shale gas boom and China's potential in developing shale gas through cooperating with US, and Downs takes an investment perspective and analyzes the opportunities and risks brought up by the US shale gas boom for Chinese global investment.

   An introduction to shale gas as well as the Sino-American shale gas development cooperation is provided by Jennifer Turner and Kexing Liu in their research paper "Shall We Dance? Explore a New Area of US- China Energy Cooperation", April 2011. In this article, Turner and Liu give a comprehensive overview on questions including the definition of fracking and the related issues, shale gas development in the US and China and current US-China's commencement of their cooperation in shale gas development on the government and corporate level at the time of writing. The authors hold a neutral view on shale gas development and conduct an objective observation on shale gas development.
In the article Turner and Liu explain the idea of shale gas and fracking: shale gas is the natural gas locked in sedimentary shale rocks, which is the reservoir and source of natural gas, and the technology that is used to extract shale gas is called hydraulic fracturing, also known as "fracking". Shale gas production has been a controversial issue: The fracturing process has received a lot of criticism due to the fact that fracking is highly water intensive, uses toxic chemical additives in the injected fluid and may potentially contaminate underground water and cause seismic activities such as earthquakes and tremors. The role of shale gas as a cleaner alternative to coal and oil is also debatable, as the emissions of natural gas during extraction and transportation may cause air pollution and leakage of methane, a greenhouse gas. The development of shale gas may displace cleaner renewable energy industries. On the other hand, Turner and Liu also argue that some of these problems could be fixed through strict industry regulations and technological advancement.

According to Turner and Liu, China and US are similarly rich in shale gas resources-- the US has 862 trillion cubic feet technically recoverable resources and China has an estimated amount of 1,275 trillion cubic feet (Turner and Liu, April 2011). The significant commercial drilling started in the US only during the past decade, yet shale gas is playing a more important role in total natural gas production, which was the second largest energy source at the time of writing. In contrast, China has only recently started to explore shale gas, and the share of natural gas production was only about 3% of the total domestic Chinese energy production at the time of writing. Despite the fact that shale gas in China is at the early stage, China has been actively exploring natural gas as a cleaner
alternative to air pollutant emitting coal. To encourage shale gas production, the Research Center for Oil and Gas under the Chinese Ministry of Land and Resource has been identifying shale gas prospect and in 2010, and government officials announced a subsidy and tax incentive for the Chinese shale gas explorers.

Turner and Liu also conduct a review over the cooperation between the US and China in shale gas production. In 2009, the Obama-Hu Sino-American Presidential Summit pioneered the Shale Gas Initiative, "an agreement that aims to increase bilateral collaboration on regulations and technology development of shale gas reserves while also protecting the environment and communities around such exploration in both countries" (Turner and Liu, April, 2011). The cooperation agreement is designed to promote collaboration on shale gas resource assessment, technology and investment. Besides the cooperation on a state level, Chinese state owned enterprises are also working with oil and gas firms from other countries. Turner and Liu briefly introduce the recent Chinese investment in the US including CNOOC's investment in Chesapeake, PetroChina's acquisition of stakes in Encana, Canada as well as international companies such as Royal Dutch Shell and BP's effort in investing in China's shale gas.

In comparison with Turner and Liu’s overview on the shale gas industry in the US and China, Erica Downs in her "Implications of the US Shale Energy Revolution in China" further elaborates on the topic of Chinese investment in foreign energy and provides a deeper insight in the impact of the US shale gas revolution on China from an investment perspective. She argues that with the Chinese companies' increasing amount
of outbound investment in foreign energy, the opportunities brought by US shale gas boom may affect China’s investment not only in the US but also on the global level.

Downs states that the shale gas has provided great investment target assets for Chinese companies seeking to acquire foreign energy assets. Chinese investment has been historically left out of high quality investment in the energy industry. However, this situation is changed by the shale gas boom. Chinese national oil companies have been actively participating in the shale gas boom. "Since 2010, China's national oil companies have spent more than $10 billion to acquire upstream assets in the United States, most of which has been spent on unconventional projects" at the time of the paper (Downs, November 8, 2013). The US shale gas boom also provides more investment opportunities for Chinese investors in other countries and regions. With more US oil companies selling assets abroad to free up their cash to participate in the US shale gas boom, more good quality conventional oil and gas assets in other countries are becoming available for Chinese investment and the competition for these valuable assets is becoming less fierce.

Besides new investment opportunities, Downs also gives a brief overview on the impact of the US shale gas boom on China's existing investment in other regions and the world geopolitical energy landscape. Firstly, China's investment in the US shale gas industry has a direct impact on its investment in oil and gas in other regions. For example, the increasing investment in the North American region will further limit China's national oil companies' investment expansion in countries like Iran because the US may oppose Chinese investment due to China’s economic cooperation with Iran; the increasing
energy assets also give China more leverage in natural gas pipeline discussion with Russia. Secondly, the shale gas industry development may lead to a change in the US's global energy policy, which will affect China indirectly. The shale gas boom will ultimately allow the US to be more (if not completely) energy independent, which as a result may lead to its reduced military presence in the Persian Gulf region. This could potentially cause China and other Asian oil buyers to step in to ensure secure oil flow.

2. Chinese Investment in US Shale Gas Industry

The Chinese investment in US shale gas industry has received mixed views. Authors such as Shihoko Goto claim that the Chinese investment is for strategic purposes, which should raise concerns over its impact on US economy security. Other authors hold different opinions. Douglas Atkinson argues though the energy industry is of strategic importance, the US government allows Chinese investment in shale gas for technological innovation and capital raising purpose. Other authors such as Ryan Dezember and James Areddy believe that the success of Chinese investment in US shale gas is due to the fact that Chinese companies are more conscientious with their investment approach and trying to avoid political backlash.

Shihoko Goto in her article "Why U.S. Angst over Chinese Buyouts is Warranted" points out that Chinese investment is much more than the corporate overseas acquisition as it appears to be. She argues most of the Chinese investment originates from Chinese state-owned enterprises, which sets them apart from investments from other countries. These state-owned enterprises are controlled by the Chinese government and
have been strategically focusing on the food, real estate and energy industry, the key industries for a country's economic independence, which justifies the concern over the threat Chinese investment poses to US's economic security.

Authors such as Goto have expressed their concern over the threat posed by Chinese investment to US national security. In contrast, Douglas Atkinson believes the US government is welcoming Chinese investment due to the shale gas industry's urgent need for technology and capital. Other authors such as Ryan Dezember and James Areddy conclude that it is the Chinese investors that are taking a different strategy, which allows them to invest in the US without threatening the US energy security.

In his thesis "Explaining Energy Resource Cooperation: Shale Gas, Chinese Investment and the Changing Calculus of US Energy Security", Atkinson reviews the Chinese investment history in the US oil and gas industry and compares the Chinese investment in 2005 and the investment since 2009. He states that the success of the investment was the result of a compromise from the US policy makers.

From a national energy security perspective, Atkinson argues that energy acquisition is a zero sum game: one country's gain comes at the price of another country's loss. For energy-deficit states such as China and the US, energy security, defined as "the state's ability to ensure an adequate supply at a reasonable price" (Atkinson, January 1st, 2012), is vital, and they will most aggressively guard these assets against other deficit states.
In his thesis, Atkinson concludes that the reason why the US allows Chinese investment in shale gas industry is to enable technological innovation and provide the needed capital, which will further ensure energy security. Atkinson's theory is that the investment in the US energy industry will be allowed if the technological and capital intensity in the area is high. The United States can "no longer seek to obtain energy security independently, or to limit investment only to close allies who pose no threats to energy supplies" (Atkinson, January 1st, 2012). Despite the fact that China is an energy competitor to the US, high costs and rapid technological development have forced the United States to allow Chinese investment to come in.

Atkinson conducts two case studies to prove his theory. The first case study is the attempt of CNOOC (China National Oil Offshore Corporation) to purchase Unocal, a California headquartered oil and gas company with large reserves of natural gas in 2005. In this case, there was little need for technological advancement as Unocal's assets had been largely developed with the existing technology. The CNOOC purchase was deemed as a threat to the US energy security and the denial of the purchase received bipartisan support. Senator Ron Wyden commented on this case, "I am a free trader but being a free trader is not synonymous with being a chump" (Atkinson, January 1st, 2012).

The second case study is the Chinese investment in the shale gas industry after the shale gas boom. The shale gas technology breakthrough has made the US "the Saudi Arabia of natural gas", according to President Barrack Obama's address at the 2012 State of Union. However, the hydraulic fracturing technology is still at the very beginning.
stage-- only 11 years of the 100 years' worth of domestic shale gas reserves can be produced at the current rate of consumption. The technological advancement required for the discovery and exploration of the remaining 89 years' worth of natural gas reserves requires a large amount of capital invested in research and development, which has become a heavy financial burden for independent natural gas firms. The Chinese capital came at the right time when it had been hard for natural gas firms to acquire capital due to the 2008 recession and the low gas prices in the United States.

There have been three deals since the year 2010: the deal between CNOOC and Chesapeake in 2010 in Eagle Ford formation, a similar deal between the two in 2011 for drilling activities in Colorado and Wyoming and Sinopec's acquisition of shale assets of Devon Energy in 2012. Chinese companies have also been active in acquiring US shale technology firms. The political reaction of the US has been positive: nothing was said in Washington DC about the three gas deals. The reason behind this silence in Washington is to ensure energy security, the US needs to invite in Chinese investment to push technological innovation forward. Also by "helping China obtain the required technology to tap into its own large domestic reserves", the Chinese demand for foreign energy products will also be reduced (Atkinson, January 1st, 2012).

Based on his theory, Atkinson also makes a general forecast of the US government’s attitude towards Chinese investment in US shale gas in the future. He argues that as the capital and technology requirement can be expected to grow as "energy firms move from the easily accessibile shale formations to more difficult ones" and the
US policy maker will continue to allow investment "to the point that it offers potential for further energy security" (Atkinson, January 1st, 2012).

Ryan Dezember and James Areddy in their "China Foothold in US Energy" take a different angle from Atkinson. Dezember and Areddy also conduct a detailed review on China's investment history in the US energy industry since 2005. However, their argument is that the success of Chinese investment was not necessarily due to a change in America's political attitude towards Chinese investment, but a change in Chinese companies' investment strategy. Having learned their lesson from CNOOC's failure in the Unocal Acquisition in 2005, Chinese companies are becoming more subtle with their investment and have started to focus more on public relations. More importantly, unlike the major takeover in 2005, the investment since 2010 does not involve ownership of American oil and gas assets.

Dezember and Areddy compare the deals in 2005 and after 2010 in transaction size and company investment strategy. The Chinese company CNOOC's attempt to purchase Unocal in 2005 caused opposition in Washington DC: for fear that "deal would put crucial US energy resources in Chinese hands" (Dezember and Areddy, March 6, 2012), which led to the deal being delayed and later pulled by CNOOC.

However, after avoiding the North America market for 5 years, the Chinese companies have developed a new strategy: "Seek minority stakes, play a passive role and in a nod to US regulators, keep Chinese personnel at arm's length from advanced US technology" (Dezember and Areddy, March 6, 2012). The deals between Chinese state
owned companies with American shale gas companies since 2010 all have one thing in common: the Chinese companies provide the needed capital and do not receive ownership or control over the company. For example, the $1.08 billion worth deal between CNOOC and Chesapeake gives CNOOC one-third stake in the Eagle Ford Shale formation in South Texas, yet no control over the production of the assets. Also, for fear of political backlash, the deal excluded "secondment", the temporary assignment of one company's employee to another, a common practice in the oil & gas industry. This limited the direct inter-company transfer of the drilling technologies. The deal between the two in Wyoming and Colorado and the deal between Devon Energy Corp and Sinopec are similar in nature--"a minority, nonoperating interest in an asset without taking the oil and gas home".

The benefit in these investment activities for the Chinese companies, Dezember and Areddy argue, is technical know-how advancement, though limited, and possible American partnership in the Chinese shale gas market. Chinese companies may gain insight in shale gas operations and management skills through partnering with American shale gas firms.

3. China's Investment in US Shale Gas and China's Shale Gas Boom

Though many authors believe the Chinese investment in the US shale gas boom targets the fracking technology, yet if the technology transfer is going to lead to another shale gas boom in China remains to be seen. It appears that Chinese shale gas industry is facing many challenges. These challenges include fragmentation in the legal system, lack
of private investors and an effective market mechanism, oligarchy in the Chinese energy market and environmental issues.

Kai Zhu in "The Path to Shale Gas Development in China and the United States" compares the development of the shale gas industry in China and that in the US. He analyzes the US's advantages in developing the shale gas industry. In addition to the favorable geological factors in certain areas of the US, government support has also played an important role in the shale gas boom. The US government has not only provided favorable policies and legislation on both the federal level and the local level such as tax exemptions and government subsidies, but has also set up public funded technology research and development projects to further the industry's growth. Another contributing factor to the US shale gas revolution is an effective economic system that encourages competition and entrepreneurship. The sound property rights system and mature market mechanism encourage entrepreneurship and allow small or medium sized companies to participate in shale gas boom and boost technological development.

Zhu mentioned that the Chinese government has also been working painstakingly to open the shale gas industry to private capital and encourage shale gas production. China has included the shale gas industry as one of the nation's new strategic industries. The Chinese government has been providing subsidies (¥0.4/m³) for shale gas production and building shale gas pipelines to facilitate the industry's growth.

Despite all the government favorable policies, Zhu argues that a lack of private investors is a major challenge for the Chinese shale gas development. The two
state-owned oil and gas giants, CNPC (China National Petroleum Corporation) and Sinopec, with their unparalleled capital and government support, have control over most of the country's conventional gas sites. Most of the favorable shale gas sites overlap with these conventional oil and gas sites controlled by CNPC and Sinopec, which keeps private investors away from shale gas development. In September 2012, the Ministry of Land and Resources invited tenders for shale gas exploration rights. Though one third of the bidders are from the private investors, only two out of the nineteen companies that won the tender were privately owned. Without a pool of private oil and gas companies to operate in shale gas and drive technological development forward, the government subsidies alone will not be enough to lead to another shale gas revolution in China.

Jonathan Chanis in his "Will the ‘Oil and Gas Revolution' Pass China by" also elaborates on the private investor issue. He argues that the Chinese state owned oil and gas companies not only crowd out private investors through direct competitions but also through pipeline ownership. The dominance of CNPC in the pipeline sector keeps their potential competitors from using the pipeline network.

Chanis concludes that China's constraints on the shale gas industry can be divided into two categories: one is the challenges that any country would face in their shale gas development such as environmental problems, natural gas royalties and taxes reform; the other kind is the problems that could strike at the heart of the Communist Party's interest including the lack of private mineral ownership and domestic oil and gas oligopoly. He argues that the first kind of problems would not be especially challenging for China yet
the second kind would require an extensive round of market-oriented reforms (Chanis, December 16th, 2013).

Unlike Zhu or Chanis, Paolo Davide Farah and Riccardo Tremolada in their "A Comparison between Shale Gas in China and Unconventional Fuel Development in the United States: Health, Water and Environmental Risks" discuss the current constraints on the Chinese shale gas industry from an environmental perspective.

Farah and Tremolada hold a generally positive opinion on the shale gas development in China. They argue that shale gas, as a carbon friendly source could potentially meet China's future energy and environmental objectives (Farah and Tremolada, October 11th, 2013). Yet, part from the overall optimistic view, Farah and Tremolada focus more on the current risks for China, especially in terms of environmental issues.

Hydraulic fracturing has been criticized for the use of large amount of water and possible contamination of underground water. This is especially a challenge for China considering drinkable water is scarce resource in China, probably even more than energy. The major reservoirs of shale gas in China all have water issues: the shale gas rich Sichuan Basin provides roughly 7 percent of China's rice and wheat, which means an intense demand for clean water and zero tolerance for water pollution; other shale gas basins such as Xinjiang, Tarim and Inner Mongolia, the arid and hot climate makes adequate water supply a financial burden.
According to Farah and Tremolada, the environmental risk also lies in a flawed environmental law system. Farah and Tremolada point out three issues in the Chinese legal system: Institutional fragmentation that leads to conflicts of interests between the Ministry of Environmental Protection and the National Development and Reform Commission; The lack of explicit laws and regulations to provide guidance for shale gas exploration or tackle the environmental issues in fracking; The historical unsatisfactory record of environmental law and regulation enforcement.

Farah and Tremolada in their article also discuss the challenges to the Chinese shale gas companies. Though Chinese companies are benefiting from imported American shale gas technologies, there are still many risks Chinese companies need to consider when it comes to operations. One of the operation risks is financial risk: Shale gas drilling and completion techniques make shale gas wells cost 3 times more than conventional wells, and for the shale gas company it can take years before the investment begins to generate returns (Farah and Tremolada, October 11th, 2013). The financial risks have become an even more serious issue for Chinese shale gas companies due to the inadequate infrastructure such as pipelines. Yet the biggest challenge is yet to come-- the environmental issues in company operations. The potential threat to public safety and health caused by one company's wrongdoing or operation accident could raise a public negative opinion and hence undermine the development of the infant shale gas industry in China, which has been proved by the banning of the shale gas exploration in several European countries such as France and Bulgaria.
4. Concluding Thoughts on Existing Literatures

The review of existing literature provides a broad picture of US and China's development and cooperation in the shale gas industry. Based on the literature review, the shale gas industry's development has provided an unprecedented opportunity for both the US and China, two of the world's most energy thirsty countries. The significant commercial drilling of shale gas started within the last decade in the US, and is only in its infancy in China. The US and China are cooperating both on the government level as well as the corporate level. On the government level, the leaders of the US and China are signing the Shale Gas Initiative to cooperate in shale gas development; on the corporate level, Chinese state-owned enterprises are investing in shale gas in the US and inviting international oil and gas companies such as BP, Royal Dutch Shell and Exxon to enter the Chinese market.

The US and China's cooperation on the corporate level, especially Chinese investment in the US, has received a lot of attention. Some authors argue that Chinese investment mounts a potential threat to the US energy security. Authors such as Atkinson argue that though China is US’s competitor, the reason why the US is accepting Chinese investment is because there is a change in the US energy security policy. Yet authors such as Dezember and Areddy disagree and conclude the reason is that the Chinese investment may not necessarily affect the US energy independency. The minor stake holding of Chinese state-owned companies in US shale gas projects is more likely to be China's attempt to import the US shale gas technology and management model back to
China than to take control over US oil and gas resources. The Chinese companies are taking small steps: none of the deals struck between Chinese companies and US companies are significant enough to affect the company's ownership.

However, if the American model can be imported to China is still an open question. Though Chinese government has set shale gas development as a strategic goal, China has many of its own problems to solve. Existing literatures have analyzed the challenges from different perspectives including environmental risks, market mechanism, legal fragmentation, underdeveloped infrastructure, etc.

The existing literatures provide general background information on the Chinese investment in the US. However, there are some major flaws in the information gathered from existing literatures. One clear issue is that most of the existing literatures do not have a deep understanding in the shale gas industry and the investors. Firstly, the reviewed literatures tend to analyze Chinese investment in US shale gas without providing much detailed information on the mergers and acquisitions trend in the US shale gas industry. The Chinese investment in the US shale gas is not necessarily that special if the US shale gas industry has attracted investment from all over the world or if joint venture is general practice in the industry, which is what the existing literatures have failed to mention. Secondly, the authors in the existing literatures have ignored China’s investment in US tight oil, the unconventional oil equivalent to shale gas or the difference between dry gas and wet gas. Tight oil as another shale resource has also attracted Chinese investment, and that being said, it is necessary to also review China’s investment
in tight oil resources when analyzing China’s interest in shale gas as they are often bundled in their exploration. Thirdly, the existing literatures do not provide background information on the investors in the deals. Most of the authors generalize them as the Chinese state-owned companies or briefly mention their names in the transactions. However, to fully understand the existing investment and future investment trend, a more detailed research on the background of the investors is needed.

Moreover, when analyzing the US government’s attitude, the existing literatures show a clear lack of depth. Firstly, none of these research papers give a comprehensive review on Chinese investment in the US. The existing literatures either generally elaborate on Chinese investment trend in the US without going into specific industry analysis like Shihoko Goto’s general view on Chinese investment, or single out Chinese investment in US energy like Atkinson’s review on Chinese investment in US shale gas. The growing Chinese investment in the US has been across different sectors, and to analyze US’s attitude towards Chinese shale gas investment it is necessary to review the overall current Chinese investment in the US as well as Chinese investment in US shale gas. Secondly, another issue in the political barrier analysis of the literatures above is they generally comment on the US government’s attitude without systematically analyzing the US government review process on Chinese investment and the government’s concerns when reviewing the foreign investment. This type of analysis creates the illusion that the government is one integrated body in deciding whether to approve foreign investment, while in reality, there is one specific government
entity—Committee on Foreign Investment in the US—responsible for reviewing foreign investment when there is a threat on national security.

The last issue with the literatures is a technical issue. The reviewed literatures are, though recent, not the most updated research papers on Chinese investment. The shale gas industry is experiencing rapid changes and there could be acquisition deals being negotiated or signed at the very moment of writing. Most of the research papers that provide deep insight in Chinese investment do not provide the newest transaction information, and to study the current industry trend, this research thesis will need the most updated first-hand information on the existing transactions.
Chapter Three

Shale Gas Development in China and the US

1. What is Shale Gas? Shale Gas, Hydraulic Fracturing and the Related Issues

Figure 1. Schematic geology of natural gas resources


Shale gas is a type of unconventional natural gas. Both conventional and unconventional oil and gas originate from the same geologic formations known as shale or mudstone (EIA, December 5th, 2012). As shown in figure 1, Conventional oil and gas is the oil and gas that have migrated from the deeper shale to the porosity of overlying rock layers such as sandstone and siltstones and can flow more easily across this porosity.
Due to the permeable nature of the formations, conventional oil and gas can be extracted just by pumping or compression operations with the natural pressure of the wells.

Shale gas, as one of the unconventional natural gases, refers to "natural gas that is trapped within shale formations" (EIA, December 5th, 2012). As the reservoir and source of shale gas, the shale formation has very low permeability; hence shale gas needs to be extracted with the technology called hydraulic fracturing, also known as "fracking".

Hydraulic fracturing, as shown in Figure 2 below, is the process that enables an operator to pump fracturing fluid into the wellbore at a high rate, which then raises the pressure, causing the rocks to crack and release natural gas into the boreholes which are kept open with the help of proponents contained within the fracturing fluid (Turner and Liu, April, 2011).

Source: EIA, "What is shale gas and why is it important", December 5th, 2012
The development of shale gas has triggered a lot of debate among policymakers, environmentalists and with academia, on account of its perceived negative effect on the environment.

Firstly, the hydraulic fracturing process poses a potential threat to the environment. The fracturing process is highly water intensive and "involves the injection and extraction of a large amount of potentially harmful contaminants, such as acid, iron control and gelling agents" (Turner and Liu, April 2011). It was estimated that fracking uses between 1.2 and 3.5 million US gallons of water per well, with the largest using up to 5 million US gallons. (Andrews, 2009, P7 & P23). Moreover, a shale gas well could potentially require refracturing, and when wells are refractured, more water will be needed in the process (Abdalla and Drohan, 2010). As well, the hydraulic fracturing process generates a lot of wastewater and the fluid used in hydraulic fracturing has numerous toxic chemicals, which could potentially pollute underground water and surrounding environment if mismanaged. It is also believed that hydraulic fracturing could potentially cause seismic activity. According to the United States Geological Survey, though the earthquakes caused by hydraulic fracturing are too small to be of concern, the disposal of wastewater through injection into deep wells, which is enabled by hydraulic fracturing operations, could lead to stronger earthquakes that cause damage (Ellsworth, Jan 17th, 2014).

Furthermore, though the combustion of natural gas generates lower levels of carbon dioxide and sulfur than coal and oil, the shale gas extraction process could lead to
the leakage of the primary component of natural gas, methane, which is a greenhouse gas more harmful than carbon dioxide to environment (Khalil, November 1999). According to a report issued by ProPublica in January 2011, the assumption on low greenhouse gas emissions from natural gas does not "account for the methane and other pollution emitted when gas is extracted and piped to power plants and other customers" (Turner and Liu, April, 2011). Aside from the emission of methane into atmosphere, the transport of water for hydraulic fracturing has also caused more carbon dioxide emissions.

2. The US Shale Gas Boom

The extraction of shale gas in the US dates back to 1825, when the first well was drilled in Fredonia, NY. (Milam, September 2011). However, shale gas did not play any significant role in the 19th or 20th century, until the maturing of the hydraulic fracturing process.

Figure 3. Lower 48 states shale plays

Source: EIA based on data from various published studies, updated in May 2012
technology in the late 20th century (Wang and Krupnick, April 2013). Shale gas production was never considered economically efficient before the technology matured.

The technological development of shale gas is facilitated by favorable US government policies. The favorable policies began in the 1970s, when the government put an emphasis on energy production. Under the 1970s energy crisis background, the natural gas market was going through a shortage in production and natural gas technically recoverable reserves due to the price ceiling regulation, which discouraged production and stimulated demand (Davis and Kilian 2011). The proved natural gas reserve peaked in 1967 and absolute level of natural gas production peaked in 1973, and it was advised by several major studies commissioned by the Federal Power Commission, the Energy Research and Development Administration and the US Department of Energy in the 1970s that subsidizing and encouraging the unconventional natural gas industry could be a potential solution to the natural gas shortage (Wang and Krupnick, April 2013, P7). The US government hence created policies to stimulate the unconventional natural gas industry's growth, including government funded research and development programs, provided tax credits and price incentives to shale gas explorers (Wang and Krupnick, April 2013, P 3).

Thanks to the partnership between the natural gas industry and the Department of Energy, shale gas drilling technology developed quickly in the late 20th century, which led to the rapid growth of US shale gas production in the first decade of the 21st Century. One of the major contributors to technological innovation in shale gas production is the
natural gas company at the Barnett Shale formation, Mitchell Energy, which was later acquired by Devon Energy in 2001 (Source: Devon Energy, August 2001).

Figure 3 illustrates the current geographical locations of formations in the US and figure 4 shows the production growth of the 8 major shale formations. As displayed in the graph, the Barnett Shale based in Bend Arch–Fort Worth Basin, North Central Texas has been the pioneer in shale gas production since the beginning of the 21st Century, though its growth rate was later surpassed by that of other shale formations including Haynesville and Marcellus after 2010. In the 1980s and 1990s, despite the low production rate, Mitchell Energy's owner George P. Mitchell was perseverant in his experiment with the drilling technology at his drilling wells in Barnett. Aided by the government research and development support and subsidies, Mitchell Energy achieved several major
technological breakthroughs such as horizontal drilling after approximately two decades of experiments (Shellenberger, December 12, 2011). The technology was then imitated by other companies and further boosted shale gas production of the industry in the 2000s (Zhongmin, Wang and Alan, Krupnickage, April 2013). George Mitchell, "the father of fracking" received much credit for his commitment in fracking technology advancement. The Economist commented that "few business people have done as much to change the world as George Mitchell" (Schumpeter Columnist, August 2013).

The US shale gas boom greatly changed the US’s energy landscape. Shale gas development led to greater natural gas production. For instance, as shown in figure 4, in 2000, shale gas accounted for only 1.6 per cent of US natural gas production, and this percentage quickly rose to 4.1 percent by 2005, thanks to the drilling activities in Barnett. By 2010, when several other formations’ production started to quickly grow, the percentage of shale gas jumped to 23.1 by 2010. (Zhongmin, Wang and Alan, Krupnickage, P1) According to figure 5, by the end of 2012, the percentage of shale gas in total production skyrocketed to approximately 40%. This trend continues, and the driving force of shale gas production comes from the continuing technological innovation, which has boosted the shale gas production growth at a quicker rate than expected. For example, the Marcellus region, which produced less than 2 billion cubic feet per day as recently as 2010, produced more than 12 billion cubic feet per day in 2013. By December 2013, the Marcellus region was expected to provide 18% of total US natural gas production (EIA, December 9, 2013). The quick growth of Marcellus exceeded energy...
experts' expectations, "a year ago, we were not expecting the Marcellus to be at 12 billion cubic feet", said an analyst from the EIA (Legere, October 2013).

The US shale gas boom has contributed to the energy independence of the US through meeting domestic energy needs and thus leading to a decrease in natural gas import and increase in natural gas export. According to the EIA natural gas production lookback 2013, since 2010, domestic production has satisfied 88% of US natural gas production, and according to the latest updated report from EIA, the estimation of US shale gas technically recoverable reserves increased to 1,161 Tcf, the largest in the world. Note the definition of technically recoverable reserves is the volume of oil and gas that "could be produced with current technology" (EIA, June, 2013), which means the amount of shale gas technically recoverable reserves depends on technological advancement and
could increase as the drilling technology improves. The future potential in shale gas development is indefinitely large, as more shale gas reserves become extractable with the more advanced technology.

US natural gas imports continue only as a marginal source of supply, largely during cold weather and pipeline maintenance outages. (EIA, Natural Gas Production Lookback 2013, January 16th, 2014) As shown in figure 6, the EIA Annual Energy Outlook 2014 has forecasted that natural gas imports will continue to fall by 30% to 3.1 Tcf by 2040, with more demand being met by domestic production. At the same time, the US natural gas exports through pipelines and liquefied natural gas (LNG) are also expected to be increasing. The EIA Annual Energy Outlook 2014 also forecasted that the US pipeline natural gas exports to Mexico and Canada will increase to 4.5 trillion cubic feet (Tcf), and LNG exports will increase to 3.5 Tcf by 2040. With a high production projection of natural gas and renewables, the EIA estimated that U.S. total domestic energy production will increase from 79.1 quadrillion Btu in 2012 to 102.1 quadrillion Btu in 2040, and the net use of imported energy sources, which was 30% in 2005, will fall from 16% of total consumption in 2012 to 4% in 2040. (EIA, December 16, 2013)
Figure 6. US natural gas imports and exports, 2000-40


Figure 7. US energy production by fuel, 1980-2040

Moreover, the increase in US shale gas production has also greatly changed the US energy landscape. As shown in figure 7, natural gas has replaced coal as the largest source in US domestic energy production. In 2012, natural gas production accounted for 31% of the total US energy production and coal accounted for 26%. The EIA forecasted that the percentage of natural gas is expected to keep rising to 38% and the percentage of coal is expected to drop to 22% by 2040. This leads to a change in energy consumption and a reduction in greenhouse gas emission. With the attractive cheap price of natural gas, natural-gas-fired generation is expected to replace the generation formerly supplied by coal and nuclear plants. EIA's annual energy outlook 2014 estimates that in 2040 natural gas will generate 35% of total electricity and coal will generate 32%. The shift from carbon-intensive coal to low carbon natural gas reduces carbon dioxide emissions. The EIA's forecast indicates that with more plants fueled by lower carbon fuels including natural gas and renewables, carbon dioxide emissions will "remain below 2005 level in every year through 2040". (EIA, December 16th, 2013)

3. China's Energy Landscape

China, with the world's largest population and fastest growing economy, has become the largest energy consumer and producer in the world (EIA, Feb 2014). According to the EIA country report, China became the world's largest power generator in 2011; China's oil consumption growth accounted for one third of the world's oil consumption growth in 2013; China is the world's top coal producer, consumer and importer and accounted for half of global coal consumption.
However, for the largest energy consumer, China's consumption over-relies on carbon-intensive coal and oil. As shown in figure 8, the majority of China’s energy supply comes from coal (69%) and oil (18%), while the other energy sources including hydroelectric power (6%), natural gas (4%), nuclear (1%) and other renewables (<1%) only account for a small portion of the total energy consumption (EIA, Feb 2014).

China's large consumption of coal has created many environmental problems including carbon dioxide emissions and heavy air pollution in major industrial areas. For example, as shown in figure 9, in 2011, China released 8,715 million metric tons of CO₂ in 2011, as the world's largest Carbon Dioxide emitter (EIA, Feb, 2014). In an effort to ease the country's reliance on coal and increase environmental sustainability, the Chinese
government has set a target in their 12th five-year plan to cap total coal use to below 65% by 2017. The US EIA projected that coal share of total energy mix to fall to 63% by 2020 and 55% by 2040s. China also intends to reduce its overall carbon dioxide emissions by at least 40% between 2005 and 2020 (EIA, Feb, 2014).

**Figure 9. Global energy related carbon dioxide emissions**

![Graph showing global energy related carbon dioxide emissions](image)


In order to reduce China's current overreliance on coal, China has been working painstakingly to increase the shares of low carbon sources including natural gas in its energy mix. The government is expecting to boost the share of natural gas to 10% by 2020 from the current 4% in order to alleviate the high pollution caused by the overconsumption of coal (EIA February 4th, 2014).

The domestic production of natural gas has been growing steadily. From the year 2002 to 2012, China more than tripled natural gas production to 3.8 Tcf and is planning
on increasing the amount to 5.5Tcf by 2015. However, the growth in natural gas production, though impressive, has not been able to meet China's fast growing demand for natural gas. China has been a net natural gas importer since 2007, and natural gas currently takes up 29% of China's total natural gas demand in 2012 (EIA February 4th, 2014). According to China's 12th five-year plan, the Chinese government is expecting the percentage of imported natural gas to grow to more than 35% of the total demand by 2015, which will "pose a new challenge to China's energy security" (The Chinese National Development and Reform Commission, October 22nd, 2012, P2). Further boosting its natural gas domestic production has become imperative for China's sustainable growth.

**Figure 10. China EIA/ARI shale gas/oil assessment**

![Image of China EIA/ARI shale gas/oil assessment](image)

Source: EIA, An Assessment of 137 Shale Formations in 41 Countries outside the US, 2013.
The potential in shale gas provides a solution to China's energy independence issue. China has one of the world's largest shale gas technically recoverable reserves. According to the most recently released Energy Information Administration/Advanced Resources Institute (ARI) World Shale Gas Shale Oil Resource Assessment report, China has a total amount of 1,115 trillion cubic feet of shale gas technically recoverable reserves, the second largest shale gas reserves after the US's 1,161 Tcf (ARI, June 2013). The majority of China's technically recoverable shale gas reserves are located in the southern region, northwestern region and northeastern region, as shown in figure 10.

As in figure 11, currently China is the only nation outside of North America that has been able to produce shale gas in commercial quantities (EIA, October 23rd, 2013). China held its first shale gas licensing round in 2011 and the second round in mid-2012, and opened the door to both state-owned and privately owned companies. The shale gas industry overall is still at a very early stage, with less than 1% of the country's total...
natural gas production in 2012. The industry is facing challenges including water resources challenges, regulatory hurdles, transportation constraints and competition from conventional natural gas (EIA, February 14th, 2014).

In order to facilitate the shale gas industry's development, China has been actively working with the US. In November 2009, to promote Sino-American cooperation in cleaner energy sources, President Obama and President Hu launched a package of clean energy and energy efficiency research programs and agreements, including the US-China shale gas initiative (Lee, November 2009). The US-China shale gas initiative, which aims at enhancing US-China cooperation in shale gas development, allows the US to share expertise in shale gas assessment and conduct jointly technical studies in shale gas development with China. Moreover, the initiative promotes shale gas investment in China through study tours, workshops focused on shale gas development and the US-China Oil and Gas Industry Forum, a panel discussion that convenes periodically among Chinese and American energy companies (The White House, November 17th, 2009). The initiative has developed beyond governmental cooperation and facilitated mutual investment in the private sector. For example, in December, 2012, the United States Trade and Development Agency (USTDA) invested $378,000 to host workshops with members of the Chinese shale gas industry, including Chinese shale gas companies and government officials to "help introduce Chinese energy sector officials and project sponsors to US shale gas best practices, policies and technologies" (Richardson, December 12th, 2012)
With government support, Chinese and American companies have been seeking shale gas development partnership in both countries. This cooperation has gone further than corporate site-visits and business conferences. Chinese companies have invested billions of USD in US shale gas and US companies have recently started to actively search for partnerships with Chinese companies in Chinese shale gas development. In the following three sections, this paper will conduct an analysis on the future of Chinese investment in US shale gas through extrapolation, qualitative analysis, political risk analysis and scenario analysis.
Chapter Four

Overview on the Forecast

1. Methodology Overview

In order to make a forecast of the future trend of Chinese investment in US shale gas, this thesis uses four different approaches: extrapolation, qualitative analysis, political risk analysis and scenario analysis.

The extrapolation analysis is conducted through analyzing the historical Chinese foreign direct investment in the shale gas industry. This method is based on the very general overview of past Chinese investment numbers to identify the future investment pattern.

In order to give a more detailed and accurate forecast of the investment, this thesis also conducts a qualitative analysis on the current investment. The qualitative analysis section reviews the industry M&A trend, current major players in shale gas asset acquisitions as well as the transaction information including investors, investment target, investment strategy and arrangements, demonstrated investment trend as well as the political implication behind the investment.
Following the qualitative analysis section is the political risk analysis on Chinese investment in US shale gas. The sensitive nature of Chinese investment implies there could be potential US policy barriers for Chinese investment. The analysis from this section gives an insight in the US government's attitude towards Chinese investment in US shale gas and evaluates the political hurdles for the investment.

The last analysis method used in this research paper is scenario analysis. Even with various driving factors considered among the previous sections, there are still scenarios out of the scope of this research paper that could have an impact on Chinese investment in US shale gas. This section analyzes some of these influencing factors on Chinese investment, review the occurrence of various scenarios and discuss their influence on the investment. With the scenario analysis, a more comprehensive forecast can be made.

2. Causal Model Building

![Causal model building in Chinese investment in US shale gas](image)
Through qualitative and political risk analysis, three major driving factors for Chinese investment are defined. These three factors include political will, economic efficiency as well as US policy barriers. The first two factors are being identified in the qualitative analysis section and the last factor is identified in the political risk analysis section. With the three factors, a causal model could thus be built:

- **Political Will**: The political will factor is the preliminary driving factor identified in this paper. The Chinese investors are major national oil and gas companies that follow the government’s will in learning the shale gas drilling technology. China’s need in its own shale gas development motivates the Chinese oil and gas companies to join the US shale gas boom in order to gain experience in shale gas development.

- **Economic Efficiency**: Economic efficiency factor is the value of the investment projects. Economic efficiency is reflected in China's choice between tight oil and dry natural gas. The low price of natural gas in the US is a major factor that directs investors, including the Chinese investors from dry shale gas investment to tight oil or wet shale gas.

- **Political Barriers**: Unlike the first two factors that are motivations behind Chinese investment, the last driving factor is the political force beyond the investment itself. The US's potential resistance or block of Chinese shale gas deals could alert Chinese investors and discourage future shale gas investment from China.

These three factors jointly influence Chinese investors’ decision making in investing in US shale gas. The political will, the attempt to learn the US shale drilling
technology, is the determining driving factor for Chinese oil and gas companies’ decision in investing in the US shale resources; while the economic efficiency factor, the valuation of US shale oil and gas resources, is the driving factor that directs Chinese investment into tight oil or shale gas in their investment; the US policy barrier is the factor that discourages future Chinese investment.
Chapter Five

Forecast with Extrapolation Analysis

1. Methodology Overview

In this section, this research paper will make a general forecast of the future trend of Chinese investment in the US shale gas industry through analyzing the past data on Chinese outgoing foreign direct investment, Chinese investment in global energy industry, Chinese investment in the US energy and more specifically Chinese investment in US shale gas. Through observing the history of China's investment in the past, futures investment trends can be forecasted. This methodology can only be used to make a

![Figure 13. China’s historical outbound investment](image)

Source: AEI Chinese Global Investment Tracker, 2005-2013
general forecast, and in order to paint a more accurate picture of the future investment trend, it needs to be combined with qualitative analysis and scenario analysis.

2. Analysis of China's Historical Global Investment

<table>
<thead>
<tr>
<th>Year</th>
<th>China's Investment in the US (million)</th>
<th>China's Investment in US Energy (Million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>$1,740</td>
<td>$0</td>
</tr>
<tr>
<td>2006</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>2007</td>
<td>$8,600</td>
<td>$100</td>
</tr>
<tr>
<td>2008</td>
<td>$6,770</td>
<td>$0</td>
</tr>
<tr>
<td>2009</td>
<td>$7,910</td>
<td>$1,680</td>
</tr>
<tr>
<td>2010</td>
<td>$8,820</td>
<td>$4,010</td>
</tr>
<tr>
<td>2011</td>
<td>$2,170</td>
<td>$200</td>
</tr>
<tr>
<td>2012</td>
<td>$9,340</td>
<td>$3,740</td>
</tr>
<tr>
<td>2013</td>
<td>$14,550</td>
<td>$2,860</td>
</tr>
</tbody>
</table>

Table 1. China's Investment in the US

Data Source: AEI Chinese Global Investment Tracker, 2005-2013

Figure 13 gives an overview of the history of China's outbound investment from 2005 to 2013. With China's quick economic growth, its outbound foreign direct investment has been increasing over time. The total investment amount rocketed from 10 billion in 2005 to over 80 billion in 2013. China's investment in the global energy industry has also jumped and stayed at a high level. In 2005, China's investment in the global energy industry was 6 billion dollars, and this number increased by 6 times to 36 billion dollars in 2013. In total, the energy sector has been China's top priority in global investment and accounted for almost half of China's total outbound investment. China's total overseas investment from 2005 to 2013 was 478 billion dollars, and the investment in global energy industry mounted to 225 billion dollars in total.
However, according to the data, only a small piece of China's global investment targets the US. China's total investment from 2005 to 2013 was $59.9 billion, which pales in comparison to the total global amount of 478 billion dollars. The investment in the US does not appear to have a clear correlation with the increasing Chinese global investment: even if the Chinese outbound investment has been growing over the years, the investment in the US has failed to demonstrate a trend of constant growth. Based on Figure 13 and Table 1, though a considerable amount of Chinese investment has flowed into the US, the investment is not growing steadily annually. For example, in 2006, the total amount of Chinese investment dropped to $0 from $1.7 billion in 2005, and this number skyrocketed into $8.6 billion the next year. Though the total amount of Chinese investment in the US has been growing in the past three years and reached an unprecedented $14 billion in 2013, whether this trend will continue is still an open question considering the historical fluctuant growth rate of Chinese investment amount in the US.

China's investment in US energy started to increase only very recently in 2008; however, the investment has remained at a low level and does not demonstrate a clear growing trend. The amount of Chinese investment in the US energy sector fluctuates from year to year. The most recent Chinese investment in the US increased more than 10 times from $200 million dollars in 2011\(^2\) to $3.7 billion in 2012 and then decreased by

\(^2\) In the AEI Global Investment Tracker, the two transactions made between and CNOOC Chesapeake Energy were both recorded in 2010, though the closure of CNOOC’s first investment agreement was announced in November 2010 and that of the second investment agreement was announced in February 2011. The slight time difference could be due
almost 900 million dollars to $2.8 billion in 2013.

The total amount of China's investment in US energy industry was $12.6 billion from 2005 to 2013, of which 4.8 billion dollars was in the shale gas sector. There were two investment deals in the shale gas industry in the time period, the first one was CNOOC's investment in Chesapeake Energy in 2010, with a total amount of $2.37 billion. The second one was Sinopec's investment in Devon Energy in 2012, with a total amount of $2.44 billion. These two deals did not demonstrate a continuously increasing trend in Chinese shale gas investment. As a matter of fact, in 2013, Chinese investment focused more on global conventional oil & gas industry and there was no growth in the investment amount in US shale gas.

3. Forecast Based on Extrapolation

Based on the historical investment data, a general forecast can be made on Chinese investment in US shale gas industry in the near future: though China's investment in the US has been growing, China is only initiating its investment in US energy, especially in the shale gas industry. The shale gas investment is at the beginning stage and does not demonstrate a clear growing trend. Historical data alone does not indicate that the shale investment is going to increase significantly and consistently in the near future (next 5 years) and is not sufficient to make a long term forecast.

The problem with this approach is that historical data only tells part of the story.

to the record method AEI adopted in data collection and it does not have a significant influence on the conclusion of this thesis.
Two issues stand out in this forecast and need to be considered in the conclusion:

China's historical increasing global investment shown in the data has been associated with its quick GDP growth, and this GDP growth has been slowing down recently. According to the World Bank country data, this GDP growth has decreased to 7.8% in 2012 from 9.3% in 2011, and is expected to go down further in the future (Yang, January 20th, 2014). The may also lead to a slowdown in China's global investment, including its future investment in the US in US shale gas.

China's investment in the US is generally speaking more heavily influenced by the US-China partner & rival relationship, which is one of the reasons why the Chinese investment US has not grown consistently with its investment globally. The investment from China is more likely to be affected by political oppositions compared to China's investment in other regions. China's growing investment in US shale gas could be stifled by potential barriers in policies and regulations or promoted by potential deeper partnership in the energy sector. For example, the US-China shale gas initiative launched by the US and Chinese government since 2009 has greatly facilitated China and US's cooperation in the private sector, and the investment could potentially increase at a faster rate with deeper governmental cooperation. However, if the Chinese investment receives another political objection from Washington DC like CNOOC's failure in investing Unocal in 2005, the Chinese capital may shy away again from the US (Atkinson, January 1, 2012). These political and economic factors and assumptions will be analyzed in the qualitative analysis, political risk analysis and scenario analysis sections.
Chapter Six
1. Methodology Overview

This section conducts a qualitative analysis on the economic driving factors and political incentives in China's investment in US shale gas. This approach is the main forecast method in this research project. Compared to the extrapolation method, qualitative analysis will provide more detailed information on investors, investment targets as well as the investment trend in both the long term and short term.

The qualitative analysis section will firstly give an overview of the current foreign investment environment in US shale gas and provide background information on the shale gas industry’s mergers and acquisitions general practice. Following the overview of foreign investment, a detailed review on the current Chinese investment details, including investor and investee profiles as well as transaction amounts and terms, will be conducted. Through a closer observation on the existing investment, the thesis will analyze the current Chinese investment strategy and also discuss the Chinese investors' purpose behind the investment. This analysis will allow a more accurate forecast to be made.

3 In this thesis, short term refers to within the next 5 years and long term refers to 10+ years.
2. Background: An Overview of Foreign Investment in US Shale Gas

Though the Chinese acquisition in US energy has made headlines lately in US social media, it does not stand out when put into the big picture. The US energy industry, though often described as an industry of strategic importance by the US government, has historically attracted foreign investment from many countries. According to Ernst & Young, foreign investment in the US oil and gas totaled approximately 112 billion between 2008 and 2013, and the majority of these deals are for ventures involving shale gas, as demonstrated in figure 14 and figure 15 below. The review of foreign investment in US shale gas energy in general will provide background information on the industry as well as US's general attitude towards foreign investment in shale gas.

Figure 14. Foreign investment in US oil and gas by sector

Source: Ernst & Young
Figure 15. Foreign investment in US oil and gas by country

The KPMG shale gas M & A report has described the US shale gas industry as "seeing consolidation, repositioning and the entry of new domestic and foreign investors into the sector" (KPMG, May 2012, P12). It has attracted investors of different sizes from all over the world. Besides foreign takeover of the whole US company or company shale assets, such as the Australian BHP Billiton Oil Company's acquisition of Houston based Petrohawk Energy Corp, another widely adopted approach in shale gas investment is setting up joint ventures between an American company and a foreign oil and gas company, which accounted for 20% of the total $133.7 billion of domestic and foreign investment in shale plays between 2008 and 2012 (EIA, April 8th, 2013). Joint venture is the approach Chinese companies as well as many smaller size oil and gas companies or companies without the shale drilling technology are taking. In these joint ventures,
foreign investors usually buy a percentage of the host company's shale play acreages through an upfront cash payment with a commitment to cover a portion of the drilling cost within an agreed-upon time frame (drilling carry). The foreign investor is the non-operation partner in this type of joint venture and the company that receives investment is the operator that may obtain the needed capital flow for their drilling activities. This joint venture model is adopted by the majority of the foreign investors other than the international oil and gas giants with existing operations in shale gas development such as BP and Royal Dutch Shell. Compared to the smaller size foreign oil and gas companies, the multinational oil and gas giants have a significant historical presence in the US market as well as the technology and operating experience required in shale gas drilling. The companies that receive the investment in the joint ventures are not

![Figure 16. Top 10 foreign owners in the selected plays](source)

**Top 10 Foreign Owners in the Selected Plays (Note 1)**

<table>
<thead>
<tr>
<th>Company</th>
<th>Net Acreage Holding</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Royal Dutch Shell</td>
<td>1,487,000</td>
</tr>
<tr>
<td>2 BHP Billiton</td>
<td>1,100,000</td>
</tr>
<tr>
<td>3 Statoil ASA</td>
<td>1,069,000</td>
</tr>
<tr>
<td>4 BP (exc. Haynesville – note 2)</td>
<td>550,000</td>
</tr>
<tr>
<td>5 Encana</td>
<td>535,000</td>
</tr>
<tr>
<td>6 CNOOC Ltd</td>
<td>466,000</td>
</tr>
<tr>
<td>7 Reliance Industries</td>
<td>313,000</td>
</tr>
<tr>
<td>8 Sinopec</td>
<td>285,000</td>
</tr>
<tr>
<td>9 Talisman Energy</td>
<td>282,000</td>
</tr>
<tr>
<td>10 BG Group</td>
<td>187,000</td>
</tr>
</tbody>
</table>

Source: Evaluate Energy Shale Play Database
American oil and gas conglomerates such as Exxon Mobil, but mid-sized oil and gas companies without deep pockets such as Devon Energy, Hunt Oil and Chesapeake who are seeking foreign capital for their operations (EIA, April 8th, 2013; Pennenergy, September 20, 2013).

As shown in figure 16 and figure 17, European companies are currently the biggest foreign shareholders in US shale plays. A very high percentage of the ownership is split between Netherlands Royal Dutch Shell, Norway Statoil and British Petroleum. Australian companies such as BHP Billiton also have a large share in shale asset ownership.

Compared to these companies, Chinese investors' shares concentrate in the relatively underdeveloped shale plays, except for the shale assets in Eagle Ford from...
CNOOC's deal with Chesapeake and in Marcellus Shale through a deal recently signed between Shenhua and ECA. For the Chinese investors, on one hand, the investment in underdeveloped shale gas reserves means there is no significant return yet; on the other hand, compared to other foreign investors, Chinese oil and gas companies are late in the game, and a concentration on less developed shale gas resources may have more potential in return generation in future shale gas development.

Based on the review of the current foreign investment in US shale gas market, two conclusions can be drawn:

(1) The US shale gas market is open to international financing. Foreign investors have taken a considerable share in the market and greatly contributed to the US shale gas development. Chinese energy companies, despite the attention drawn on them from US media, are only a few of the many foreign investors.

(2) International companies invest in US shale gas through direct asset purchase and joint ventures. While international energy conglomerate such as Shell and BP directly purchase shale gas resources, other foreign investors without the technologies, including the Chinese investors, are taking the second approach and partnering with small to mid-sized US energy companies in shale gas development.

(3) In the joint venture structure, foreign investment provides the essential capital for small to mid-sized American oil and gas companies in shale resources exploration and technology research and development hence mitigating operating risks for these companies. Therefore, the incoming foreign investment allows small-to-medium-sized
shale gas companies to operate independently and contribute to a booming shale gas industry. This explains the motive of the US to keep the shale gas market open to foreign investors.


3.1 Current Chinese Investment Overview

The following section reviews the current Chinese investment in the US, including the profiles of the involved parties as well as transaction details.

There are currently 5 deals in US shale resources, with 3 of them focused on shale gas and two of them focused on tight oil. Though tight oil is out of the scope of this research, this paper will also include the two oil transactions because the investment in tight oil is directly relevant to that in shale gas: (1) Shale gas and tight oil are both shale resources. The exploration of tight oil often comes with production of shale gas, and the exploration of shale gas adopts the same drilling technologies as the exploration of tight oil, including hydraulic fracturing and horizontal drilling. (2) The deals in tight oil and shale gas are structured in the same joint venture manner.
<table>
<thead>
<tr>
<th>Year</th>
<th>Investor</th>
<th>Amount (mil)</th>
<th>Stake</th>
<th>Invested Company</th>
<th>Field</th>
<th>Shale formations</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010/2011</td>
<td>CNOOC</td>
<td>$3,427</td>
<td>33%</td>
<td>Chesapeake Energy</td>
<td>Gas</td>
<td>3 formations[1]</td>
</tr>
<tr>
<td>2012</td>
<td>Sinopec</td>
<td>$2,440</td>
<td>33%</td>
<td>Devon Energy</td>
<td>Gas</td>
<td>5 formations[2]</td>
</tr>
<tr>
<td>2013</td>
<td>Sinochem</td>
<td>$1,700</td>
<td>40%</td>
<td>Pioneer Nat Resources</td>
<td>Oil</td>
<td>Wolfcamp Shale play</td>
</tr>
<tr>
<td>2013</td>
<td>Sinopec</td>
<td>$1,020</td>
<td>50%</td>
<td>Chesapeake Energy</td>
<td>Oil</td>
<td>Mississippi Lime</td>
</tr>
<tr>
<td>2014</td>
<td>Shenhua</td>
<td>$90[3]</td>
<td>50%</td>
<td>ECA</td>
<td>Gas</td>
<td>Marcellus Wells</td>
</tr>
</tbody>
</table>

[1] Eagle Ford, Denver-Julesburg (DJ) and Powder River Basins
[3] The transaction is ongoing

**Table 2. China's investment in US Shale Gas & Oil**

Source: China’s Global Investment Tracker, EIA; Company News Release

As mentioned above, the transactions between Chinese investors and American oil and gas companies fall into the joint venture category. All these transactions are structured similarly in three ways:

1. All the transactions include incoming capital from the Chinese investors in trade for a minority stake in the ownership in one or multiple specific sale formation(s).

2. The American companies remain the operators of the new joint ventures and are in charge of all the operating activities such as drilling, leasing, completion, operations and marketing activities in the joint ventures.

3. The majority of the deals, except for the Chesapeake-Sinopec deal in the Mississippi Lime play and Shenhua-ECA deal in Marcellus shale gas play, involve a drilling carry, where the Chinese companies agree to fund drilling and other expenses of the American partners besides the expenses of their own share for a predetermined length of time.
3.2 Investor Profile Review

There have been four Chinese companies investing in US shale gas, including Sinopec Group, SNOOC, Sinochem and Shenhua Group. To take a closer look at the current Chinese investment in the US, a detailed introduction to each individual of the four investors is given below.

Sinopec Group, also known as China Petroleum and Chemical Corporation, is one of the world's largest oil and gas companies with a size comparable to the other international oil and gas conglomerates: it is Asia's largest oil refining and petrochemical enterprise, and currently ranks 4th on the global fortune 500 list after Royal Dutch Shell (1st) and Exxon Mobil (3rd) and before CNPC (5th) and BP (6th), with about $386 billion in revenue (CNN Money, March 2014). Sinopec Group's business covers a variety of upstream and downstream oil and gas related activities, including oil and gas exploration, as well as sales of refined oil and gas chemical products. Sinopec Group's main subsidiary is internationally public traded company Sinopec Ltd, which Sinopec Group controls 73.38% of its total shares as of the first half financial year of 2013. Sinopec Ltd is responsible for major divisions of Sinopec Group's business, including oil and gas exploration, as well as oil and gas chemical products sales, imports, and exports (Sinopec Company News Release, March 22nd 2014). Sinopec Group currently has China's largest overseas investment, with a total amount of approximately 60 billion dollars investment in global energy industry from 2005 to 2013 (AEI, March 2014).
China National Offshore Oil Corporation, or CNOOC Group, is the largest offshore oil and gas producer and the third-largest national oil company by revenue in China, after CNPC and Sinopec Group (CNN Money, March 2014; CNOOC, 2014). Though its traditional business focuses on offshore oil and gas exploration, its operations have expanded to the downstream sector (EIA, Feb 2014). CNOOC ranks 93 on the global fortune 500 list in 2013, with 83.5 billion dollars of revenues (CNN Money, March 2014). CNOOC Group's major subsidiary is CNOOC Ltd, which is a public company listed in both Hong Kong and New York since 2001 and responsible for CNOOC Group's oil & gas exploration and sales (CNOOC, March 22nd, 2014). CNOOC currently has China’s third largest outbound investment in the oil and gas sector after CNPC and Sinopec (AEI, March 2014)

Sinochem Group, formerly known as China National Chemicals Import and Export Corporation, is China's fourth largest producer in oil and gas. It is also the largest agricultural input company (fertilizer, seed and agrochemicals) and its business spans over energy, agriculture, chemicals, real estate and financial service (Sinochem, March 2014). Sinochem ranks 113 on the global fortune 500 list in 2013, with around $71 billion in revenues. Sinochem currently owns more than 300 subsidiaries inside and outside China, including listed companies such as Sinochem International, Sinofert and Franshion Properties (Sinochem, March 2014). Despite Sinochem's significant size, its investment in global energy industry compared to Sinopec and CNOOC is relatively small: from 2005 to 2013, Sinochem's total overseas investment was only approximately $ 9 billion (AEI, March 2014).
Shenhua Group, with a rank of 178 on the global fortune 500 company list in 2013, is currently one of the world's largest coal producing companies and China's largest coal producer, with $54.518 billion in revenue (CNN Money, March 2014). Compared to CNOOC and Sinopec, Shenhua is a newcomer in the oil and gas industry and overseas investment. Though it has comparable assets as the other investors, most of its business focuses on domestic coal mining and coal-related projects, including coal chemicals, coal-liquids, coal generated electricity, and coal transportation such as ports and railroad (Shenhua Group, March 22nd 2014). According to AEI’s China global investment tracker, its overseas investment has been mostly in the coal industry, and its total investment from 2005 to 2013 was around 1.6 billion dollars, only a minimal portion of the total Chinese overseas energy investment (AEI, March 2014).

3.3 Existing Transaction Review

The closure of the investment transaction between CNOOC International Ltd, a wholly owned subsidiary of CNOOC Limited, and Chesapeake Energy Corporation was announced in November 2010. This investment was the first Chinese investment deal in US shale gas. CNOOC purchased a one-third undivided interest in Chesapeake's 600,000 net oil and natural gas leasehold acres in the Eagle Ford Shale project in South Texas. The consideration of the transaction was $1.08 billion in cash, plus an additional 40 million payment adjustment at closing. In addition, CNOOC also agreed to fund 75% Chesapeake's share of drilling and completion cost up to $1.08 billion, which Chesapeake expected to occur by year-end 2012 (Chesapeake Energy, November 2010). The closing
of a similarly structured deal between Chesapeake and CNOOC was announced later in February 2011, where CNOOC purchased one-third stake in Chesapeake's 800,000 net oil and natural gas acres in the Denver-Julesburg (DJ) and Powder River Basins in Northeast Colorado and southeast Wyoming for 570 million in cash, plus 66.7% of Chesapeake's share of drilling and completion cost up to $697 million, which is expected to occur by year-end 2014 (Chesapeake Energy, February 2011).

The second investment was made between Sinopec and Devon Energy. In January 2012, Devon Energy Corporation announced it has signed an agreement for a $2.5 billion investment with SIPC, Sinopec International Petroleum Exploration and Production Corporation, the subsidiary of Sinopec that is responsible for Sinopec's overseas oil and gas exploration, in exchange for a third of Devon's interest in the 1.3 million acres of oil and gas assets in five shale plays, including Tuscaloosa Marine Shale in Alabama and Mississippi, the Niobrara in Colorado, the Mississippian, the Ohio Utica Shale and the Michigan Basin shale plays. SIPC would also reimburse Devon Energy for drilling cost and acreage acquisition cost. According to the agreement, in total, SIPC makes a $900 million cash payment upon closing and $1.6 billion paid in the form a drilling carry expected to be realized by year-end 2014, which would fund 70% of Devon's capital requirements in operations (Devon Energy, Jan 2012).

The transaction between Sinochem and Pioneer Natural Resources as well as the transaction between Sinopec and Chesapeake Energy are tight oil focused. Tight oil and Natural Gas Liquids are also resources existing in shale formations and are often
explored with shale gas. Tight oil, also known as shale oil, is the petroleum equivalent to shale gas, the oil that consists of light crude oil contained in petroleum-bearing formations of low permeability, often shale or tight sandstone (Mills, 2008, P158-159)

Natural gas liquids (NGLs) are hydrocarbons and are in the same family of molecules as natural gas and crude oil. NGLs are composed exclusively of carbon and hydrogen, and include ethane, propane, butane, isobutene, and pentane. The shale gas that comes with a significant amount of NGLs are also called "wet gas"(EIA, April 20th 2012) The exploration of shale gas, tight oil and NGLs often come hand in hand and all adopt the drilling technologies such as hydraulic fracturing and horizontal drilling. The two investment deals took place in Mississippi Lime and Wolfcamp, the shale formations that contain mostly tight oil with a considerable amount of natural gas liquids (“The Mississipian Lime: Not New”, March 23rd 2014; “Wolfcamp Shale Graduates”, October 1st 2013). Hence, the two deals are categorized as investment in unconventional oil rather than natural gas, even though the shale plays also hold shale gas.

In May 2013, Pioneer Natural Resources announced it had signed the agreement with Sinochem Petroleum US LLC, a US subsidiary of the Sinochem Group, to sell 40% of Pioneer's interest in approximately 207,000 net acres leased by Pioneer in the Wolfcamp shale play for a total price of $1.7 billion. According to Pioneer Natural Resources' official website, Pioneer Natural Resources is the largest acreage holder in Wolfcamp shale play that is located in Permian Basin, western Texas and southeastern New Mexico. The Wolfcamp shale play is oil rich, and as of November 2013, Pioneer Natural Resources’ operations in Wolfcamp Shale delivered 3,605 oil equivalents per day,
with an oil content of 74%, according to Pioneer Natural Resources’ new release. In the agreement, out of the $1.7 billion, 500 million was the up-front portion of the transaction price before normal closing adjustments ($522 million after closing adjustments), and the remaining $1.2 billion was paid through Sinochem carrying 75% of the Pioneer Natural Resources' drilling costs within the next 6 years. Pioneer Natural Resources remains the operator for the drilling activities (Pioneer Natural Resources, May 2013).

In July 2013, Chesapeake announced the completion of its transaction with SIPC in the Mississippi Lime formation. Chesapeake is currently the largest leasehold owner in the Mississippi Lime formation, the predominantly oil-prone reservoir located across north-central Oklahoma and Kansas, according to Chesapeake's official website. The investment amount was $1.02 billion in cash, in exchange for 50% undivided interest in approximately 850,000 acres in north Oklahoma. 93% of the $1.02 billion was received upon closing, and unlike the other deals, there was no drilling carry and all the future costs would be shared proportionally between the two. Chesapeake is the operator for the joint venture and conducts all the operation activities for the joint venture (Chesapeake Energy, July 2013).

The most recent deal was between Shenhua American Holdings Corporation, the subsidiary of Shenhua Group, and Energy Corporation of America (ECA) in shale gas development. The deal was announced in December 2013 and the total investment amount has not been announced as of the day of the thesis. Shenhua and ECA entered into a 50/50 joint venture to develop 25 natural gas wells in Greene County PA, in the
Marcellus shale play, over the 18 months after December 2013. In the joint venture, the first $90 million is contributed by Shenhua and the rest of the drilling cost is split evenly between the two (ECA, December 27th 2013).

3.4 Investment Strategy Analysis and Investment Forecast

As stated above, the Chinese companies’ investment strategy is buying a minority stake in shale resources in American companies through joint ventures. With the investment strategy clear, we may identify the potential investors and investees.

The target companies for Chinese investors in this investment strategy are small to medium energy firms with a focus on unconventional natural gas resources exploration in the US. These companies, though decent in size, are in need of capital from the enormous Chinese energy conglomerate for business development purpose and are solely responsible for operations in the joint venture. For example, out of the four companies that have received the investment, Chesapeake, Devon Energy and Pioneer Natural Resources are public companies each with around 30 billion USD in total enterprise value as in March 2014, which is mid-sized in the energy industry (Yahoo Finance, March 2014). Energy Corporation of America is a Denver-based privately held company with a smaller size. It currently has about 4,600 wells, which is the less than half of the over 10,000 wells owned by Pioneer Resources, the smallest one out of the three (ECA, March 2014; Pioneer Natural Resources, March 2014).

The Chinese companies that invest in American companies must be able to afford the expensive and risky shale gas development project and cover a considerable
percentage of the drilling cost for their American partners. This has identified the scope of future Chinese investors in US shale gas-- major Chinese oil and gas companies with deep pockets.

The Chinese energy industry has been one of the few industries that the Chinese government has not loosened control on and is currently dominated by four national oil companies including China National Petroleum Corporation (CNPC), China Petroleum and Chemical Corporation (Sinopec), China National Offshore Oil Corporation (CNOOC), and Sinochem. All four companies are among the global fortune 500 companies and are state-owned enterprises managed by the State-owned Assets Supervision and Administration Commission (SASAC), directly under the State Council. The SASAC represents the ownership of the Chinese central government, "performs investor's responsibilities, supervises and manages the state-owned assets of the enterprises under the supervision of the Central Government"(SASAC, March 22nd).

These four companies all have a variety of upstream and downstream oil and gas assets, yet with different focuses. CNPC has a focus on upstream assets, with its subsidiary PetroChina accounting for an estimated 53% and 75% of China's total oil and

<table>
<thead>
<tr>
<th>Company</th>
<th>Investment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sinopec</td>
<td>$60,280</td>
</tr>
<tr>
<td>CNPC</td>
<td>$59,300</td>
</tr>
<tr>
<td>CNOOC</td>
<td>$35,530</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$155,100</strong></td>
</tr>
<tr>
<td><strong>Total Chinese Investment in Global Energy</strong></td>
<td><strong>$225,870</strong></td>
</tr>
</tbody>
</table>

**Table 3. Top Chinese Investors in Global Energy**
Source: Chinese Global Investment Tracker, 2005-2013
natural gas output. Sinopec focuses on downstream assets, which currently makes up over 76% of its revenues. CNOOC has been historically focusing on offshore oil and gas exploration. Sinochem's business includes the producing and trading of oil, fertilizer and other oil-related chemical products (EIA, Feb 2014).

These national oil and gas companies, especially Sinopec, CNPC, and CNOOC, have a historical record of investing in foreign oil and gas assets. The majority of Chinese outbound investment in the energy industry derives from the three largest Chinese national oil companies. As shown in figure 18, the Chinese overseas investment is led by Sinopec, CNPC and CNOOC, with the same order as their sizes by revenue. According to the AEI China global investment tracker 2005-2013, the three companies combined account for almost two thirds of the total Chinese investment in the energy industry. The rest of the investors are comparatively small in investment amount: the fourth largest investor in energy, China Investment Corporation has invested less than 10 billion over the same period, less than a third of CNOOC's overseas investment.

Three out of the four National Oil Companies, Sinopec, CNOOC, and Sinochem, have already invested in US shale oil and gas. The other investor, Shenhua Group, is not among the four major oil and gas conglomerates. Shenhua has an operation focus on coal and its deal size so far ($90 million) is relatively speaking minimal compared with the other deals. Therefore, we can expect CNPC, Sinopec, CNOOC and Sinochem to keep being the major source of investment in the future while companies like Shenhua Group will be a minor source. Plus, the current investors, including Shenhua are all
well-financed Chinese state-owned energy companies. These state owned companies are likely to continue to be the main source, if not the only source of future Chinese investment.

Though CNPC, the other major Chinese oil and gas company aside from Sinopec, CNOOC, and Sinochem, has not invested in US shales yet, it has demonstrated its interest in investing: CNPC has announced that it was "currently studying" investing in the US shale gas and has openly expressed its desire to double its overseas oil production to 4 million barrels a day by 2015. Moreover, though CNPC hasn't entered the US market, it already invested in shale acreages of Encana Group in Canada in December 2012 (“CNPC Reading $40 Billion”, March 2013). It is reasonable to believe that it is only a matter of time before CNPC starts to invest in US shale gas.

Based on the analysis above, the following forecast can be made:

In the near future, CNPC will participate in the US shale gas boom. As other major Chinese energy companies have already entered the US shale gas industry, CNPC has also expressed its willingness to participate. Hence, we may expect new deals between CNPC and independent American oil and gas companies to come up in the near future.

Over the long term future, the majority, if not all of the future investment will keep coming from the large Chinese state-owned conglomerates, specifically Sinopec, CNPC, CNOOC and possibly Sinochem. This is because these national oil and gas companies have historically dominated the Chinese domestic market and overseas
investment. With the strong financial record, they are able to bear the financial burden in the joint venture strategy with US oil and gas companies. The potential of investment in global energy industry from smaller Chinese investors or private Chinese investors in the future is limited.

3.5 Investment Political Implication Analysis and Forecast based on the Analysis

As mentioned above, all the current Chinese investors are national oil and gas companies. These Chinese companies are all under the management and direction of the Chinese central government, thereby providing the Chinese investments in US shale gas its political implications: China has a goal of replicating the US's shale gas boom.

As analyzed in the “Shale Gas in China” section above, shale gas development has become a promising solution to China's energy needs. China has started developing its shale gas resources and has seen some impressive progress being made. According to China's "12th 5-year plan on shale gas development" published by China's Ministry of Energy in 2012, China is planning on producing 6.5 billion cubic meters (about 230 billion cubic feet) of shale gas by 2015, and this number is expected to increase tenfold by 2020.

This goal has been criticized for being too ambitious under current conditions. The two largest oil and gas companies, CNPC and Sinopec have announced shale gas development projects in China yet their production projection hardly met the expectation. CNPC and Sinopec, which combined own almost 80% of China's shale gas resources,
have together targeted shale gas production at around 95 Bcf in 2015, and this goal is only half of that set by the government for 2015 (EIA, February 2014). By comparison, the US produced about 9,394 Bcf in 2012 (Haas, Benjamin, Feb 2014). Researchers at the Paulson Institute have estimated that China would need to invest about $350 billion if it wants to meet a 2020 target of 60 billion to 100 billion cubic meters annually (Haas, Benjamin, Feb 2014).

China's shale gas operations are faced with many challenges. 1) The majority of China's shale basins are located either in the mountainous terrain of deserts, which has raised the question of whether there will be sufficient water available for the water consuming shale drilling operations. 2) The difficult geological conditions also rendered shale gas operations in China costly. For example, according to economists at CNOOC, a single shale gas well in costs about $15 million, and in comparison, the cost per well in Arkansas's Fayetteville shale in the US is about $2.3 million (Haas, Benjamin, Feb 2014). 3) With the Chinese government regulated cheap natural gas price, this situation has become even worse. According to CNPC researchers, the company could lose about 10 cents on each cubic meter sold under the current system as unconventional gas is sold at the same price with the cheaper conventional gas (Haas, Benjamin, Feb 2014).

However, it is too soon to tell if there will be a Chinese shale gas boom. There is an upside in this story. CNPC and Sinopec have achieved some technological breakthroughs in their shale gas operations. Both companies announced they had mastered the technologies needed for shale gas exploration (Chongqing Daily, March
According to EIA's latest China country report, Sinopec has recently achieved success in its Fuling Shale operations, which has resulted in the company's doubling its shale gas output goal, "making the government's overall shale gas targets seem more feasible" (EIA, February 2014).

In addition, China is also opening its shale resources to foreign investors in hope of encouraging technological development and capital inflow. The current foreign investors in the field are the multinational oil and gas conglomerates including Royal Dutch Shell, Chevron and PhilipConocos. In March 2012, Shell and CNPC signed the first agreement in Fushun-Yonghchuan block of shale gas in Sichuan basin for jointly production. Shell has also partnered with Sinopec and CNOOC on two other shale gas plays. Plus, Shell has pledged to invest over 1 billion each year in the next five years to develop China's shale gas resources (“Shell and CNPC to Jointly Seek Shale Gas”, March 26th 2014; EIA, February 2014). Besides Shell, Chevron and ConocoPhilips are also working with Sinopec in the Qiannan and Sichuan Basins, respectively in Southwest China (EIA, February 2014).

With China's ambition in shale gas revolution in mind, the Chinese companies' investment is more than a simple foreign asset purchase, but also an effort to learn from advanced drilling technologies as well as building partnerships with unconventional oil and gas companies for their own shale gas development.

The terms in the deals facilitate a technology transfer between the Chinese and American partners in the joint venture structure. Though the current US investment does
not feature a clear technology buyout term in the agreements, it is most certain the joint venture structure in the deals allows the Chinese companies to gain more insight in US shale gas exploration: in the Sino-American shale gas joint ventures in the US, with little, if not at all, previous experience in shale gas development, the Chinese partners participate through buying a minority stake in American oil and gas companies' shale assets and funding their partner’s drilling cost, and the American companies in the deals are solely responsible for all the operating activities. Through this partnership, the Chinese companies may learn about the technologies in terms of shale assessment and infrastructure construction from their partner's operations. Zhong Hua, chief financial officer of the publicly traded arm of China's CNOOC, said in an interview that the company's U.S. exposure will advance its technical know-how: "With the U.S. experience, the company is fully capable of developing and deploying its own technologies within a short period of time in the coming years" (Dezember and Areddy, March 6, 2012).

China is also acquiring drilling technologies through investing in shale gas in Canada. Though the investment activities have been limited to setting up joint ventures so far in the US, the Chinese investors are also conducting shale oil and gas company takeovers in Canada. In February 2013, CNOOC finished its $15.1 billion takeover of the Canadian oil and gas company, Nexen, with significant operations in shale gas development, which is China's largest foreign takeover in history (Rocha, Euan, February 2013). If buying a minority in US shale gas operations still leaves the occurrence of inter-firm technology transfer in question, it is without question that intra-firm
technology transfer is happening between CNOOC and its wholly owned subsidiary Nexen.

China's investment in the US is also Chinese companies' effort in seeking partnership with American companies to pave the way for their cooperation in China's shale gas development. When speaking on the Devon Energy and Sinopec deal, David Hager, the spokesperson of Devon Energy, "The most likely outcome (of Sinopec and Devon's cooperation in the US) is that they (Sinopec) would want us to participate with them in China" (Dezember and Areddy, March 6, 2012).

The purpose of the Chinese investment is not for the resources itself, but to improve domestic resource exploration in the long run. Hence this type of investment has a transition nature. The investment does not make more economic sense than the alternative of conventional oil and gas acquisition, as shale gas exploration is generally speaking riskier than conventional oil and gas exploration and the joint venture structure does not grant investors full ownership of the assets. As soon as the purpose behind the investment, in this case, technology transfer and partnership building, no longer exists, the investment may very likely discontinue as a consequence. With all the hurdles faced by the Chinese shale gas industry, if the shale gas resources do prove to be out of the reach for Chinese companies due to either technological or geological reasons, the Chinese investors may stop investing in US shale gas as there will be no need for drilling technology transfer or partnership building for shale gas development.
Even if the Chinese shale gas proves to be explorable, this investment trend may no longer continue in the long run. Though foreign investment facilitates China's domestic shale gas exploration, foreign technology transfer can only improve China's drilling technologies to a certain extent, considering the differences between China and US's geological conditions. Once the Chinese oil and gas companies have learned the initial shale gas drilling technologies, the geological difference will require the Chinese companies to focus more on independent technology research and development rather than technology transfer (Cao, May 2012).

It is anticipated that in the event of another shale gas boom occurs in China, more foreign investors like Shell will flock in the Chinese shale gas market and look for joint venture opportunities with Chinese companies once the Chinese government loosens regulations on foreign investment in shale gas, just as the investment fever in the US shale gas industry. This type of joint ventures may also facilitate a drilling technology transfer between Chinese companies and foreign oil and gas investors with more experience in shale gas development, and moreover, these joint ventures will mostly likely provide room for technology research and development with a focus on China's geological conditions. The joint venture activities in Chinese shale gas will defeat the purpose of Chinese companies looking for joint venture opportunities with partners in the US, as the technology transfer and partnership opportunities through joint ventures will show up at their door.
In short, there will also be a switch in Chinese oil and gas companies' investment geographic focus if a similar shale gas boom happens in China. Once the Chinese shale gas reserves has demonstrated a more realizable potential in exploration with success in investors' drilling activities, the giant profitability will keep investors' capital in the domestic market and even attract more international capital. China's oil and gas companies will invest more heavily in domestic resource exploration and drilling technology research and development. This will undermine the Chinese investors' capability to continue investing in US shale gas and make them focus on the domestic market.

Based on the analysis above, the following forecast can be made:

China's ambition in domestic shale gas development and the promising picture in domestic shale gas production imply China's continuous investment in US shale gas asset in the near future. China's effort in its shale gas development has seen some promising results, which motivates China to keep investing in the US shale gas in the hope of gaining more experience and further boosting its technology innovation.

However, the motive of domestic shale gas development also limits China's investment in US shale gas in the long run. As the purpose behind the investment is technology transfer, this investment trend is likely to discontinue once domestic shale gas development is found to be unachievable or the Chinese investors have developed the advanced shale gas drilling technology and developed a Chinese shale gas boom.
3.6 Tight Oil, Wet Gas and Dry Gas: Investment Trend Analysis and Forecast

One of the trends the past Chinese investment has seen is that Chinese companies preferred to invest in shale gas resources with tight oil content and wet natural gas-- the natural gas with significant amount of natural gas liquids (NGLs) rather than traditional dry natural gas. In 2013, the joint venture set up by Sinochem and Pioneer Natural Resources as well as the one set up by Sinopec and Chesapeake are both in shale plays with mostly tight oil than dry shale gas.

The reason behind the investment focus switch is the decreasing average price of natural gas. As shown in the graph below, according to the US Bureau of Labor's statistics, the Producer Price Index (PPI)\(^4\) for natural gas, measured on an annual average basis, fell 56.8 percent between 2007 and 2012 (US Bureau of Labor, May 20th 2013). This decreasing price in natural gas is the result of the increasing natural gas production and flat consumption in the US. Though according to EIA analysts, it is hard to quantify precisely the effect of shale gas production on natural gas prices as the tracking period of shale gas boom is too short, yet it has become well acknowledged that the shale gas boom has contributed to a declining trend in annual natural gas prices. As EIA noted, "increased natural gas supply tends to dampen prices. In turn, lower prices can erode incentive for drilling, which eventually results in decreased production" (US Bureau of Labor, May 20th 2013).

\(^4\) PPI measures the average change over time in the selling prices received by domestic producers for their output.
In reaction to the market condition of natural gas, there has been a shift in the industry mergers and acquisitions focus. With a dropping natural gas price, investors have been more attracted to shale reserves with more natural gas liquids and tight oil content such as Bakken and Eagle Ford formations in the past few years (KPMG, 2012). Moreover, according to the KPMG Shale Gas Outlook report, the rising volume of NGL is also likely to depress NGL pricing relative to that of oil, which will, just like what has happened to the natural gas price, diminish the attractiveness of wet gas shale (KPMG, May 2012). Currently the Natural Gas Liquids Price has not demonstrated a sharp drop yet, but the ample supply, flat or moderating demand, export constraints and domestic infrastructure constraints have kept the natural gas liquids price flat or moderately down from 2012 to 2013 (EIA, July 29th, 2013)
With the analysis above, it can be forecasted that, in the near term, due to the market continued oversupply in comparison to the flat demand of natural gas, the higher return on investment in the tight oil and wet gas shale reserves will appeal more to Chinese investment in comparison to dry natural gas shale reserves, as tight oil and NGL production also provides Chinese investors with the same insight in the drilling technologies and generates more value than dry gas.

In the long term, however, there could be a change in natural gas prices. According to the EIA Annual Outlook 2014 Early Release, natural gas prices are expected to grow within the next two decades, driven by faster growth of the consumption of natural gas in the industrial and electric power sectors and growing demand from natural gas exports at LNG facilities (EIA December 16th, 2013). Even though the Chinese investment in US shale gas is not expected to grow substantially in the long run in the previous forecast section, if the natural gas market was heated enough, Chinese investors could nevertheless be lured into the shale gas market for the high evaluation of shale gas reserves instead of shale drilling technologies. Should that happen, Chinese companies would be more likely to conduct major natural gas asset acquisition than setting up joint ventures. However, China’s acquisition of shale gas also depends on the US government attitude, especially if the investors want to take over shale gas assets and companies instead of setting up joint ventures. This factor will be analyzed in the following political risk analysis section.
Chapter Seven

Forecast with Political Risk Analysis

1. Methodology Overview

The third method used in this project is political risk analysis. Political risk refers to "the risk of a strategic, financial, or personnel loss for a firm because of such nonmarket factors as macroeconomic and social policies (fiscal, monetary, trade, investment, industrial, income, labor, and developmental), or events related to political instability (terrorism, riots, coups, civil war, and insurrection)"(Kennedy, 1988, p. 21) In this case, the political risk for Chinese companies is the US policy barriers towards Chinese investors. Through the analysis of political risks facing Chinese investors, the conclusion drawn will be combined with the conclusions from the previous two sections to make a comprehensive political economic forecast both in the long term and short term.

Chinese investment in the US shale gas has received a lot of attention due to its sensitive nature. The energy industry is defined as one of the critical industries in terms of US national security. After the September 11th terrorist attack Congress passed and President Bush signed the US PATRIOT Act of 2001 (Uniting and Strengthening
America by Providing Appropriate Tools Required to Intercept and Obstruct Terrorism), which provided a special support for "critical industries", including a list of industries such as energy, telecommunication, financial services and water that is regarded "so vital to the United States that the incapacity of destruction of such systems and assets would have a debilitating impact on security, national economic security, national public health or safety, or any combination of those matters" (Jackson, March 6th, 2014). In addition, the Homeland Security Act added key resources to the list of critical infrastructure/Key Resources (CI/KR), which consist of 18 sectors including the energy sector (Jackson, March 6th 2014).

In this case, the investment is even more sensitive as it originates from Chinese state-owned oil and gas companies. Though the previous sections have concluded that the reason behind the investment is the Chinese companies' desire to learn the shale gas drilling technology instead of controlling American oil and gas companies, there is still a high level of national security concern in China's investment in the US. What is the attitude of US government towards Chinese investment? How likely is it that there will be potential political objection? This section will analyze the current US government's policy on Chinese shale gas investment.

2. Background: Chinese Investment in the US and the US's General Reaction

As analyzed in the extrapolation section, China's investment in the US has been growing over the years and reached a record high of more than $14 billion in 2013. However, the US as the largest economy in the world, is hardly China's top investment
market. China's stake in the US is relatively small compared to that in the leader Britain with more than $440 billion and Japan, the second largest Chinese investment holder, with roughly $300 billion (Eckert, June 9th, 2014).

One of the most obvious reasons behind the relatively speaking small investment number is the political barrier that Chinese investment has been facing in the US.

When it comes to foreign investment, the US government scrutinizes the transaction and its impact thoroughly when the foreign investment could potentially pose a threat to national security. This is especially the case when the investment originates from a foreign government, not to mention China and US have a historically bittersweet relationship. State-owned companies are a major source for Chinese outbound investment, though currently the majority of Chinese investment is from private investors. According to a report by the Rhodium Group, a New York based firm that looks closely at Chinese investment, private firms and high worth individual investors accounted for 87 per cent of the transactions and 76% of the total value of the investment in 2013 (“Chinese Investment Doubled”, Jan 8th, 2014). However, when it comes to Chinese investment, even private firms are often under investigation as they are suspected to be associated with the Chinese government indirectly, such as the cases in Huawei and Shuanghui.

This policy barrier makes the Chinese potential investors question the US's attitude towards foreign investors. As 65th United States Secretary of State, Colin Powell once remarked, "money, capital, is a coward; it will go nowhere where it is put in fear" (Colin Powell, April 23rd, 2002). The Chinese companies, in this case also tend to shy
away from the investment when they are put under the spotlight by the government. According to April Kappler, the state official in charge of drawing investment from Asia in North Carolina, "A lot of these (Chinese) companies want to invest in the U.S., but they want to stay under the radar because there's a level of anxiety related to Chinese investment" (Eckert, June 9th, 2014).

3. An Introduction to Committee on Foreign Investment in the United States (CFIUS)

The key US government entity in Chinese investment approval is Committee on Foreign Investment in the United States (CFIUS), an inter-agency government committee addressing the national security concerns in foreign investment in the US.

Originally established by an Executive Order of President Ford in 1975, the Committee was established to monitor the impact of foreign investment in response to the congress's growing concern over the political motives behind the rapid increase in investments by Organization of the Petroleum Exporting Countries (OPEC) countries in American portfolio assets (Treasury securities, corporate stocks and bonds). Since it was founded, CFIUS's power has grown tremendously. Through the Exon-Florio provision of Omnibus Trade and competitive Act of 1988 passed by the US Congress over the concerns over Japanese FDI, the president was granted the authority to suspend or prohibit any foreign acquisition, merger or takeover of a US business where the transaction was determined to threaten the national security of the United States. In 1992, Exon-Florio was amended to require an investigation of any merger, acquisition or
takeover by companies controlled by a foreign government which could affect the national security of the United States. The mandate of CFIUS was later expanded significantly again with the Foreign Investment and National Security Act of 2007 (FINSA) as a response to the congressional debate over a UAE state-owned company Dubai Port World's acquisition in the US in 2005 (Boker Botts, August 30th 2013).

Now chaired by the US Department of Treasury and consisting of representatives from nine federal agencies, including the US Departments of Defense, State, Commerce, Energy, Justice, Trade, Science and Technology Policy and Homeland Security, CFIUS is an inter-agency committee authorized to review transactions that could result in control of a U.S. business by a foreign person ("covered transactions"), in order to determine the effect of such transactions on the national security of the United States. CFIUS may review, investigate, and recommend blocking the transactions to the US president once they determine that the transaction could result in threats for the national security of the US (Jackson, March 6th 2014).

The law allows CFIUS to review all covered transactions to determine whether a transaction threatens to impair the national security, or the foreign entity is controlled by a foreign government, or it would result in control of any "critical infrastructure that could impair the national security" (Jackson, March 6th 2014).

The control of a US business means the power to direct or decide important matters affecting the business, which may include the power to appoint and dismiss officers, select new lines of business or control the finances of a company. CFIUS
provides a very broad view of how "control" can be acquired, including through the ownership of a majority or dominant minority of the total outstanding securities, proxy voting or contractual arrangements (Baker Botts, August 30th, 2013).

Essentially, CFIUS has jurisdiction to review almost any foreign investment transaction that may have an impact on national security. According to the report of Baker Botts LP, an international law firm, the only foreign investment that is out of the scope of CFIUS's review is the so called "greenfield investments", where a new venture is built and no existing business is being acquired. All other transactions, regardless of the nationality of the acquirer or the type of business - must be analyzed at least at a superficial level (Baker Botts, August 30th, 2013).

Filing a CFIUS review is voluntary and there is no requirement for companies to file a request for review when it comes to foreign investment, though the CFIUS have the authority to initiate a review and even unwind the transaction after the investment has been closed or executed should there exist a threat to US national security. The CFIUS's review process usually takes a 30-day initial review, which could lead to another 45 days of investigation if CFIUS determines that the deal could threaten the US national security. After the initial review and additional investigation, in extreme cases, as most of the companies will either restructure their deals to gain approval or withdraw their acquisition before a deal reaches this stage, CFIUS will refer the transaction to the president, who will make a final decision on whether to block or unwind the transaction within 15 days (Jackson, March 6th 2014).
Generally speaking CFIUS's review process has a quite high complete rate, and most of the transactions were withdrawn during the review and investigation process. As shown in table 4, according to the CFIUS annual report 2013, during the period of 2008-2012, CFIUS reviewed a total number of 538 proposed foreign mergers and acquisition cases, out of which 467 transactions, or 87% of the total transactions were completed, 70 transactions withdrew in the review or investigation, and only one transaction received a president's decision, which will be discussed below in the following section.

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Notices</th>
<th>Notices Withdrawn During Review</th>
<th>Number of Investigations</th>
<th>Notices Withdrawn During Investigation</th>
<th>Presidential Decisions</th>
</tr>
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<tr>
<td>2008</td>
<td>155</td>
<td>18</td>
<td>23</td>
<td>5</td>
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<td>2009</td>
<td>65</td>
<td>5</td>
<td>25</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>2010</td>
<td>93</td>
<td>6</td>
<td>35</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>2011</td>
<td>111</td>
<td>1</td>
<td>40</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>2012</td>
<td>114</td>
<td>2</td>
<td>45</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>538</td>
<td>32</td>
<td>168</td>
<td>38</td>
<td>1</td>
</tr>
</tbody>
</table>

*Table 4. Number of Transactions Reviewed by CFIUS, 2008-2012*

*Source: CFIUS, Annual Report to Congress, December 2013*

4. CFIUS and China's Investment in the US
The power of CFIUS makes it one of the major obstacles in foreign investment in the US especially for Chinese companies. Considering the structure of the relatively more government-oriented Chinese economy, Chinese investors are often suspected to be connected with the government, not to mention that in the oil and gas industry, the major investors are state-owned companies. As contributors from Mondaq, a global legal research company put it, "Chinese projects may have raised more questions than projects from other countries because of their substance, but they may also raise more questions because they are Chinese" (Burk and Feldman, January 31st, 2014), even Chinese private investors often seem suspicious to the US government. According to the Annual Report

<table>
<thead>
<tr>
<th>Country</th>
<th>Manufacturing</th>
<th>Finance, Information and Services</th>
<th>Mining, Utilities and construction</th>
<th>Wholesale Trade and Retail Trade</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>UK</td>
<td>32</td>
<td>28</td>
<td>3</td>
<td>5</td>
<td>68</td>
</tr>
<tr>
<td>China</td>
<td>20</td>
<td>7</td>
<td>12</td>
<td>0</td>
<td>39</td>
</tr>
<tr>
<td>Canada</td>
<td>2</td>
<td>10</td>
<td>18</td>
<td>1</td>
<td>31</td>
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<tr>
<td>France</td>
<td>20</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>28</td>
</tr>
<tr>
<td>Japan</td>
<td>14</td>
<td>6</td>
<td>1</td>
<td>2</td>
<td>23</td>
</tr>
<tr>
<td>Israel</td>
<td>8</td>
<td>8</td>
<td>0</td>
<td>1</td>
<td>17</td>
</tr>
<tr>
<td>Netherlands</td>
<td>3</td>
<td>8</td>
<td>2</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>Sweden</td>
<td>4</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>13</td>
</tr>
<tr>
<td>Total</td>
<td>132</td>
<td>109</td>
<td>52</td>
<td>25</td>
<td>318</td>
</tr>
</tbody>
</table>

Table 5. Number of Transactions Reviewed by Countries and Industries, 2010-2012

Source: Annual Report to the Congress, CFIUS, December 2013
to Congress, China has become one of the countries with most investment transactions under CFIUS review. In 2012, China surpassed the United Kingdom as the source for the largest number of foreign investments undergoing national security reviews, with 23 deals reviewed within the year 2012, out of the 29 deals undergoing review that are from countries that are non-allies of the US (Burk and Feldman, January 31st, 2014). The CFIUS annual report specifically identified a few perceived threats specifically targeting non-ally investment countries, in this case, primarily China, including: the transactions are controlled by a foreign government; the transactions are from a country with a record on nonproliferation and other national security-related matters that raise concerns; have historical records of taking or intentions to take actions that could impair U.S. national security.

With the historically unprecedented amount of Chinese investments under review by the CFIUS, there was also a large jump in the numbers of transactions withdrawn from 6 in 2011 to 22 in 2012. The CFIUS report shows that 20 out of the 22 transactions were withdrawn during the investigation period, which indicates there were problems in the transactions arising during the investigation period, compared to when during the 2008 financial crisis, most transactions were withdrawn during the initial period indicating the impact of an economic collapse on the investment. 10 of these 22 transactions were not refiled, which implies that those deals could not get approved by CFIUS even with additional time taken to revise the deal structure (Loeb, February 5th, 2014). Though CFIUS does not expressly disclose the nationalities of the withdrawn reviews, analysts
have argued that it was safe to surmise that the jumps in the number of withdrawn transactions from 2011 to 2012 largely mirrors the jump in the number of Chinese transactions under review (Burke and Feldman, January 31st, 2014; Loeb, February 5th, 2014).

One of the most eye-catching case was in September 2012, recommended by the CFIUS following a review and an investigation, President Obama issued an executive order for Ralls Corporation, the American subsidiary of the Chinese privately-owned company Sany Group, to divest itself from an Oregon wind farm project, as the placement of the wind turbines by Ralls was near or within restricted Naval Weapons Systems Training Facility airspace where drones are tested (Jackson, March 26th 2014; Flannery, September 13th, 2011). This is the second time the president of the US issued such an order since the authority was granted in 1988, after President Bush in 1990 using the authority to direct coincidentally another Chinese company, China National Aero-Technology Import and Export Corporation to divest its acquisition of MAMCO Manufacturing (Burke and Feldman, January 31st, 2014; Jackson, March 26th, 2014). Ralls later filed a suit against the president for his decision in the United States District Court for the District of Columbia yet this case was dismissed for the court ruled it has no jurisdiction (Jackson, March 26th 2014). There is quite a surprise factor in this case, as a lawyer from Law 360, an online legal news publisher put it, "Who would have predicted, a few years ago, that geographic "proximity" to sensitive locations would become a dominant element of CFIUS' analysis?"(Loeb, February 5th, 2014) Yet, the "proximity to
military facilities" factor has become one of the deciding criteria in terms of CFIUS's decision for many Chinese acquisition and takeover deals, according to Bloomberg News report, before the wind farm deal, CFIUS previously had blocked at least three transactions that would have resulted in Chinese companies gaining control of assets near sensitive facilities (Penty and Forden, March 1st, 2013).

Another Chinese investor that has stirred political debate widely in the US is Huawei's investment in the US, which has triggered a political dispute beyond a review from CFIUS. As the world's largest manufacturer of telecom equipment after Telefon AB L.M. Ericsson, the alleged Chinese privately owned company Huawei has been accused by the US government for their potential leakage of confidential US government information to the Chinese government. In 2011, due to the US political opposition, Huawei decided to withdraw its purchase of assets and technology from 3Leaf systems, after the CFIUS recommended against the deal and before President Obama made a final decision (Raice and Dowell, February 22nd, 2011).

The debate over Huawei was not over after the withdrawal of the transaction. In October 8th, 2012, the US congress released a report accusing Huawei and another Chinese company ZTE for threatening the US's national security and suggested that these two companies be blocked from acquiring any assets in the US. The report pointed out these Chinese companies' could be participating in illegal activities including bribery, corruption and immigration law violations as well as having a close relationship with the Chinese government. According to the report, "private-sector entities in the US are
strongly encouraged to consider the long-term security risks associated with doing business with either ZTE or Huawei for equipment or services" (Roberts, October 8th, 2012). This has further led to a political conflict when the Chinese foreign ministry in return "demanded explanation" from US National Security Agency (NSA) as NSA was proved to be hacking into Huawei and the government network of other countries such as Iran and Pakistan that use services produced by Huawei, based on the document leaked by Edward Snowden (Wan, March 24th, 2014).

Despite the rejection cases such as Huawei and Ralls Corporation, there has been success in China's investment in the US. For example, Shuanghui's investment in the US went more smoothly. In May 2013, China's Shuanghui International Holdings announced it would acquire the Smithfield for $4.72 billion or $7.1 billion including the company debt and the acquisition was closed later in September after a review and investigation from CFIUS. The deal made so far the largest Chinese acquisition in the US (Barttlein, September 24th 2013). Smithfield Foods is the leading US pork packer and producer, capturing about 26% share of the domestic U.S. hog market and produces around 20-22 million hogs per year, compared with the Chinese market that slaughtered nearly 694 million hogs in 2012 (Jackson, March 6th, 2014).

Though Shuanghui was also a private company and its business is not high-tech focused, a few lawmakers have aired concerns about the company's safety record, and argued the acquisition could lead to Shuanghui stealing Smithfield's intellectual property. On September 6th, 2013, after the 30-day initial review and 45-day investigation, CFIUS
decided to not oppose the proposed acquisition, and on September 25th, 2013, Smithfield shareholders voted overwhelmingly to approve the transaction. While the Shuanghui purchase went through eventually after the CFIUS's review and investigation into the national security implications of the transaction, the political debate is not over. As Congresswoman Rosa Delauro released in her statement after CFIUS's decision was announced, "I am deeply troubled by the decision to approve this merger and have serious concerns over the negative long-term ramifications of this deal. Smithfield's acquisition by Shuanghui raises a host of economic and public health issues", "I look forward to discussing with Treasury officials and other regulators…to protect intellectual property rights, as well as the safety and security of the US food supply system" (Delauro, September 6th 2013).

5. CFIUS's Attitude towards Chinese Investment in US Oil and Gas

When it comes to the China's investment in the US oil and gas industry, one of the major cases reviewed is CNOOC's failure in acquiring the American oil and gas company Unocal. In June 2005, CNOOC's outbid its competitor Chevron in the heatedly debated by the congress citing security concerns, including possible transfer of military technology to China, and the House of Representatives voted 398-15 calling on President Bush to review the CNOOC bid. The investigation process did not proceed smoothly and CIFUS was about to recommend against the deal. The then-CEO Fu Chengyu public defended the deal in a Wall Street Journal article titled "why is America Worried" that CNOOC would preserve American jobs and most of Unocal's reserves were outside of
America anyway. Later, due to the political risk, on August 2nd, 2005 CNOOC announced that they had formally withdrawn their acquisition offer for Unocal. (Dezember, March 6th, 2012; “CNOOC Withdraws Bid”, August 4th, 2005).

The political objection CNOOC received sent a clear message of Washington DC's attitude towards Chinese investment in the energy sector. Until recently, the Chinese energy investors have been staying away from investing in the US. Compared to CNOOC's failure in 2005, the recent Chinese energy investment in the US has made some progress in the review from the US policy makers.

Unlike the reaction from congress in 2005, this time, China's investment in US shale gas went through quietly. So far, there have been no open objections from the congress. Also, it seems that CFIUS also eased upon Chinese investment in US shale gas. Though whether any of these companies have filed a voluntary filing to CFIUS for an initial review is not disclosed, none of the current Chinese shale gas joint ventures mentioned a CFIUS approval, as CFIUS approval is not a precondition to close a deal.

As a few of the deals were sealed swiftly, the short time period excluded the possibility of a CFIUS review or investigation. For example, Chesapeake and CNOOC's first deal was firstly announced on October 10th, 2010 and was closed on November 15th, 2010, which means CFIUS did not conduct any investigation on the deal as the review and investigation process usually takes 75 days combined (Chesapeake News Release, November 15th, 2010). CNOOC and Chesapeake's second agreement in DJ Basin and
Powder River took only about 2 weeks to close, which means the deal was not even reviewed by CFIUS (Chesapeake Energy, February 16th, 2011).

Aside from the fact that there is no breaking news on Chinese companies' joint venture activities causing any political objection, the US government's reaction on CNOOC's acquisition of Nexen's oil and gas assets in the Mexican Gulf reveals their skeptical attitude towards Chinese energy investment. CNOOC's purchase of Canadian oil company Nexen's assets in the US was reviewed and approved by CFIUS in 2012. Nexen has operations in Canada, the UK North Sea and offshore West Africa (Penty and Forden, March 1st 2013). The US's approval came on February 12, 2013, after the deal had already passed regulatory muster in Canada and Europe for the acquisition also included that of Nexen's more than 200 drilling leases in the primary US oil source Gulf of Mexico (Tracy, March 1st, 2013).

CFIUS's approval of CNOOC's acquisition activities demonstrates US's more open attitude towards Chinese state-owned oil and gas companies' acquisition activities in the US, in contrast with the congress's fierce objection to CNOOC's acquisition of Unocal in 2005. However, this gesture should be taken with a grain of salt. Despite the fact the CFIUS has allowed the Nexen takeover to complete, the control structure of the drilling leases was modified due to the security concerns of the CFIUS, because Nexen is reported to control platforms in the near-shore West Delta oilfield within 50 miles of the US Naval Air Station Joint Reserve Base at Belle Chasse, Louisiana, southeast of New Orleans (Kwong, March 3rd, 2013). The CNOOC surrendered operating control of the
assets in Mexican Gulf and removed its role from an operator to a non-operator, though the Chinese state-owned oil company still retains ownership of the assets and is allowed some general oversight and to collect revenue from the properties (Penty and Forden, March 1st 2013).

Though seen as a milestone in China's investment in US energy, this deal, just like the other transactions such as Smithfield, also reflects the US's concern over Chinese investment, especially considering CFIUS has previously granted approvals for state-owned companies including Norway's Statoil ASA and Brazil's Petroleo Brasileiro SA to fully control drilling and production in the Gulf (Penty and Forden, March 1st 2013).

6. Analysis on the Progress Made in Chinese Shale Gas Investment in the US

CFIUS's reviews as well as the congress’s reaction on the current Chinese cases reflect the US's general view on Chinese investment: though the US in principle accepts Chinese investment, there is a deep concern on the threat of the investment to US national security.

The US government is officially open to Chinese investment, even in the energy sector. The high review number as well as the rejection cases can be interpreted that the US also holds a skeptical view towards Chinese investment, even though the fact that the US is not reacting as fiercely as they reacted to CNOOC's acquisition of Unocal in the past shows that the US has a more open view.
China's success in setting up shale gas joint ventures and CNOOC's surrendering the control demonstrates that the current general practice in Chinese investors' acquisition activities that is accepted by the US government. The direct control of Chinese investors as operators would meet more hurdles or even get rejected, yet CFIUS tends to allow Chinese investment in US shale gas through joint venture, especially when the Chinese investors are not the operators in the deal.

The reason why Chinese companies have made progress in setting up joint ventures in the US is due to several factors. Firstly, shale gas industry is in need of foreign capital and joint venture is a common practice for American companies to get the capital. As analyzed above, the US shale gas industry has attracted investment from all over the world, and the Chinese investment does not stand out among investment from other countries. The Chinese companies holding ownership in part of the US shale gas resources does not pose a threat to the US national security, as in the joint venture structure, Chinese companies' participation in shale gas development activities is minimized. Also, the technology transfer of drilling technologies is not likely to raise any concern on the US national security.

Secondly, aside from the fact that Chinese joint ventures with American companies does not mount to a threat to US national security, having learned their lesson from several past rejections, the Chinese companies are also taking a more careful approach in terms of public relations to not raise a red flag in their investment. For example, in the Smithfield as well as the Nexen deals, both companies voluntarily submit
their filings to CFIUS, a gesture of information disclosure to policy makers to avoid any potential misunderstanding on the purpose of Chinese investment.

Besides the above two reasons, another possible reason behind the US's approval of Chinese investment in US could be that the US would like to China to return the favor and allow US companies to get access to China's tremendous amount of shale gas reserves. With the launch of the US-China shale gas initiative as well as international oil and gas companies such as Shell and Conoco looking to participate in a potential shale gas boom in China, an overly strict investment environment in the US could lead to retaliation from China in terms of approval of American companies' investment. The Chinese government has a relatively speaking more strict and hostile environment than the US in terms of foreign investment in energy, and it is no secret that the US also wants China to open its gate wider to foreign investment, especially investment from the US.

However, the US intention of investing in China could potentially backfire in the Chinese investment case, which will make Chinese investment in the US more of a bargaining chip in the negotiation rather than a national security issue. There are dissenting voices that the US should hold off Chinese investment to force out better terms in China's investment environment. As Professor Alisa Newman Hood from Georgetown University put it, "US companies would be better served by a Congress willing to apply some heat to China to ensure reciprocal access rather than keeping its head down in order not to offend" (Newman Hood, January 5th, 2012). The US government's act of putting heat on the Chinese investment could potentially cause more barriers for Chinese
companies to invest in the US. During CNOOC's acquisition of Nexen's oil assets in America, Charles Schumer, the Senate's No. 3 Democrat and a frequent critic of China's trade and currency policy in a draft letter obtained by Reuters, said that CFIUS should not approve the deal until China makes "tangible, enforceable commitments" on market access for US companies. Schumer said in the draft letter, "I respectfully urge you, in your capacity as chairman of the Committee on Foreign Investment in the United States (CFIUS), to withhold approval of this transaction to ensure US companies' reciprocal treatment" ("China-Canada Deal Raises Hackles", July 27th, 2012). It is paradoxical that China and US's effort in opening each other's border could potentially lead to more conflicts and political risks for their mutual investment in the short term. Whether this strategy of threatening to block each other's investment is effective or justified is out of the scope of this paper, yet it is without doubt the ultimate purpose of the objection is essentially to facilitate a reciprocal treatment in foreign investment and stronger Sino-US connection. It can be concluded with more and more mutual investment at stake, both China and US will likely to eventually open up their border for foreign investment. Another take-away point is that even though eventually CFIUS approved the transaction in this case, the objection from the congress has proved that CFIUS's work can potentially be influenced by political agenda, which increases the future risk of political uncertainty in China's investment in the US.
7. Forecast Based on Political Risk Analysis

Based on the political risk analysis, the following short-term and long-term investments can be made.

In the short run, considering the successful investment record in the joint venture strategy, it is unlikely that the Chinese companies will be meeting more obstacles if the Chinese companies keep the joint venture investment strategy. This practice is accepted by CFIUS as the investment a) benefits the US shale gas boom b) does not appear to pose a threat to the US national security.

Yet, even though China's investment in shale gas has demonstrated a successful investment pattern, there is still a considerable level of political risk in these transactions. Even the so called "safe deals" could crush, for reasons other than the structure of the investment itself, such as the location of the assets involved are in proximity to US military or government facilities.

Moreover, joint venture is still one step away from directly acquiring an American company. Though Chinese companies are successful in setting up joint ventures and acquiring Nexen's assets in the US, taking over an existing American oil and gas company will be more challenging. The political conditions mean that in the short term, the Chinese investors will not be able to directly invest in US shale gas assets through company takeover or asset buyout.
In the long run, the US government's attitude could potentially change as the US-China economic bond is getting strengthened. The mutual investment in US and China could potentially be the leverage in their negotiation and force both sides to open up investment opportunities for each other. Though the road to a more open environment could be bumpy and even with short term setbacks as conflicts arise, but as the time goes, with more mutual investment in China and US, the stronger US-China economic bond could contribute to a more open investment environment in both the US and China over the long term.

However, another long term possible scenario could also happen: if CFIUS's mandate were to be again expanded, Chinese investment would be faced with more political hurdles. Since CFIUS's founding, it has evolved from an advising committee to a committee with the power to review and block almost all the foreign takeover transactions. The US lawmakers have demonstrated to a pattern of enacting new acts to enhance CFIUS's power in reaction to foreign governments' high-profile investment. This enhancement in power of CFIUS could happen again if the Chinese companies conduct more high-profile acquisitions in the American oil and gas assets. In that scenario, the foreign investment environment could be more restricted for Chinese investment and scare off Chinese energy investors.
Chapter Eight

Scenario Analysis

1. Methodology Overview

This paper endeavors to make a comprehensive forecast of Chinese investment in US shale gas, however, there are always some wildcard factors that are out of the scope of this research or hard to predict. What we don't know can have a huge impact on the future -- just like before the discovery of Australia, people in the world are convinced that all swans are white, there could likely be "black swan"—a future event that is out of the author's knowledge in this forecast (Taleb, April 22nd, 2007, P1).

Though it is hardly possible to make a complete list of wildcard factors, this thesis has identified some of these factors and will conduct a scenario analysis based on the potential occurrence of these factors. This section will be complimentary to the previous sections and the analysis is built on the basis of the forecast made in the previous sections.

2. Economic Meltdown in US or China

With the US financial crisis just a few years ago, the world economy is still recovering from the effect of the crisis. The US regulations on bank loans have since the
financial crisis tightened, and it is not likely there will be another mortgage led financial crisis. However, the US economy is hardly prospering, for example, according to the US Department of Commerce’s official data, the GDP growth rate of the 1st quarter of 2014 was only 0.1%; People have expressed their concern over the next financial crisis, especially considering the large amount of sovereign debt this country has taken (Sorkin, April 29th, 2014). Just like Warren Buffet once said, "You never know who's swimming naked until the tide goes out"(Buffet, April 29th, 2014), no one can predict exactly when there will be another financial crisis and what will be the trigger to the crisis.

Hypothetically speaking, if a US financial crisis did take place, foreign investors, including Chinese investors, would certainly withdraw their investment, just like before the 2008 financial crisis, CFIUS reported many foreign investors withdrew their investment during the initial review process for fear that the US economic would not be able to provide a stable investment environment.

Moreover, even though China has been the most fast growing economy in the past few decades, there is a possibility of another economic crisis in China, which can be caused by many reasons, among which most likely, the property bubble. The high housing price and investors’ continuing interest in the housing market have given the Chinese government much pressure in controlling the asset bubble. It has been forecasted over and over again that the Chinese economy is facing an “economic apocalypse” in the past few years (Ranganathan, April 3rd, 2014). Though the apocalypse has not manifested itself, some of the signs of an economic crisis are already showing. For example, the
housing bubble in China has created many "ghost cities", which are houses and cities with very few people living in (Mamta, 2013).

Under this scenario, if an economic crisis actually hit China, the effect on Chinese outbound investment, including investment in US shale gas would be huge. The potential currency inflation, high unemployment rate and even political turmoil during an economic crisis could hurt even the most wealthy Chinese state-owned oil and gas conglomerates, just like the ancient Chinese saying, “when the nest is overturned, no eggs stays unbroken”.

3. Disastrous Accident/Proven Contamination Due to Shale Gas Drilling Activities

Hydraulic fracturing or fracking is currently one of the most contentious topics due to its potential environmental risk. Hydraulic fracturing is currently banned in many European countries or regions (“Nine Countries Ban Fracking”, October 14th, 2013). For example, in France, fracking is banned until there is proof that shale gas exploration won't harm the environment or "massacre" the landscape, according to French President Nicolas Sarkozy (Patel, October 4th, 2011). In US, fracking is also protested against as many environmentalists argue that it would contaminate drinking water. States have taken various measures in terms of regulating fracking, and in May 2012, Vermont became the first state to officially ban any hydraulic fracking activities. Governor Peter Shumlin said during the news release that he hopes "other states will follow" (State of Vermont, May 17th, 2012).
Oil and gas operations are not risk free. Accidents can happen due to many reasons such as geological issues or mismanagement. For example, in 2011, CNOOC and ConocoPhilips’s joint venture operation had a major oil spill in the Bohai Bay and led to a major shutdown of their oil exploration activities in the area (He, July 8th, 2011).

In the shale gas sector, although currently there are relatively speaking few documented and confirmed cases of accidents occurring, especially considering the shale gas industry size (Frum, June 20th, 2012). For an energy industry as contentious as the shale gas industry, if fracking's contamination of drinking water was definitively proven or a disastrous accident happened, there could be a wide protest from the mass or even a ban on shale gas drilling activities in the US due to the pressure from policy makers and environmentalists. And this type of event is not unprecedented: after the Fukushima accident in Japan, nuclear projects are widely banned/stalled throughout the world (Chossudovsky, January 25th, 2012). The hypothetical ban on US shale gas would certainly shut out Chinese investors, even if China still held an interest in shale gas development.

4. US China Trade War

Though a political risk analysis is conducted on the US government's attitude towards China's investment in shale gas, it is worth noting that the current US attitude towards Chinese investment may very likely change anytime soon, due to the unpredictable nature of foreign relations.
The US-China relationship has always been filled with fights and arguments. The competition-partnership relations between China and US in politics and economic development are one of the most eye-catching issues in the political arena. During the 2012 campaign year, President Obama filed 12 trade complaints to WTO against China (Roberts, October 08th, 2012), and US's foreign economic policy towards China was one of the most debated policy issues during the 2012 presidential campaign (“Transcript of Presidential Debate”, October 23rd, 2012).

This type of incident may happen any time for any reason such as diplomatic miscommunications, economic recessions, or government political agenda. Though CFIUS’s work is relatively independent, yet it has been analyzed in the political analysis section that it is subjected to the influence from congress and could potentially expand its mandate. A hypothetical trade war between the US and China could thus worsen and thus discourage Chinese investment in US shale gas. Also, on the Chinese side, as the investment originates from state-owned companies, which are directed by the Chinese government in their foreign investment activities, Chinese oil and gas investors were also very likely to stay away from the US market should a trade war happen.
Chapter Nine

Conclusion

This thesis conducts a comprehensive political economic analysis on Chinese investment in US shale gas, based on which a forecast of the future investment trend in both the short term and long term are made. Combining the conclusions from all the previous sections, the following forecast can be made on future Chinese investment in US shale gas.

In the short term, which is within the next 5 years, the general trend is that Chinese state-owned oil and gas companies, which are the main source of Chinese investment, are likely to keep setting up joint ventures in order to learn the advanced US shale drilling technology. That being said, there are some limitations placed on the short term investment trend:

1) The investment itself is not likely to increase substantially. The past Chinese investment in US shale gas did not demonstrate a fast growing trend. The reason behind Chinese investors’ tepid interest is that Chinese companies are taking a low profile investment strategy in order to not draw too much attention from the US government, especially considering CFIUS still holds a skeptical view on
Chinese investment and tends to block direct Chinese investment in critical infrastructure.

2) Investors prefer to invest in wet gas assets and tight oil assets than dry shale gas. Natural gas market is currently experiencing an oversupply as a result of the shale gas boom. In order to pursue higher return on investment, Chinese companies in the short term will keep investing in shale resources with a high oil and NGLs contents.

In the long run, which is in 10 years or later, there are more unpredictable factors playing in the investment trend, as there will be potential changes in various economic and political factors.

1) This joint venture investment trend may very likely not continue, due to its transitioning nature. The purpose of this investment is seeking advanced shale gas technology, which will be no longer needed once Chinese companies have mastered the technology or if shale gas proves to be out of the reach for oil and gas companies.

2) In the long run, the US government’s attitude towards Chinese investment and the economic efficiency of shale gas investment are determining factors in Chinese investment in US shale gas. The government’s attitude towards Chinese investment could invite in or drive away Chinese investment, which in the long term will also be driven by the economic efficiency in their investment.
government’s attitude in this scenario is hard to predict: Though the US government’s history shows that the government tends to tighten the restrictions on foreign investment for national security concerns, the investment environment for foreign investment could also potentially be more open as the cooperation between US and China deepens. Should the US government allow Chinese investment to come in and should the US natural gas price rise, the Chinese investment would be no longer limited to the joint venture structure and also include major international mergers and acquisitions in oil and gas companies or assets.

To make this forecast more accurate, this thesis also considers various factors that are out of the research scope with a scenario analysis, such as a potential economic meltdown, major US China trade war or disastrous accidents in the shale gas industry. However, it is important to realize that there is no way this list exhausts all the possible scenarios. There could be potentially many other scenarios coming up in the future that will have a determining effect on the investment. Just as Alan Greenspan said, “we really can’t forecast well, we pretend we can but we can’t” (Greenspan, April 29th, 2014). Though a precise prediction is impossible, the author hopes this thesis will shed light on current trend of Chinese investment in US shale gas as well as the driving factors behind the investment, and inspire more future research in this industry.
Works Cited


EIA, “Marcellus Region to Provide 18% of Total US Natural Gas Production this Month”, *EIA Report*, Web. December 9th, 2013


Greenspan, Alan, Brainy Quote from Alan Greenspan, n.d. Web. April 29th, 2014,


“Nine Countries or Regions that Ban Fracking”, *Oil Patch Asia*, Web. October 14th, 2013


Appendix 1: US Natural Gas Price Change

Historical Change in US Natural Gas Prices (in Nominal Dollars), Data Retrieved from US Energy Information Administration, May 17th, 2014

Data 1: U.S. Price of Natural Gas Delivered to Residential Consumers (Dollars per Thousand Cubic Feet)

Data 2: U.S. Price of Natural Gas Sold to Commercial Consumers (Dollars per Thousand Cubic Feet)