Essays on Energy Price Innovations, Bond Returns, and Default Probabilities

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Declaration for SOAS PhD Thesis

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Eleanor J. Morrison

Signed: ____________________________ Date: _________________

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Abstract

The objective of this thesis is to analyse the impact of oil price shocks on emerging market countries and independent oil producing firms. In the case of emerging market countries, the response of bond portfolios, constructed using selected emerging market sovereigns with oil exposure in either an exporting function or an importing function, to oil price innovations will be studied. In the case of independent oil producers, hedging strategies will be analysed in terms of their contribution to firm financial and operational resiliency and default probabilities.

Three models are presented to study the energy price shocks, debt asset prices, and producer hedging program interactions. The first study applies a time series structural autoregressive model (2007-2015), to examine the significance of the interaction of global oil prices on the total bond returns for portfolios of emerging market sovereign oil importers and exporters. The second study considers the response of these emerging market sovereign bond portfolios to the impact of OPEC production quota announcements (2011-2016) using an event study methodology. Two additional portfolios are included in this study, representing total bond returns for international oil producing majors and small cap independent shale oil producers. In the third study, a balanced fixed effect panel model, with quarterly frequency over five years (2011-2015), is used to investigate the effect of hedging programs by a homogeneous sample of independent United States-focused oil producers, on firm value and firm default probability, as measured by distance to default. This model presents the first extensive firm level database of financial performance and delta-equivalent hedge ratios for this important energy producer group.

This research is immediately relevant to current and future bond investors and commercial lenders. Knowledge gained from my research will afford a better understanding of the influence of energy prices on debt risk premiums and hedging strategies for oil producing emerging market nations and independent oil producer firms.

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Glossary

NAME	DESCRIPTION
ABR	Abnormal Bond Returns
ABS	Asset Backed Security
BBA	Base borrowing Amount
BOILMAX	Brent Oil Positive Innovations
BOILMIN	Brent Oil Negative Innovations
BPD	Barrels per Day
BR	Bond Return
Brent	Brent Oil Pricing location in the North Sea
BRIC	Brazil, Russia, India and China
CAPEX	Capital Expenditures
CAR	Cumulative Abnormal Returns
CBOE	Chicago Board of Trade
CL'#'	WTI NYMEX Contract # = month, CL6 is 6th month forward future contract
CL1	Nearby WTI NYMEX Contract
CME	Chicago Mercantile Exchange
D/EBITDA	Debt/Earnings before Interest tax Depreciation, Amortisation
D/EBITDAX	Debt/Earnings before Interest tax Depreciation, Amortisation, CAPEX
E&P	Exploration and Production
EBIT	Earnings before Interest and Tax
EBR	Excess Bond Return
ECB	European Central Bank
EDF	Expected Default Frequency
EIA	Energy Information Administration
EM	Emerging Market
EM EXP	Emerging Market Exporter portfolio
EM IMP	Emerging Market Importers portfolio
EMBI	Emerging Market Bond Index (JP Morgan)
EMBI	Emerging Market Bond Index (JP Morgan)
EMBI Export	Portfolio of Export Countries using EMBI country indices
EMBI Import	Portfolio of Import Countries using EMBI country indices
EMBI-D	Emerging Market Bond Index - Diversified (JP Morgan)
EMVIX	Emerging Market VIX
ETF	Exchange Traded Fund
EU	European Union
FE	Fixed Effect
HH	Henry Hub (natural gas trading location)
ICE	Intercontinental Exchange
IFI	International Financial Institutions
IPO	Initial Public Offering
LHS	Left Hand Side
LIBOR	London InterBank Offer Rate
LNBDI	Log Baltic Dry Index
LNBRENT	Log Brent Oil Prices
LNBRL	Log Real Brazil Total Bond Returns
LNCLP	Log Real Chile Total Bond Returns
LNCNY	Log Real China Total Bond Returns
LNCOP	Log Real Colombia Total Bond Returns
LNEMBI_EXPORT	Global EMBI Exporter Portfolio
LNEMBI_IMPORT	Global EMBI Importer Portfolio

LNGLOBAL	Log Global Production
LNKZT	Log Real Kazakhstan Total Bond Returns
LNMXN	Log Real Mexico Total Bond Returns
LNPHP	Log Real Philippines Total Bond Returns
LNPLN	Log Real Poland Total Bond Returns
LNRUB	Log Real Russia Total Bond Returns
LNTRY	Log Real Turkey Total Bond Returns
LNUSA	Log Real USA Total Bond Returns
LNVEF	Log Real Venezuela Total Bond Returns
LNWTI	Log West Texas Intermediate Oil Prices
LNZAR	Log Real South Africa Total Bond Returns
MAJOR	Oil Major Integrated Company portfolio
MSCI	Morgan Stanley Capital International (indices provider)
NGL	Natural Gas Liquids
NYMEX	New York Mercantile Exchange
OBR	Observed Bond Portfolio Returns
OLS	Ordinary Least Squares
OPEC	Organisation of Petroleum Exporting Countries
OTC	Over the Counter
OVX	Oil VIX
PBR	Premium Holding Period Bond Returns
PDP	Proved Developed Producing
PEMEX	Petróleos Mexicanos
RBF	Resource based Financing
RBL	Resource based Lending
Repo	Repurchase Agreement
RHS	Right Hand Side
S&P500 HY	Standard & Poors 500 high yield grade index
S&P500 IG	Standard & Poors 500 investment grade index
SME	Small Medium Enterprise Oil Producer Portfolio
SME IND	Small Medium Enterprise Independent Oil Producer Portfolio
SVAR	Structural Vector Autoregressive Model
Tight Oil	Unconventional Shale Oil Extraction Methods
TR	Treasury Bond Return
TRACE	Trade Reporting and Compliance Engine (US Regulatory)
US	United States
VIX	CBOT Volatility Index
VXXLE	volatility of US Energy Market ETF called XLE
WACC	Weighted Average Cost of Capital
WTI	West Texas Intermediary
XLE	ETF representing US Sector Equity Returns
YTM	Yield to Maturity

1.0 Introduction

1.1 Motivation

The 2008 financial crisis reverberated across all global markets as liquidity contagion spread and investor anxiety resulted in an investment shift to lower risk instruments. Government policy makers responded by injecting liquidity into the market via quantitative easing programs, intended to support cash flow investment channels, to promote stability in the markets and eventually return to a growth trajectory. Government yield curves in developed countries shifted lower due to increased bond demand under quantitative easing programs. Government bond prices climbed to high levels that discouraged further demand as associated yields created a real level of returns close to zero. As global market fears abated, investors diverted cash flows to riskier opportunities, in response to lower risk free returns. Beneficiaries of this shift in investment flows were high-yield debt issuers, such as emerging market sovereigns and independent oil producer firms with low ratings, sub-investment grade ratings, or no rating at all.

In 2014 global debt markets were estimated to be near 100 trillion USD (Walker and Capo McCormick, 2014), almost double the size of international equity markets. The importance of debt markets to meet the capital funding requirements of borrowers, from capital-rich lenders, is paramount to this achievement and composes the central theme of this research. Governments finance their balance sheets with a combination of short- and longer term debt issuances. Matching investment time periods of institutional investors with sovereign issuers makes good sense because payout requirements are longer term. Investor demand for higher alpha returns and portfolio diversification supported the growth in longer term global sovereign debt products. Emerging market governments were pleased with this public debt market demand and access, as it provided an alternative to costly international financing institutions, such as the World Bank, where strict policy prerequisites are a requirement for borrowing.

Portfolio investment strategies of institutional investors have evolved from passive fixed income investments to globally focused diversification portfolio strategies composed of higher risk constituents. Pension funds, in particular, have vast sums of capital that must be invested in order for future payout obligations to be met. This has pushed pension fund investors, as well as insurance companies, to create portfolio strategies that are directly linked to their future expected liability requirements. The transition from defined benefit to defined contribution pension plan has escalated the importance of prudent capital allocation. Investor demand for investment vehicles has been serviced by a broad industry supply of global financial products at all levels of risk. Diversification strategies assume market fragmentation, represented as a low correlation in the development risk models. Financial innovation in new products, combined with a reduction in foreign investment limitations, has allowed all types of investors to access most of the international equity and debt capital markets. For example, an individual investor can invest in crude oil futures, gold futures, or South African sovereign debt using exchange-traded funds (ETF). This effect of broad global investment, in turn, could result in reduced market fragmentation, as investors with similar risk tolerances are present in all markets. Investor flight-to-safety events, such as observed in 2008, can cause significant vulnerabilities to higher risk markets. This theme is studied in my thesis in terms of bond market return responses to energy market price innovations.

While global markets focused on stability and recovery after the liquidity shock that originated from the United States credit crisis, a dramatic shift in the physical global crude oil market was well underway. The ongoing success in research and development in drilling technology to access crude oil deposits in horizontal rock formations, primarily focused in North America, resulted in the capability to extract these crude oil deposits under more profitable conditions. In the five years following the financial crisis, the addition of this crude oil production source to global supply balances resulted in the United States reducing imports and thereby shifting the international physical crude oil flows. The traditional crude oil sellers to the United States, such as Nigeria, now needed to seek out new buyers for their raw crude oil exports. Crude oil futures markets responded to this new source of shale oil supply with a strong shift lower in the entire term structure of the curve. Crude oil exporting emerging market sovereigns were surprised by the large negative shock to prices and promptly began to reassess oil hedging programs, if indeed they existed in the first place, along with fiscal receipts in response to lower foreign revenue.

Emerging market sovereign bond markets reaped the benefits of investors' search for higher yields in the lower interest rate milieu created to support economic recovery channels post-2008. Institutional investors shifted capital flows into emerging markets and higher risk debt assets. Emerging market sovereigns have a higher borrowing cost and are often considered high-risk investments linked to their higher expected risk premiums. In light of this increased institutional investment exposure to emerging market sovereign debt and the negative oil price innovations observed in 2014, my research will focus on the impact of oil market price innovations on emerging market sovereign bonds in countries with oil price exposure, in either an importing or an exporting capacity. My enquiry is conducted from an investor perspective using total bond returns, which in turn provides an understanding of the impact of oil price shocks to the cost of borrowing for emerging market sovereigns. This study of energy price innovations on emerging market sovereign total bond returns is motivated by my interest in understanding how exporting countries are impacted by oil price fluctuations and the possible role of oil price hedging to mitigate this uncertainty.

The role of the Organisation of Petroleum Exporting Countries (OPEC) as a market control mechanism, using spare production capabilities, in oil markets has been actively debated since the organisation's establishment in 1960. Energy market participants regard bi-annual OPEC quota setting meetings with caution, as decisions on consortium production levels can have a significant price impact on the global oil market. Due to asymmetric response behaviour, OPEC meeting decisions during market extreme peak and trough price environs are observed more closely. After the oil market price collapse in the fourth quarter of 2014, all eyes turned to the OPEC meeting held 27 November, 2014, waiting for OPEC's response. Prior to many OPEC meetings, market expectations were built into the futures price curve; therefore the event aspect of the response to the public announcement of the meeting's outcome is generally muted. In advance of this November 2014 meeting, there was no clear consensus on what, if anything, OPEC planned to do in response to the shale oil provoked lower price environment. The ultimate decision to continue production at current levels meant that OPEC was refusing to take responsibility as a swing producer to provide stability to and a lower threshold for market prices. Building on my study of oil price interactions with emerging market sovereign bond returns, I created an event study model to observe bond market responses to OPEC's decision to abate its responsibility as a swing producer. This study will identify market fragmentation effects across bond markets and discuss the role of investors.

Emerging market countries that rely on oil exports to fund their fiscal policies face difficult policy decisions under low oil price regimes. The ability to insulate fiscal revenues from oil price volatility, through implementation of a hedging program, would decrease these challenges. The study of the relationship between sovereign bond riskiness and a sovereign's hedging program strategy can provide information on the importance of hedging programs to the cost of borrowing. Limitations on the access to data on government energy hedging programs required that I take a different approach to analysing the importance of producer oil price hedge programs. To study this relationship, I selected a new independent shale oil producer group established in the United States, a highly homogeneous group, to understand the importance of hedging programs on firm performance. While equity and debt holders have a shared desire for strong financial performance in a firm, the ultimate concern of each group is different. Equity holders calculate the value of the firm based on the sum of share appreciation and cash flow dividends. On the other hand, debt holders are concerned with cash flow stability to ensure that debt payments can be guaranteed. Firm value, while important to both firm capital holders, is more interesting to equity participants, because debt holders are concerned about firm default probabilities. This concern is paramount with high-risk issuers with low credit ratings, in keeping with the independent shale oil producer group. The results from a study of oil hedge programs and producer default probability may be used as a discussion tool for emerging market oil producing countries.

The importance of global debt capital markets as a funding mechanism for emerging market governments and risk prone junior innovative producers reinforces the motivation for this energy price innovation research on bond returns. The convergence of increased debt instrument supply and increased demand for debt products, supported by opportunistic institutional investors employing innovative portfolio management programs, makes this research timely and fills a void in the debt capital market literature. Market fragmentation will be studied as a theme throughout this research. Positive correlations between market segments, in particular between capital markets and energy markets, have increased since the financial crisis, described as the financializing of energy markets. This phenomenon, along with a more active globally present investor, suggests that market interaction between energy and debt markets is critical for all current and prospective debt market participants.

1.2 Recent Events

Over the course of my doctoral research, several important developments have taken place on the global stage. These include the Paris Climate Change Conference, implementation of further global financial regulations, increased geopolitical concerns and a move towards protectionist behaviours such as Brexit, expected tightening of loose monetary policies, and the surprising election of Donald Trump as US president, which is having broad-based global ramifications on trade, climate change, and regulations.

The 21st Conference of the Parties (COP21) sponsored by the United Nations Framework Convention on Climate Change was held in Paris during December 2015. The milestone Paris Climate Agreement signed during COP21 is seen as a great success in what has been a series of lackluster climate change conferences since 1994. The annual COP conferences are marathon efforts for government delegations trying to agree on substantive outcomes for the climate change agenda. The Paris agreement was seen as a breakthrough because all nations participated in a reduction framework with specified intended national determined contributions to target the proposed limit of a 1.5^{o} C increase in global temperatures. Although COP21 is seen as a global success in negotiations, the framework consisted of promises and no legally binding targets. Fossil fuel producers can keep producing in a commercially viable manner as usual. Aviation and shipping, which expect growth of three times and four times respectively, were not included for voluntary reductions or as part of the carbon market (Buxton, 2016). There were no funding mechanisms created for assisting emerging market countries to manage current and future climate change impacts. The implications of this lack of funding is unknown. We do know that many emerging market countries are susceptible to climate changes that will limit economic growth, due to lack of resilient energy services and agriculture production. This puts further pressure on the countries' fiscal budgets, via imports of energy and food products, showing the importance of access to international capital flows through global debt markets.

Less than one year into his presidency, Trump announced the withdrawal of the United States from the Paris climate agreement, the reason being that it was going to have a negative effect on the country's economic growth. This signaled that industries in the United States were free from federal pressure to reduce carbon emissions, removing any uncertainty of additional environmental costs for independent shale oil producers studied in this thesis. While the move is seen as undermining a global initiative, state level governments have taken a different tack in the push for better air quality for their communities, thereby mitigating the impact of climate change. While a bottom-up approach to climate change policies grows in the USA, China is also seeing this same push for better air quality, resulting in the national government implementing more climate change regulations. Given these recent events, climate scientists have turned from the United States and are now looking to China for leadership on climate change (Foster, 2017).

Geopolitical events have unfolded at a fast rate over the past few years. The Arab spring revolution that started in late 2010 saw protests across North Africa and the Middle East, with several country governments falling in the process. Large migration from Africa and the Middle East into Europe, resulting from the Syrian Civil War, continues to flow and stress European governments dealing with massive numbers of refugees in the social systems. Tensions between the West and Russia have escalated over events in Ukraine and Syria, as well as the on-going gas policy strategy for Europe. The UK and Europe are starting the negotiation on Britain's exit from the European common marketplace. This is not a comprehensive list of events, but it illustrates the high level of uncertainty in international politics. Investors respond to uncertainty by reallocating capital to risk aversion assets. This move to less risky investment instruments has not happened, because under a low interest rate environment, investors continue to be incentivized to remain in risky investments. My research studied high yield market participants in emerging markets' sovereign debt and high yield independent oil producers. A flight to lower risk assets, such as US treasuries, will decrease the demand for higher risk bonds and thereby increase the cost of borrowing for these higher risk profile borrowers.

The remaining point to discuss in my list of global developments over the past few years is the end to loose monetary policies in developed economies. Since 2009, governments have used rate reductions and quantitative easing programs to stimulate economic stability and growth. While economic performance has improved in developed countries, central banks are still reticent to increase rates in case they may precipitate an economic decline. Higher central bank rates will have an immediate effect on investment grade corporate borrowing rates. Emerging market sovereign debt and other high yield debt instruments would not see an immediate increase in the cost of borrowing, as most of the yield valuation is a result of the idiosyncratic risk of the specific bond. If central bank rates see a rapid increase, defaults become a real risk as the majority of global borrowing instruments are indexed to central bank base rates.

1.3 Dissertation Objective and Research Questions

The purpose of my research is binary. First, to study emerging market debt asset price response to energy price innovations, predominantly under negative energy price shocks. Second, to study the efficacy of commodity price hedging programs, as a tool to protect oil producers from undue oil price movements.

To examine the interaction of oil market price innovations on debt asset prices, the following research questions are presented with application to emerging market sovereign bonds for portfolios of countries exposed to oil prices in either an importing or an exporting context.

Research Question 1: Do oil price innovations have a statistically significant interaction with total bond returns of portfolios of emerging market sovereign bonds?

Research Hypothesis 1.1: Oil price innovations will have a direct significant interaction with portfolios of total bond returns of emerging market sovereign oil exporters.

Research Hypothesis 1.2: Oil price innovations will have an inverse significant interaction with portfolios of total bond returns of emerging market sovereign oil importers.

The second question concentrates on the role of OPEC conference quota announcements and the resulting interaction on portfolios of emerging market sovereign bonds exposed to oil prices in either an importing or exporting context. For this enquiry, portfolios of independent shale oil producer bonds and international oil majors were included for comparative responses.

Research Question 2: What is the reaction of portfolios of oil producer/exporter bonds and oil importer bonds to OPEC production quota decisions?

Research Hypothesis 2.1: Bond returns from an emerging market sovereign exporter's portfolio will respond negatively to OPEC production quota decisions that do not support higher oil futures market prices.

Research Hypothesis 2.2: Bond returns from an emerging market sovereign importer's portfolio will respond positively to OPEC production quota decisions that do not support higher oil futures market prices.
Research Hypothesis 2.3: Small independent shale oil producer's bond portfolios have greater sensitivity to OPEC production quota decisions that do not support higher oil futures market prices when compared to the bond portfolio responses of large multi-national oil producer corporations.

The final research question investigates the success of commodity price hedging programs in assuaging exposure to oil market price factors, as examined in the first two research questions. The sample used for this empirical model, small- to medium-sized US situated independent shale oil producers, was selected to create a homogenous data sample, in an attempt to isolate the contribution of commodity price hedge programs to an oil producer's firm solvency and firm value.
Research Question 3: Do oil producers with higher production hedge ratios have lower default probabilities as measured by distance to default?
Research Hypothesis 3.1: Oil producers' hedge programs with larger production hedge ratios exhibit a lower probability of default.
Research Hypothesis 3.2: Oil producers' hedge programs with larger production hedge ratios demonstrate a higher representation of firm value.

1.4 Dissertation Contribution

My thesis makes three significant contributions. First, my research on debt asset pricing responses under energy price innovations and OPEC quota announcements contributes empirical support to the understanding of sovereign bond market dynamics in emerging markets. Second, I constructed a database on hedging and financial metrics for independent shale oil producers, which is the first of its kind and a crucial source of information by which to study shale oil producer behaviour, performance, and resiliency. Third, my empirical findings on the significance of hedge volumes on firm default risk, as measured by distance to default, signals the importance of hedging programs for oil producers. The void in research on debt markets responses to energy price shocks further highlights the importance of this research.

Until recently little research has focused on debt capital market asset pricing. This was due to limited data accessibility and market characteristics. Debt markets are more decentralised than equity markets, with much of the trading volume over the counter rather than via transparent exchange platforms. This required researchers to hand-collect data from a variety of price reporting agencies and publications to construct datasets for use in empirical analysis. Gathering and preparing databanks on debt instrument pricing became easier post-2002, after the launch of the Trade Reporting and Compliance Engine (TRACE) in the United States. Further research on debt asset pricing is urgently needed as debt markets continue to expand and investors, particularly institutional investors, are injecting capital into riskier areas of global debt markets. Investors need further research to understand a bond return's sensitivity to exogenous factors, because debt market liquidity can limit portfolio adjustments. Contributions from my first two research questions add to the emerging market bond literature by adding knowledge on the interaction of oil price innovations and emerging market bond risk premiums, represented by real bond total returns. This research also provides further information on the significance of a country's commodity dependence on the variability of market-based borrowing costs.

Oil price innovations on bond returns and investors' perception of oil price innovations on sovereign credit risk have the capacity to profoundly affect national economies. A time series structural vector autoregressive (SVAR) model was constructed to study the effects of oil price shocks on the portfolios of total bond returns of emerging market sovereign oil importers and exporters, using JP Morgan Emerging Market Bond Index (EMBI) total bond returns. This builds on the earlier work of Kang et al. (2014), who applied a similar SVAR model structure to study oil price innovations on US bond returns. The results from the current study will have immediate relevance to the academic and financial communities, given the importance of emerging market sovereign bond portfolio allocations to both opportunistic hedge funds and longer term strategic institutional investors, such as pension funds and insurers.

Event study applications were initially designed for firm level idiosyncratic risk analysis of an individual firm's announcements. The success of firm level event study analysis led researchers to apply similar model structures to macroeconomic announcements on equity market indices and US Treasury bond markets. Event study research on debt asset instruments is limited due to data availability, as mentioned earlier, and the previous lack of investor demand for this applied research. Debt market investors traditionally implemented long-term passive strategies with little concern for occasional macroeconomic or firm level event implications. Active management styles have altered the passive approach to bond investing and include, with increasing frequency, portfolio re-balancing in response to market behaviour. This supports the need for event study applications on debt asset pricing. There is extensive event study literature on the outcomes of OPEC conferences on global energy market prices and global equity index returns. No literature exists on the effect of OPEC quota announcements on debt asset pricing, specifically on debt instruments, issued by emerging market sovereigns. This event study analysis compares the responses of four discrete portfolios of bond returns: emerging market sovereign exporters, emerging market sovereign importers, independent shale oil producers, and large multi-national major oil producers. My contributions will provide important information on the magnitude and direction of bond portfolio return responses to OPEC quota announcements.

Independent oil producers have shown themselves to be instrumental in shale oil production growth and the movement towards US oil independence. The capability of the industry to maintain and further develop domestic shale oil production requires an understanding of financial and operational resilience. Equity investors have contributed, and debt providers have also contributed, to firm capital structure scalability in what is a cyclical industry. The risk of firm default during an energy price trough is critical for equity and debt valuations. My empirical model investigates the effect of hedging programs by independent, domestically based shale oil producers, a homogeneous group, on firm value and firm distance to default. In order to determine if hedge programs influence firm value and firm financial distress metrics, forty-four domestic shale oil producers were analysed over a five-year period, utilising a balanced fixed effect panel model. The results provide critical information on the high-risk oil producer category.

The literature to date is divided on the value of hedging primary variable exposure to firm value. My research argues that previous model datasets are overtly heterogeneous to isolate the contribution of hedging programs to firm value and solvency. Findings from my third research enquiry add important contributions to the study of firm hedging of primary risk exposures. First, I contribute an exclusive dataset of firm production hedge ratios and financial characteristics, on a quarterly basis over five years, for a sample of independent, publically traded shale oil producers. Second, my findings on the effect of hedge ratios on firm distance to default support the conclusions of the limited previous research. Finally, my model results on hedge ratios' influence on firm value joins the diverse debate providing a strong contribution due to this uniquely homogenous dataset. This research will provide the investor community with information that will help it consider the allocation of debt or equity structured funding to this specific exploration and production (E&P) sector. Bank lenders, who require minimum production hedging in their covenant structures, will benefit from this empirical study of hedging programs and firm default risks.

My thesis studies oil price shock implications on emerging market sovereign debt asset pricing and the implications to investor responses. The strong growth and current size of global debt markets makes this debt asset pricing research an important contribution to the limited field of financial market price shocks on bond returns. Governments and corporate debt issuers will find this research helpful for debt pricing and market response to energy market price shocks. Academics will be interested in the effect of asset pricing efficiency on information flow between energy and debt markets. My research on a comprehensive unique dataset provides significant insight for independent shale oil producer management teams on firm performance and firm default under hedging programs. Institutional investors and money managers are active in the high-yield oil producer sector. This research is important to their firm level and sector level risk return analytics for investment decisions. I believe these findings can be applied to future research on oil exporting emerging market sovereigns. Oil exporting nations are exposed to similar risks as independent oil producers, albeit in a much more complex financial budgeting scenario. My findings, combined with stylized facts presented in this thesis on the Mexican sovereign hedge example, will spark a compelling conversation for other emerging market sovereign exporters, immediately relevant to investors, government officials, and policy makers alike.

1.5 Structure of Thesis

The thesis has six chapters in addition to this introductory chapter.

Chapter 2 presents an overview of global debt markets and explains the reasons behind the meteoric growth in market size. Determinants of risk premium for emerging market sovereign bonds and high-yield corporate bond issuances are discussed. The history of emerging market bond markets, as well as the growth of investor participation, are described.

Chapter 3 describes the evolution of the global crude oil market pricing system, a succinct history and the importance of OPEC, and significant price shocks observed in crude oil markets over the past fifty years. The purpose and construction of hedging programs will be presented, along with an example of the largest sovereign oil hedge program in the world.

Chapter 4 presents a time series SVAR model to study the interaction of oil price innovations with portfolios of emerging market sovereign bond returns, divided into importer and exporter categories. The empirical evidence found is supported by a bond theoretical framework on risk premiums attributed to bond instruments.

Chapter 5 presents an event study model to observe the response of four bond portfolios, with direct exposure to oil price fluctuations resulting from OPEC production quota announcements.

Chapter 6 presents a balanced homogeneous fixed effect panel model of independent oil producer firms, to study the importance of primary risk hedging on firm performance, defined as firm value and firm solvency risk, in terms of distance to default. My research is underpinned by the presence of institutional investors in risky debt assets; therefore a better measure for my analysis is distance to default, rather than firm value.

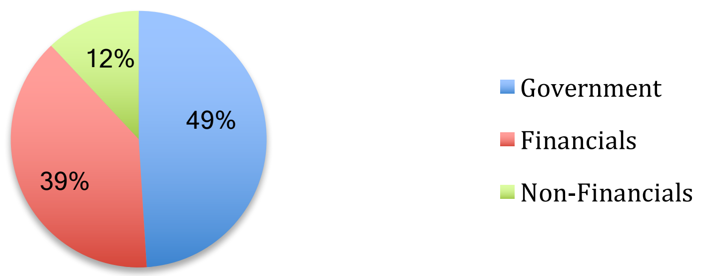
Chapter 7 concludes by summarising the important facets of this research and considers the implication of current economic, political, and social dynamics to the results found.

2.0 The Structure of Emerging Market and High-Yield Bonds

2.1 Recent History

Global debt markets, more than double the gross size of international equity markets, have grown significantly owing to quantitative easing policies; financial innovation in new products, such as asset backed securities (ABS); and the combination of new technology and lower trade barriers speeding up cross-border flow. These debt markets, both short-term and long-term, are composed of government and agencies, corporate, and ABS debt products. Government bond issuers, including all levels of government and supranational issuers, represent 49% of outstanding global debt (Figure 2.1). Currently, domestically issued debt is valued at approximately 70% of outstanding global debt. This is significant, a sign of the importance of capital flow from locally based investors in bond markets.

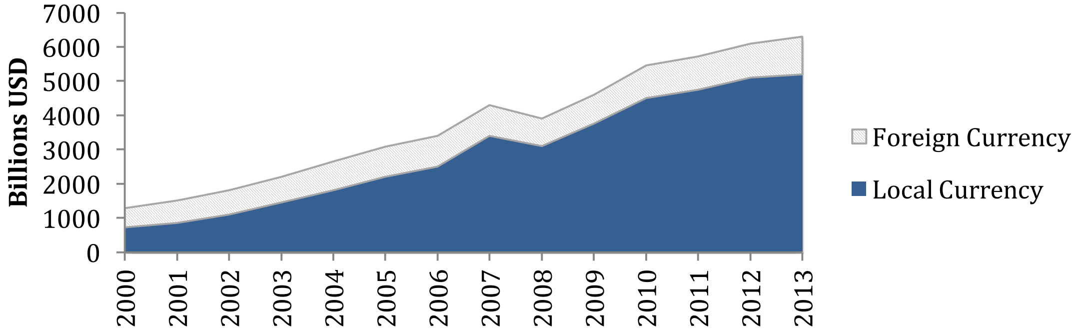
Figure 2.1: Global Debt Outstanding by Issuing Entity



Source: World Bank, 2013

The value of bond market debt issued by emerging market economies grew from a stock of 1.5 trillion USD to 6.3 trillion USD between 2000 and 2013 (Klingebiel, 2014). Most significant within this overall increase was a sixfold corresponding increase in debt denominated in local currencies (Figure 2.2). Investor demand at both the domestic and international levels for local currency debt instruments has supported this diversification from a uniquely hard currency, normally USD denominated, debt. Emerging market economies have benefited from investor interest in currency diversification, as fiscal budgets become less exposed to USD denominated repayment schedules. While this increase in local currency debt issuances is significant, many low-income and low-middle income emerging market nations still have large hard currency debt cash flow obligations.

Figure 2.2: Emerging Market Outstanding Debt: Foreign vs. Local



Source: World Bank

There was a rapid recovery, followed by the growth of global debt markets, shortly after the 2008 financial liquidity crisis. Since this global crisis, debt markets have grown by more than 50 trillion USD (Dobbs et al., 2015). This growth was attributed to a return of investor confidence and an expectation that governments would use fiscal measures to intervene and lower base rates to stimulate their domestic economies. The introduction of quantitative easing programs by advanced economies, combined with global deflationary fears, increased demand for developed market bonds, thereby shifting the yield curve down. The United States launched its first iteration of quantitative easing in late 2008 to provide support for the banking system in the wake of the Lehman Brothers bankruptcy.[1] Quantitative easing policy rules state that primary investment by government must be implemented via bond markets using money created by central bank monetary policy. The United States Federal Reserve bought upwards of one trillion USD in bonds from commercial banks and private institutions (Gagnon et al., 2010). The intent of this monetary easing was to provide immediate liquidity to the global

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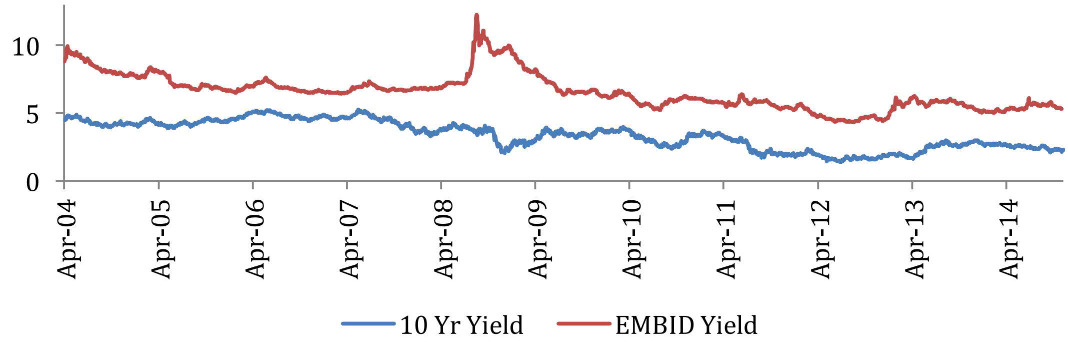
[1] The US Fed repeated the quantitative easing program in 2010 and 2012 and continued a tapered version of QE in 2014.

banking system and to provide a channel for transferring toxic debt assets from banks' balance sheets to government financial portfolios.

The effect of this government purchase program was most pronounced on bond markets; it lowered the risk free yield curve across all maturities, hence lowering all funding rates in the US market. Speculators also benefited from increased bond demand, supported by Western government created purchase programs. Government intervention reduced liquidity fears, but the expectation that economic recovery would be stimulated through bank lending for corporate investment and employment did not materialise. Instead, corporations used low cost borrowing opportunities to invest in foreign markets, make acquisitions, and repurchase company stock. The European Central Bank (ECB) quantitative easing programs were first launched in 2009. Their current monetary easing program, combined with demand for risk free investments, has resulted in yields of less than 0.10% for ten-year German Bunds. Switzerland, while a small economy, has seen ten-year bond trading at negative yields (Nelson, 2015). Figure 2.3 shows the historical US ten-year Treasury yield to maturity compared to JP Morgan's Emerging Market Bond Index Diversified (EMBI-D) yield to maturity.[2] The figure illustrates the flight to safety at the height of the financial crisis and the market response to quantitative easing programs post-2008.

[2] JP Morgan produces a suite of emerging market debt indices. The EMBI-D is the diversified version of the standard EMBI which limits a country's percentage participation in the index. JP Morgan EMBI index suite covers up to 60 emerging market countries. Country participation requires a minimum notional value of 500 million USD for index participation.

Figure 2.3: Historical US Treasury 10 Year YTM vs. JPM EMBI-D YTM



Yield to Maturity of US Treasury 10 year maturity bond and JP Morgan Emerging Market Bond Diversified Index.
Source: JP Morgan and Reuters DataStream

Overall global liquidity increased with capital infused from government bond purchase programs. Bond demand curves in advanced economies shifted higher as a result of the policy of government treasury departments becoming guaranteed buyers. To combat this shift lower in the US Treasury yield term structure, investors have redirected capital to higher risk markets to secure profitable returns on the debt spread to Treasuries. Emerging market and high-yield corporate bonds are beneficiaries of this flight of capital from developed economies. The US government yield curve is generally referred to as the accepted risk free rate in the market. As the underlying risk free rate shifted lower, borrowing rates around the world declined. Emerging market governments seized this opportunity to launch successful large-scale bond issue programs in both local and foreign hard currency. My research employs the US government 10-year maturity yield curve, rather than the near term three-month treasury bill, as a riskless reference to match the tenor of the bond portfolios studied.

2.2 Emerging Market Debt Background

Emerging market participation in global debt capital markets was firmly established after the successful launch of the Brady bond scheme in 1989. Prior to this launch of USD denominated Brady bonds, emerging market sovereigns sourced funding demands from developed economy commercial banks, international financial institutions (IFIs), development banks, and other government lenders. The majority of bank loans were not standardized, nor were the market implications of each loan structure well understood. In Mexico, the major beneficiary of the Brady scheme, American-based commercial banks previously had little advanced knowledge of a sovereign default notification. The introduction of Brady bonds was an immediate success, representing 61% of emerging market debt by 1994,[3] and provided a number of key benefits to emerging market countries. First of all, the plan introduced a common market oriented framework to negotiate debt levels and debt service schedules between emerging market economies and their creditors (Buckley, 1997). Second, it encouraged emerging market nations to actively pursue and implement economic reform packages to bolster renewed access to international debt capital markets. Third, it allowed sovereigns to access debt market lenders and reduce their funding portfolio exposure to commercial banks. By mid-2000, the majority of Brady bonds were repurchased or rolled into new bond issues, reducing their market presence to only 2% of total emerging market outstanding debt. Emerging market nations, outside of South America, did not benefit from the Brady plan, as it focused only on restructuring commercial bank issued loans.

During this same period, African countries were also struggling with imminent defaults, and renegotiation discussions were initiated with a different group of lenders: IFIs, development banks, and governments of other countries. These institutions are the traditional lenders to high-risk developing markets, with many of the debt structures tied to mandatory guidelines for economic reforms and fiscal policy management. Prior to 2003, Nigeria could not participate in international debt markets as it required debt forgiveness procedures to be completed with the Paris and London Clubs[4] (Nwiado and Deekor, 2013). A sovereign rarely makes an outright default as there is normally a restructuring or renegotiation of the debt. If a sovereign does default it is a decision that is executed by weighing the reputational risks versus paying the debt schedule (Gibson and Sundaresan, 1999). The Brady bond experience provided the impetus for emerging market governments worldwide to actively remodel and liberalise their financial markets. The success of these

[3] The Brady Plan report, Emerging Market Trade Association Bulletin, 2000.

[4] Paris Club is a group of creditor countries, established in the 1950s, that is responsible for the role of coordinating and creating restructuring solutions for debtor nations having payment difficulties. London Club is modeled on the Paris Club structure with a similar mandate and first appeared in the 1970s.

efforts, combined with strong economic growth in emerging market economies, formed the foundation for the current success of the emerging market sovereign bond markets.

2.3 The Bond Market

The role of the bond market is to match organisations with long-term financing needs, with private investors looking for long-term interest bearing investments appropriate to risk appetite (Nwiado and Deekor, 2013). Bond markets are composed of debt securities with a maturity of one or more years. The shorter dated interest bearing products are normally transacted in the money markets, for borrowing needs of less than one year. Intermediates, sometimes referred to as broker dealers, participate in all segments of the bond market, from primary issue to liquidity market-maker support of the secondary market. They provide price discovery and investor risk tolerance research to organisations contemplating bond issuances. The role of intermediaries is paramount in bond markets, as information technology systems are more rudimentary compared to the sophisticated electronic market platforms found in equity and commodity markets. The telephone remains essential as the majority of trade executions occur over the counter (OTC). The lack of a common listing platform means bond markets are decentralised. This creates fragmentation concerns for even the most mature bond markets in developed financial systems. Bond market transparency improved significantly in 2002 after the launch of TRACE, which required all trades of publically issued corporate bonds to be reported to the National Association of Securities Dealer, which in turn makes this data public via a web interface (Bessembinder and Maxwell, 2008).

Bonds are contractual promises, by the issuing entity, to make a series of “coupon” interest payments and return the final principle “face value” borrowed according to the contract terms. Zero coupon bonds, meaning no coupon payments, are common in government bond markets and are transacted at a discount from the face value equivalent to the market’s expected default risk premium. Standard bond theory states that a bond yield must reflect the bond’s default risk. At the moment of issuance, a bond's market yield to maturity is usually very close to the selected coupon rate, which represents the market return required for the default risk of this specific bond instrument. In the secondary market, the bond's yield to maturity reflects current idiosyncratic and systematic market risks, which may be different than the assigned coupon rate. If a bond's market yield is trading higher than the coupon rate, the implication is that the risk associated with this bond is perceived to be higher than at issue. A bond with a market yield lower than the coupon rate, insinuates that there is lower risk attributed to this particular bond product. This can be due to changes in either systematic or unsystematic risk factors. Issuers usually hire credit rating agencies[5] to provide an ordinal rating on each bond issuance, indicating the risk of default. A bond price is quoted in the secondary market as a 'clean price' and is transacted at the 'dirty' price, which adds the interest accrued since the most recent coupon payment date to the clean price.

Underwriters endeavour to ensure a successful bond issuance by building a book of investor interest in conjunction with setting a market supported coupon rate and a maturity term, as well as seeking a bond credit rating in line with the bond's promoted risk characteristics. Sovereign issuers use intermediaries and auction processes to offer debt instruments to the markets. At the corporate level, most primary bond issues are sold to investors through private placement. The function of the secondary market is the buying and selling of bonds that are mid-stream in their maturity. A liquid secondary market is critical, as it provides primary market investors a mechanism for price transparency and allows for trading and risk management of bond portfolios.

Bond markets with archaic information systems have been shown to have a slower ability to respond to market shocks than stock markets (Gilchrist et al., 2009). The secondary market for bond trading was less liquid in 2014 than in the years prior to 2008. One of the contributing factors to this situation was new banking regulations

[5] Credit rating agency examples Standard & Poor, Moody's, Fitch.

that applied to the majority of bond market intermediaries. Under Dodd-Frank[6] regulations in the United States and Basel III[7] regulations intended for global implementation, commercial banks are subject to minimum capital requirements to fund business activity. Prior to the 2008 financial liquidity crisis, banks typically held about 3% equivalent capital to support their trading activity. Under the new Basel III regulatory regime, up to 13.5% capital requirements is now mandatory. In response to these regulations banks have reduced trading volumes and inventory across all capital market products, i.e., bonds, stocks, and commodities. Many banks have taken the decision to shutter their once profitable commodity trading businesses due to these higher capital requirements. In bond markets, where the majority of activity is OTC, with minimal transparency on supply and demand, an efficient response to urgent market buy or sell signals is almost impossible. Predatory trading techniques are disruptive to markets when secondary markets are illiquid. This presents several key risks for bondholders, as first and foremost is the widening of the bid-offer spread. Unlike other financial markets, bond securities are not standardised, with the exception of government debt series. Low inventory presents liquidity concerns, as banks and other intermediaries are no longer willing to continue in the role of market makers.

2.4 Emerging Market Bond Market Characteristics

Emerging market economies issue bonds in both foreign currency, usually US dollars, and local currency. While the preference for a sovereign is to issue local currency debt instruments, this will be possible only if there is an active pool of domestic lenders or a strong demand from foreign investors for local currency yield risk. Commodity exporting countries are better positioned to finance their US dollar denominated outstanding debt, as they are receivers of US dollars through commodity export revenues. However, if export revenues contract, the government will have less US dollar revenues with which to manage fiscal liabilities. As emerging market economies diversify their bond issuances with local currency debt

[6] Dodd-Frank Wall Street Reform and Consumer Protection Act.

[7] Basel III: The Liquidity Coverage Ratio and liquidity risk monitoring tools, Bank for International Settlements.

instruments, default becomes less of an issue, as the country's fiscal policy can be modified to encourage domestic growth and revenue from alternate internal sources.

A deep local currency bond market promotes financial stability, attracts foreign investment, and promotes economic growth (Peiris, 2010). The driver behind the growth of local currency denominated bond markets is twofold. First, investor sophistication increased, resulting in demand for portfolio diversification in developed economies, both at the institutional and retail levels. This provided emerging market issuers the opportunity to float Eurobond debt securities[8] in a developed country markets. This strategy proved successful, as investors preferred to transact in established markets with regulatory oversight. The World Bank has facilitated this demand by offering its bonds in more than twenty emerging market currencies over the last decade (Herrera-Pol, 2014). Second, broad-based changes to pension systems around the world, from defined benefit plans to defined contribution plans, created a strong demand—referred to as the buy side—in the domestic markets in a number of countries. Demand for emerging market local currency bonds was driven by these domestic pension plan buy-side participants and large international pension plan portfolio managers.

The success of an emerging country's bond market depends on the national banking system and regulatory framework. National policymakers, with the guidance and support of international policymakers, need to ensure a sound heterogeneous banking system exists, in which there are a sufficient number of domestic banks to provide a competitive and diverse funding market for government and commercial activities. Governments need access to immediate liquidity in the overnight money market for balancing funding requirements. Ideally, access to the bond market should be made available to all types of investors, from individuals to institutions. While opening domestic bond markets to foreign investors is not mandatory for a well-functioning market, it provides the opportunity to limit homogeneity through diversified funding sources. China and India have large domestic bond markets, and

[8] Offshore local currency bonds.

as such, are able to restrict access by international investors. Their success is attributed to the size of their populations and the increase in their domestic savings rates. Government bonds are the pillars to all bond markets, regardless of geographic location. They provide liquidity and stability, which supports the functioning of the secondary market (to illustrate this point, public sector bonds comprise 80% of the emerging market bond domain).[9] As the bond market matures, the percentage of government bonds will decrease, but the overall notional value of the market will be higher as other borrowers issue debt. Domestic borrowing securities issued by the government of Mexico have resulted in an increase in bond market size, longer bond maturity structures, and increased liquidity in secondary markets (Jeanneau et al., 2005). A repo (repurchase agreement) market is also essential for well-functioning debt markets, by providing active short term demand for government securities. This type of market allows participants to fund portfolios for short periods of time by using existing debt positions as collateral. It has a similar function to that of the overnight borrowing rate;[10] however, repo rates tend to be lower because the repo is an asset backed security. A mature domestic bond market provides a platform for governments and firms to access capital efficiently.

China understands the importance of a liquid and transparent debt securities market, and has been actively implementing policies to grow debt markets, in order to reduce the risk concentration within their banking system. Historically, borrowers had two choices: issue equity or obtain a bank loan. There are two segments to the Chinese bond market: the interbank market, which accounts for 95% of the total bond volume, and the exchange bond market, at 5% of the volume.[11] Due to the country's foreign investor restrictions, there is negligible foreign presence in its domestic bond market. Since early 2000 foreigners have had some ability to trade in the exchange bond market—albeit with limitations in market size—but few

[9] Bank for International Settlements, 2013 data.

[10] The overnight borrowing rate, also known as the interbank lending rate, is set by a country's central bank or determined by a survey of participating banks. LIBOR was a survey index used for short-term debt instruments such as repos. After the LIBOR index manipulation scandal, market survey transparency has been improved by central banks. Emerging market countries have active overnight rates that exhibit liquidity limitations in crises situation. The overnight rate of NCB, Nigeria's central bank, reached 70% in December 2014 as short term liquidity concerns hit the domestic financial market (Bloomberg, 15 January 2015).

[11] Goldman Sachs Asset Management Division report, China's bond market, 2015.

international investors have actively participated. In 2012 China allowed participants in its Qualified Foreign Institutional Investor program to trade in the larger interbank bond market.

A strong transparent regulatory framework gives both domestic and foreign investors' confidence to participate in the domestic debt market. Lower transaction costs and unencumbered settlement procedures will ensure cash management issues do not deter investor participation. Stronger domestic institutions and an improved financial policy performance in the areas of stable inflation and strong creditor rights can result in further growth of investor participation in local domestic bond markets. This will reduce or eliminate currency mismatches, such as US dollar liability exposure, on fiscal budgets (Burger and Warnock, 2006).

Emerging market economies have overwhelmingly benefited from quantitative easing programs in advanced economies, through increased investor demand at lower nominal interest rates, while the risk spread to governments may not have changed significantly. Currently emerging market bond issuers have access to a heterogeneous group of investors. Market demand for local currency bonds has allowed foreign exchange risk to be transferred from bond sellers to foreign bond buyers. Increased demand for higher yielding bonds has shifted the demand curve higher, resulting in higher prices for sovereign and corporate bonds alike and, in fact, lowering sovereign borrowing rates as yields have compressed. In the search for higher yields, investors may trade off corporate governance rights for higher expected bond yields. This trend towards investors' acceptance of less governance protection has been observed in the primary market for high-yield corporate bonds (Celik et al., 2015). The heterogeneity of investors is important, but also exposes emerging market debt issuers to several risks. First, diversity in risk tolerance and investment horizons towards shorter term timelines can result in bond price volatility, as investors reallocate portfolio capital based on signals in the market. In a bond market populated with foreign participants, a change in the monetary policy of one country can impact the bond market demand and supply balance in another country. A shift in US monetary policy in order to restrict capital flow will result in a downward modification for the demand curve, lowering bond prices and resulting in higher yields, which could provide incentives for bondholders to reorient their portfolio holdings from emerging market bonds to US Treasury bonds. Global markets are increasingly interconnected and interrelated, to the point where contagion fears in one part of the world can have a significant impact on markets on the other side of the world. Domestic investment is less resistant to external market shocks than foreign originating investments, thereby creating price volatility for domestic government debt instruments. Governments are more likely to default if a large percentage of debt is held by foreigners. If this is the case, the government will give greater consideration to defaulting on international bonds, domestic bonds, or both (Kremer and Mehta, 2000).

2.5 High-Yield Corporate Bond Market Characteristics

As mentioned earlier, high-yield corporates in developed economies benefited from lower borrowing costs cumulating from lower risk free rates and high investor demand. In 2014, the US corporate high-yield market surpassed one trillion dollars.[12] Energy has the largest industry concentration in the US high-yield bond market at approximately 17%. Exploration and production firms compose 50% of the high-yield energy sector (Acciavatti et al., 2014).[13]

Modern bond theory suggests that holders of a given firm's risky debt can be thought of as owners of riskless bonds who have sold short a put option to firm equity holders (Merton, 1974). An increase in volatility benefits firm equity holders, as they are long volatility via the put option. Campbell and Taksler (2003) found similarly that volatility had the opposite effect on stock and bond prices. Given expected firm profits, volatility in firm value hurts bondholders because of the increased probability of default. Corporate bond yields include both systematic and idiosyncratic volatility factors.

[12] Year End 2014 Fixed Income Research report from BofA Merrill Lynch.

[13] Considering the energy volume participation of the 17% in the JP Morgan USD US High Yield Index.

Determinants of high-yield bond spreads encompass both company idiosyncratic variables and general bond market characteristics. Company-specific factors include the bond's assigned rating (if any), seniority, tenor, callable features, and the shape of coupon payment schedules. First-time issuers are seen as higher risk, as are issuances underwritten by commercial banks versus investment banks (Fridson and Garman, 1998). The promotion of a high-yield bond issuance could feel headwinds if there are general market default concerns, low demand from buyers, or surplus high-yield bond supply on the primary or secondary markets. Spread to "risk free" treasuries and inter-market spread, which is the difference between investment grade rating qualities, also impact the bond pricing strategy. General market conditions have a direct impact on bond pricing.

After the initial sale of bond issuances, trading in the secondary market will be closely monitored as a market pricing signal for any subsequent bond issuances by the same borrower. Secondary market liquidity of some high-yield corporates can be low because there is no analyst coverage of the firm and investors find it too costly to analyse the borrower's credit rating (Crabbe and Turner, 1995).

2.6 Investors

Emerging market sovereign and high-yield corporate debt are an important and growing asset class amongst both domestic and foreign institutional investors. Investor demand for diversification and higher yield returns has supported this growth.

Bond market investors with long-term investment horizons, such as pension funds and insurers, pursue a buy and hold strategy. They seek interest bearing financial products with known stable revenue streams, issued by investment grade borrowers (Impavido, 2002). Monetary easing policies have forced traditional bondholders to reconsider investment strategy, as in 2014, short-term yield curves traded near zero and ten-year maturities traded around 2% depending on the advanced economy. With risk free borrowing rates now significantly lower than expected inflation, institutional investors who are required to manage future payout obligations are purchasing bonds in emerging market sectors to increase portfolio returns. Corporate governance policies restrict many institutional portfolio managers to investment in only grade debt securities. There are currently several emerging market bond issuers deemed investment grade: China, Brazil, Mexico, Poland, Malaysia, and Thailand.[14] The combination of increased institutional investor risk appetite, transparent financial markets, and sovereign fiscal stability in investment grade emerging market economies has supported the transition of institutional investor demand from hard currency to local currency denominated debt instruments (Rauh, 2009). Investment grade emerging market countries issue the majority of debt in local currency. Many institutional investment guidelines require a country to be included in an internationally tracked index such as JP Morgan's EMBI, the Barclay Capital Emerging Market Debt, or the Citibank EM Index.[15]

Newer entrants to bond markets have different mandates for risk and time horizon, compared to institutional investors. Hedge funds and retail investor products such as ETF's adjust portfolio composition frequently based on shorter term market opportunities (Brown et al., 1998). These investors have a greater risk tolerance and seek out higher yields provided by corporations and sovereign bond issuers worldwide, ranging in credit ratings of investment grade to below investment grade. Bond covenants have evolved because of the change in investor profile. Recently, Mexico changed several key covenants in bond products to reduce the power of aggressive fund managers and provide a collective voting process for approving sovereign bond management activities, such as bond restructuring under special circumstances (Moore, 2014). These changes have been greeted positively by the market and could expand as other sovereigns consider modifying their bond covenants. Investors in emerging market sovereign and corporate debt markets continue to demand some level of transparency on planned use of funds, in particular at the corporate borrowing level. While demand for hard currency

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[14] Standards and Poor and Moody's rating agency.

[15] Sovereign debt included in a tracking index must maintain some threshold requirements set out by the index guidelines and rules, such as minimum secondary market trading, notional market size, and credit rating.

denominated debt remains, the supply is reduced, as investment grade emerging market economies provide only local currency denominated bonds.

The characteristics of investor strategy are important to consider, as the process of injecting capital flow into certain markets may not necessarily be due to a direct interest in these assets. There has been the claim that a significant fraction of the investor composition in these asset classes are so called crossover investors who have no loyalty to an asset class, and thus will opportunistically withdraw and redirect capital. This was observed in 2013, when capital outflows from emerging market sovereign debt were re-assigned to US high-yield debt to obtain a higher return risk premium (Cohn, 2014). Research has shown that capital inflows to emerging market sovereign debt can be explained by conditions outside the country or region, such as low interest rates in developed countries. Concerns have arisen when there is a reversal in conditions, such as high-yield opportunities outside the country or region, where future capital outflows could cause macroeconomic vulnerability (Calvo et al., 1993). In low interest rate environments, bond prices have a skewed risk reward profile, which can cause sudden, usually negative, price movements if investors believe monetary tightening policy rumours.

The carry trade is a popular strategy in foreign exchange markets. In this type of trade, a trader borrows a low yield currency and invests equivalent capital value in a high yield currency. Emerging market countries are targets for the carry trade, as their interest rate policies tend to provide higher returns, in keeping with the risk perception. Rapid market risk reductions due to investor fear are dangerous to smaller economies and risky firms that have benefited from an influx of capital liquidity.[16] This type of investor behaviour in a meaningful size could cause distortions and volatility in the market similar to (but of a lower magnitude than) the flight to safety seen in 2008. It is important to understand the exogenous factors impacting emerging market and other high-yield bond issuers.

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[16] Iceland and New Zealand are examples of smaller economies that experienced significant market volatility as traders unwound risk during the months leading up to the 2008 financial liquidity crisis. For example, in 2007 traders borrowed capital funding in Japanese markets (lowest global borrowing costs) and invested equivalent capital in Iceland, New Zealand, and other high interest rate countries.

The size of institutional investor portfolios has driven these investors to look outside their home countries to other regions, in order to achieve their desired portfolio diversification. The number of these types of investors has grown, thereby increasing the risk of herding and market exaggerations, particularly in smaller or less liquid markets, such as non-Treasury debt markets. The result is that investor behaviour could cause markets to become more connective and increase any associated correlation (either positive or negative), resulting in contrary conditions for portfolio diversification. This theme will be discussed as it pertains to bond returns for emerging market sovereigns and energy high-yield corporates in the context of energy price interactions.

2.7 Conclusions

Global debt markets now have an outstanding notional value more than double global equity markets. The growth in demand for sovereign and corporate bond markets has supported access to debt capital for riskier issuers such as emerging market sovereigns and high yield corporates. Emerging market governments can now access funding from debt markets rather than being solely dependent on IFI's and their demands regarding mandatory economic or performance policy changes. High yield corporates access the high yield debt markets to diversify their borrowing so as to reduce reliance on bank lending relationships that can include covenants that limit management decision making. Credit markets, which are highly linked to bond markets, are cyclical in nature and exhibit risk additive and risk reduction behaviours. High yield issuers, including emerging market sovereigns and high yield independent producer corporates studied in this thesis, are at risk of the credit cycle troughs that result in investor flight to safety via selling high risk debt instruments and diverting investment channels to accepted low risk debt instruments.

3.0 The Crude Oil Market and Hedging Methods

3.1 Background

Crude oil prices have played a central role in the global economy since the end of the First World War. Ease of transportation, either waterborne or via pipeline, has established crude oil as an internationally traded product. Although crude oil has limited use in its raw form, once it is transformed by means of separation and a refining process, it becomes a highly useful and in-demand end product. For these reasons, the market price of crude oil is closely monitored. As a result, there is an extensive body of research studying the significance of oil price and volatility to global economic performance over more than 30 years.

The oil market pricing system is centred on the price discovery at three key benchmarks: West Texas Intermediary (WTI), Brent basket, and Dubai/Oman basket. WTI is a light low sulphur physical benchmark, launched in 1983, and references the physical crude oil pipeline and storage infrastructure near Cushing, Oklahoma. Brent, created in 1988, is also a light low sulphur blend, and is a waterborne reference basket using a specified group of offshore production platforms. The Dubai/Oman benchmark, the most recent benchmark, launched in 2004, is a medium sour crude oil reference price for the Middle East and for shipments to Asia. Each benchmark has defined physical characteristics regarding viscosity, sulphur content, and acidity. These physical benchmarks are used broadly in the industry for long-term contract pricing, futures exchange settlement of contracts, and settlement of derivative instruments between companies and banks, as well as by governments for tax purposes. Many crude oil trades are formulas that reference a benchmark settlement index and incorporate either a positive or a negative differential, known as a spread, value attributed to the trade characteristics. The differential might represent the differences in quality composition or delivery location that vary from the benchmark selected.

Prior to the market-based pricing system for crude oil, exporters were instrumental in setting the price formulas used for oil sales. The time period from 1950s to the mid-1980s followed an administered pricing regime, controlled first by large international oil companies and then by OPEC. By the mid-1980s, with lower global demand under recessionary conditions and an increase in the number of non-OPEC oil producers, OPEC's ability to govern the administered pricing structure collapsed. Non-OPEC oil exporters with surplus production capacity began selling actively into spot markets, in a manner that undercut OPEC backed price structures. In 1986, Petróleos Mexicanos (PEMEX), the national oil company of Mexico, established the first market related pricing mechanism in its contracts (Fattouh, 2011). Other oil exporters soon followed, resulting in a pricing regime shift to the existing market-based pricing structure.

The crude oil derivatives market, launched in 1983 with the arrival of the New York Mercantile Exchange (NYMEX) WTI contract, offers products available for delivery over 36 future trading months and a possibility of seven calendar years. A combination of an increasing number of independent producers in a newly deregulated energy market and advances in financial engineering designed risk management strategies supported the rapid growth of trading volume in the futures market. WTI and Brent futures benefit from a vibrant spot market and a financial market with a high level of liquidity, transparency, and participation to support price formation. This allows for efficient, low cost trading for oil producers, refineries, consumers, and financial participants. Fleming and Ostdiek (1999) found that deep liquid futures markets have a moderating effect on the volatility in the underlying market. Therefore, liquid markets allow for efficient initiation of risk management programs, using the futures and options market to reduce exposure to unpredictable oil price swings for both producers and consumers, thereby mitigating client risk for market makers.

In theoretical economic models studying the long run evolution of prices and supply for a non-renewable resource, as is the case with crude oil, the Hotelling Rule (1931) is the central foundation (Livernois, 2008). The rule states that for a non-renewable resource, the net price, defined as the market price minus marginal cost, must rise at the rate of interest in a competitive market equilibrium. The term structure of the futures curve, using this theoretical approach, should be upward sloping, assuming that marginal extraction and production costs are not declining over time. Oil assets stored above ground, should also support an upward sloping oil futures curve and follow the structure where the forward price and spot price have the following relationship: $F_t = S*[1+(c-y_{conv})*t)]$, where c represents financing, shipping, storage, and insurance costs and y_{conv} represents the convenience yield which is the premium associated with holding the physical underlying product instead of a derivative. Interestingly, oil markets do not consistently demonstrate upward sloping, otherwise known as contango, patterns. Frequently, the oil futures curve is downward sloping, or backwardated, meaning that expected future prices are lower than the spot delivery price. There are several contributing reasons for this, which can include expected change in supply demand equilibrium, cheaper future expected extraction costs, spot market oil supply constraints due to inelastic infrastructure response, concern about future supply channels or financial trading anomalies.

Global oil prices over the last decade have been characterised by periods of extraordinarily high and unexpectedly low volatility. Understanding the possible exogenous drivers behind defined oil shocks during this time period is important for interpretation of the influence of these oil prices on producer borrowing yields and risk management policies. There has been ongoing debate in the research community on the significance of positive and negative oil price shocks on macroeconomic factors and stock markets. Yet there has been limited research to date on corporate and sovereign bond markets or firm level responses.

Empirical research requires a strong understanding of the fundamentals that are contributing to the generation of an oil price shock, as the oil shock itself perhaps may not be considered exogenous (Kilian, 2009). Examples of reasons behind an oil price shock include reduced production due to war, embargos, and disturbances in a producing region or a systematic decline of oil production capabilities. The 1973 oil crisis was a strong positive shock caused by supply restrictions linked to an embargo resulting from the US's involvement in the Yom Kippur War. The 1985-86 negative price innovation was a result of a rapid increase in supply from non-OPEC producers intersecting with OPEC's refusal to curb their production. On the other hand, the positive price increase leading up to 2008 was attributed to a broad increase in global aggregate demand, in particular from the BRIC[17] countries. The negative price shock in 2009 came from a rapid contraction in global demand, as a response to liquidity fears across money markets. The most recent negative price development is driven by the oil supply side, through the combination of increased non-OPEC production, led by US domestic shale oil volumes, and Saudi Arabia's resignation as the swing producer.

The role of speculators in the oil futures markets remains actively debated. In general, speculative capital in crude oil futures improves market function and allows the market to react faster, speeding up price adjustments and allowing producers and consumers to hedge (Weiner, 2002). For example, speculative traders and market making traders take directional positions opposite to hedgers to earn a risk premium. Concern regarding speculator behaviour arises when the futures market price movements do not seem aligned with current and future expected market supply demand fundamentals. The influx of institutional investors, hedge funds, and wealthy individuals in direct oil market investments or indirect index investment products has created the so-called financializing of energy markets (Tang and Xiong, 2012). The arrival of algorithmic trading in recent years has been seen as a significant market development. The growth of quantitative trading methods, including high frequency trading, that rely solely on technical signals to initiate trades rather than on fundamentals, is an open area of study. These new traders bring further liquidity to normal market environments, hence lowering transaction costs, but withdraw liquidity during adverse market movements, which can result in a higher volatility response (He, 2018), (Menkveld, 2013). Recently one new entrant

[17] BRIC refers to Brazil, Russia, India, and China.

to oil futures markets indicated that oil demand and supply fundamentals were irrelevant to their trading strategies (Meyer, 2018).

There has been much debate about OPEC's significance to oil market behaviour since the mid-1980s, and in particular during the most recent negative price evolution in 2014, under increasing non-OPEC production growth (Kaufmann et al., (2004), Bentzen (2007), Mohammed (2014)). Saudi Arabia, the largest producing OPEC member, has traditionally played the swing producer role, by adjusting its production volumes to create stability in global oil prices. With the strong growth of non-OPEC production, led by an increase in US annual oil production of 40%[18] over the last ten years, Saudi Arabia's role as global oil price stabilizer has resulted in a loss to its market share. In an effort to stop this erosion of market share, Saudi Arabia changed its policy and will no longer take on the role of swing producer. This has essentially created a more efficient open global pricing market in oil.

In 2008, prices tumbled across the entire commodity complex as investors withdrew capital from financial markets in response to liquidity contagion concerns and broad-based recessionary fears. In August 2008, the West Texas Intermediate (WTI) nearby crude oil contract settled at 146.64 USD/Bbl (Figure 3.1). By March 2009, the WTI nearby contract traded down to a low close price of 37.23 USD/Bbl.[19] The oil price recovery, which started in late 2009, was attributed to growth in emerging market economies, rather than to advanced economies that were still grappling with liquidity and debt rebalancing.

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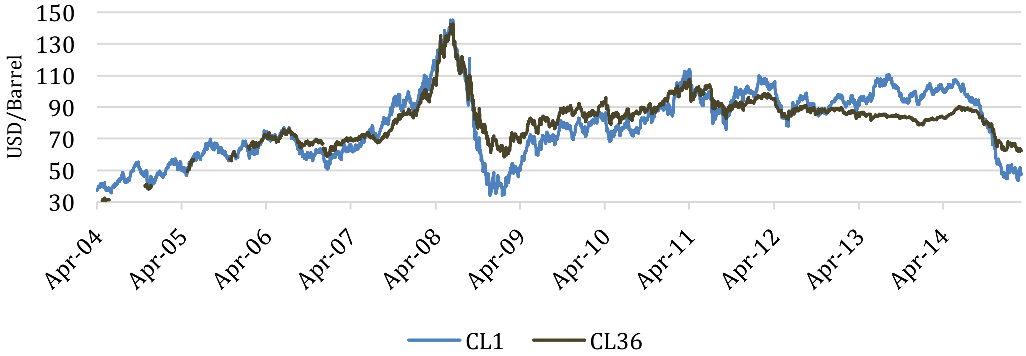
[18] EIA annual oil production data by country, 2004–2014.

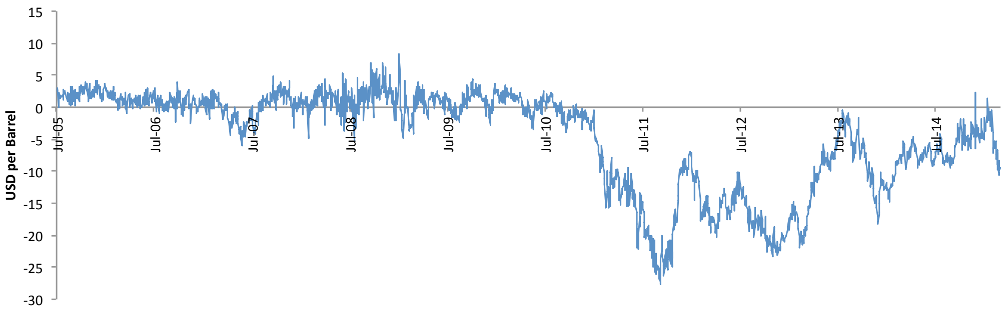
[19] High and low price data from the NYMEX WTI nearby futures contract. The Brent futures contract has a similar price pattern during the 2008 / 2009 period, yet high and low prices occurred on the WTI contract.

Figure 3.1: Historical WTI Nearby (CL1) and 36-month (CL36) Futures Contract



The slow return of North American oil demand, combined with limitations to domestic pipeline infrastructure or access to export markets, due to a US Federal policy initiated during the 1970's oil crisis, fixed limitations on crude oil exports.[20] This resulted in the structural price break between WTI and Brent benchmark oil pricing locations (Figure 3.2). Historically a small net average premium to Brent, WTI was dislocated from the global oil pricing system in 2010. This is significant, as prior to 2008 the majority of global oil purchase and sale contracts referenced WTI for settlement price purposes. Post-2010, the global oil market, ex-United States, is using Brent for contract reference price and settlements.

Figure 3.2: WTI – Brent Nearby Futures Contract Spread

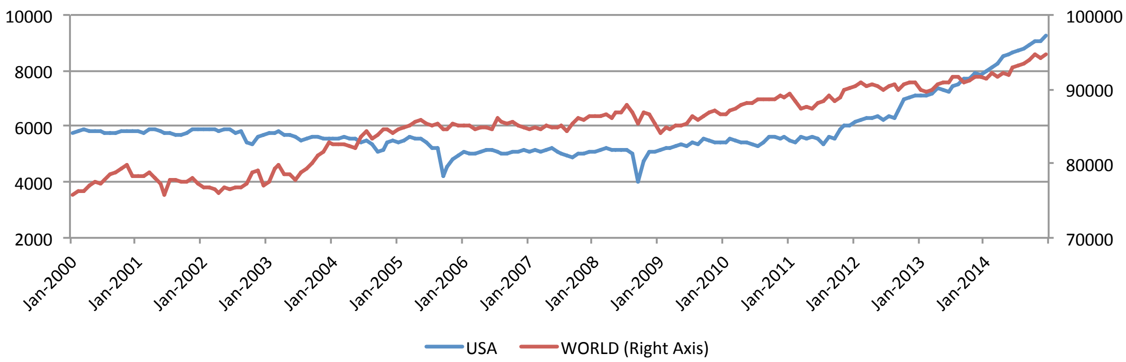


Source: Energy Information Administration

[20] The 1975 Energy Policy and Conservation Act, which bans crude oil exports except in select circumstances.

Technical innovations in shale extraction methodologies,[21] successfully exploited first in natural gas production, were eventually applied to crude oil exploration projects starting in 2009. US crude oil production increased sharply mid-2011 on the success of these shale oil discoveries (Figure 3.3). United States oil production increased 15.1%[22] in 2012 over 2011 levels, with a corresponding shift to the right of the supply curve. This increase in anticipated shale oil supply can be observed in the price trend of the WTI futures contract for delivery three years in the future (CL36), as active shale producer hedging and fundamental trader opinions put downward pressure on this portion of the futures curve (refer back to Figure 3.1). The combined shale production from small-to medium-sized corporates and the oil majors resulted in US oil production returning to nine million barrels per day, a level last observed in the early 1970s.

Figure 3.3: USA and Global Oil Production by Month in Thousands BPD



Source: Energy Information Administration

The growth of US oil production led to a change in oil transportation patterns in the global physical market. Although the US is not actively exporting crude oil, it did reduce oil imports from suppliers in response to growing domestic supply. This reduction was not uniform across all oil suppliers. Providers of light crude oil saw more drastic reductions in US demand (Figure 3.4). As a direct impact of increased US domestic shale oil production, in August 2014, Nigeria's oil deliveries to the

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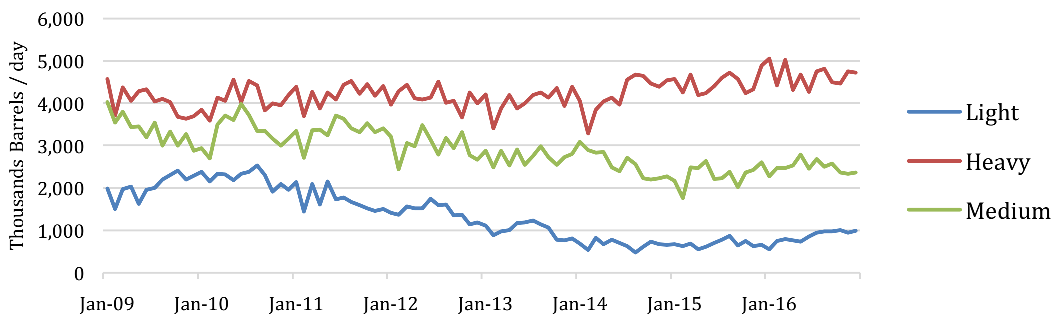
21 Shale oil is extracted using a process called hydraulic fracking, which is a drilling process which injects large quantities of water and solvent mixtures at high pressure into the ground, in order to circulate them in the shale rock geology and release natural gas and oil molecules.

22 EIA data and author's calculations.

United States halted. In response, Nigeria diverted crude oil shipment eastward to fulfil demand from Asian customers. Heavy oil grade imports, primarily from Canada, were stable during this time period, supported by demand from refineries that continued to require heavier crude oil feedstock. The refinery industry could not benefit from the increase of light sweet domestic production. Refinery processes are designed for a narrow range of crude oil qualities, thereby preventing refineries of heavy grades to efficiently process lighter grades. Altering refinery configuration or expanding refinery capacity can take up to five years,[23] which is much longer than the required time for changes to land or waterborne transportation infrastructures (Kesicki, 2010).

Figure 3.4: Oil Imports to USA in terms of Crude Oil Grade



Source: Energy Information Administration

Global oil prices were remarkably stable between 2011 and early 2014 (refer back to Figure 3.1), given the numerous geopolitical events occurring in the Middle East and North Africa (illustrated by the local political unrest that disrupted Libyan oil production). The EU and US embargos on Iran, intended to force, via economic channels, halt in nuclear proliferation activities, resulted in restricted oil production due to lost customer demand. When Libyan and Iranian oil production resumed, the extent of the US domestic shale gas contribution to global oil production volumes became more transparent. The result was global crude oil supply growth at 1.76%, which was more than twice the rate of global demand growth, at 0.84%, from 2012

[23] Environmental regulations and local opposition are significant hurdles to refinery capacity development or expansion.

to 2014.[24] This imbalance has resulted in a steep decline in global oil prices during the fourth quarter of 2014. During this time period, OPEC publically indicated it would not reduce production levels to rebalance the market. Debate ensued as to the extent of the price collapse and the duration of what may be considered low prices. A gamut of producer extraction costs, with limited transparency, have created broad speculation on the advancement of production shut-ins, necessary to create a new supply-demand equilibrium.

3.2 Oil Market Hedging

Oil demand, as with other commodities such as iron ore and copper, is cyclical in nature. The economic impact of commodity price booms and busts provides a challenge for all policymakers, in particularly for those in commodity exporting countries. Cashin et al. (2001) show that commodity cycles are asymmetric, with low price periods lasting almost two times longer than high price periods. This supports the need for oil producers to invest in price forecasting research and implement risk management programs to protect oil sales from low pricing episodes. Hedging programs can provide exporters with price protection, through fixed price transactions for a future delivery period or downside floor price protection, using a put option.

While there is a divergence in risk management policies for hedging oil price exposure amongst producers and consumers, there are several core similarities. Both importers and exporters are concerned with internal objectives, risk tolerance for price movements, future financial commitments, credit management, physical business operations, and analyses of market conditions. Risk management tools for oil producers include contractual structures, derivative instruments, vertical integration, and structured products. Oil consumers, with the exception of refiners, do not hedge as actively due to a lack of available products with which to hedge their business outputs. The classic example refers to airline corporations. Airlines hedge their jet fuel expenses, albeit at a reduced volume than company forecasted

[24] International Energy Agency data, author calculations of supply growth (Q42012-Q42014).

consumption patterns, because there is no way to hedge the income stream from consumer ticket sales.

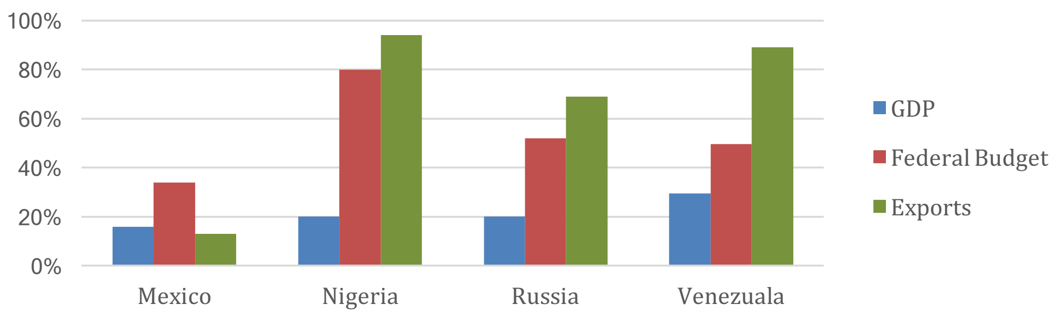
Corporate and sovereign oil producer risk management programs are designed to balance benefits with costs to implement a portfolio that mitigates oil price risk. Their risk programs have many similarities, as previously identified above. They also have several key differences, including the size of their hedging programs, their stakeholders, and their decision-making processes.

Publically traded oil companies have to manage shareholder welfare, while private companies and partnerships have defined owners. Companies with outstanding debt obligations also have creditors as stakeholders. Sovereign producers have only one stakeholder, the government. Downside risk for a corporate is seen as reduced earnings to income statements and reduced cash flow for managing liabilities. A sovereign exporter sees downside risk as reduced revenue defined in the budget.

Listed companies must inform shareholders, directly or indirectly, during the hedging strategy decision marking processes. Publically traded oil producers can experience difficulty implementing a hedging program due to lack of shareholder support. Shareholders may want to participate in oil price risk by holding onto shares of an oil producer and prefer to have the option to independently hedge oil price volatility through alternative financial instruments. On the other hand, smaller independent oil producers, which depend on bank loans and debt markets rather than equity finance, need to consider hedging programs to ensure cash flow stability in order to manage interest payment schedules. Lenders may demand active participation in hedge strategy decision-making processes, by invoking covenants that prescribe hedging protocols and future debt borrowing lines.

Crude oil prices can have significant impact on fiscal budgeting and policy development for both emerging market oil exporting and oil importing countries. Developing countries receive a large share of the national income by exporting a single commodity, while government expenditure programs depend on revenue from national oil companies (Figure 3.5). Oil transactions are priced in US dollars, creating both an absolute price risk for the commodity and a foreign exchange risk exposure between the local currency and the US dollar for both importers and exporters. Importers realise the commodity price and exchange rate risks in the expenses section of their budgeting process, whereas oil exporters account for the commodity price risk and the exchange rate risk on the revenues in their fiscal budget.

Figure 3.5: Oil Sector Contribution (%) to Country GDP, Federal Budget, Exports



Sovereign exporters can use commodity hedging programs to enhance domestic welfare through two channels. First, hedging will reduce export income volatility and allow for smoother consumption patterns through fiscal budgets. Second, hedging reduces the need to hold foreign assets, which are used to support a strong sovereign balance sheet to allow for borrowing against future export income. Precautionary saving also limits consumption capabilities and may limit economic growth during strong oil price cycles. Sovereign importers can use commodity hedging programs to cap their purchase price of oil for domestic consumption. Alternatively, the sovereign importer may have developed and continue to maintain strategic stocks that can be utilised in a scarcity situation or to insulate the country from an identified high price event.

The research literature has shown that there are several obstacles to an emerging market country implementing risk management strategies. The main obstacles have been access to financial markets, limited financial knowledge of in-country decision makers, and finding appropriate risk management strategies applicable to emerging market economies (Claessens, 2005). The use of sovereign stabilisation or savings funds, rather than financial market instruments, is common amongst the majority of emerging market countries (Devlin and Titman, 2004). Sovereign stabilisation funds are said to be flawed, because they are at risk of misuse under weak governance and short-term political interference (Daniel, 2001). Evidence of political interference has been established in both advanced and emerging market countries (Blundell-Wignall et al., 2008).

Oil producer sovereigns, with the exception of Mexico, have participated very little in hedging activity, due to the obstacles mentioned above. An additional hurdle for emerging market sovereigns to participate in hedging programs may well be the difficulty in financing the upfront cost of contingent claim programs. The alternative to option structures are future price swaps with a fixed price (or series of price fixings). These tend to be undesirable as participation in high price trajectories is excluded.

One of the best known examples of proactive energy risk management is PEMEX, which for many years has used a comprehensive annual oil hedging program to support oil sales (Parraga, 2014) and is the trend setter for sovereign exporters. The low oil prices of the mid-1980s caused a significant imbalance in Mexico's fiscal budgets. After analysing this incident, Mexico has been hedging oil output since 1990, when Saddam Hussein invaded Kuwait, and as a result of the size of its hedging program is considered to be the top sovereign derivatives trader in the world (Blas, 2017). Mexico up until recently counted on oil for up to one third of its federal revenue. Oil sales now contribute approximately 20% to its federal revenue. Diversification of government revenue streams, lower oil market prices, and implementation of a new taxation policy explain this reduction. A senior International Monetary Fund official describes Mexico's hedging strategy as "a fiscally responsible exercise that reduces the country's borrowing costs."[25] Mexico executes a conservative hedging program by going long put options or put spreads and recently spent 1.5 billion USD per year on floor protection for oil sales (Blas, 2017). The massive size of this hedging program, up to 330 million barrels of oil per year, necessitates some element of secrecy between Mexican government officials and the Wall Street banks selected to execute the hedge, to ensure that the trade house and hedge funds do not front run the trade execution in the market.

Large hedging programs can have significant short-term implications for oil markets. Increased demand for put options to protect oil producers from falling oil prices will amplify the oil option market volatility put skew and drive up the option premium for this downside protection. At the same time, underlying market prices will fall as counterparties to the put option transactions will go into the market to sell futures to prepare a delta hedge for the trade risk. The annual PEMEX hedge has had this effect on the market. Over the long term, oil markets pay attention to hedge reference strike prices designated for sovereign risk management programs, sovereign economically viable reserves, and fiscal budgeting break even prices for sovereign exporters.

Civil servants within the Mexican government ministries collaborated with external financial market experts in Wall Street investment banks to develop and implement sophisticated hedging programs. While there is little detailed information on the hedges implemented, Mexican officials have been more forthcoming recently by publically announcing average strike price and total premium payments. There is very little to no information on the oil hedging activity of other emerging market sovereigns. A question that should be asked is why other sovereign exporters have not followed the Mexican example, which shows that large-scale hedging programs can be executed effectively in the oil market. This is a relevant question, as sovereigns can proactively manage risks faced by the country through access to financial markets as an alternative to sovereign stability funds. The lack of data

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[25] Quote from Fabián Valencia, IMF economist, 4 April 2017, interview with Bloomberg.

available for an empirical study of emerging market sovereign hedging programs and their effect on sovereign fiscal balances indicates that a different producer group needs to be selected for my empirical study.

Small to medium exploration and production companies have been instrumental in the application of leading edge technological innovations in drilling to exploit US shale oil production. These companies are faster, more efficient, and lower cost than the oil majors in gathering resources and capital in the search for profitable shale oil deposits. The success of these efforts can be attributed to the strong entrepreneurial culture in the US and the access to liquid, low cost borrowing instruments in the debt markets. Changes in advanced economy government quantitative easing programs creates a significant risk for small to mid-sized E&P companies to access low cost capital for business operations or further investments. Understanding the exposure of these companies to oil price fluctuations and cost of capital volatility is useful for examining predictability of credit rating modifications, probability of defaults, and recovery rates.

Literature on oil exploration and production sector hedging has focused on US corporate markets. Hedging activity and the sophistication of hedging strategies are said to be correlated to the corporate leverage ratio (Domanski, 2015). Companies with production located in areas where commodity prices have high correlation to prices on exchange-traded derivatives markets are more likely to manage hedge risks. This tends to happen because there are no market hedge tools to protect the differential risk, or the market cannot or is unwilling to price this risk into a hedging product. The overall number of producers hedging is related to financing costs. This may be due to a lack of economies of scale which may make hedging more cost effective. The extent of corporate hedging is also linked to borrowing instrument structures and covenants that may demand minimum volume hedges to ensure that stable cash flow streams are available to service outstanding debt.

Many corporate producers have hedge programs in place guaranteeing a known floor price for a predetermined volume of production. Hedge programs provide producers with downside price protection, thereby eliminating or delaying exposure to shut-in economics. Wall Street banks are instrumental in developing comprehensive tailored hedge strategies for customers, as highlighted previously in the PEMEX hedge program. These brokers dealers and other commercial banks marketers are incentivised to convince clients to execute further transactions to further tailor hedge programs. Chen and Xiong (2014) found that natural hedgers tended to trade more than was necessary to maintain a passive hedge strategy. This may be the result of the broker dealer marketing pressure mentioned above or management trading around their hedge position, a risky proposition. Management may be tempted to monetize hedge value during large price movements to provide a large cash flow injection to income statement revenue lines. This also is a risky proposition as the producer is then left with no price protection for future oil sales.

3.3 Conclusion

The oil futures and options market is a robust liquid market with low bid-offer spreads and transaction costs that allow for implementation of risk management programs. Unpredictability in future expected oil prices supports production hedging motivations. This thesis will consider why some producers hedge and others do not under both sovereign and corporate situations. Additionally, it will debate that energy prices are not the primary driver for market-based risk management strategies; instead, the financial capabilities of decision makers and debt covenant requirements, combined with market access, explain the usage of commodity risk management.

4.0 Energy Price Implications To Emerging Market Bond Returns

4.1 Introduction

Investment in emerging market sovereign debt has grown amongst both domestic and foreign institutional investors. This growth is underpinned by the demand for higher fixed income yields. Given the importance of this debt market and the high level of integration with other financial markets, changes in investor strategy can have a large influence on bond market performance. This paper addresses the impact of oil price innovations on total returns of USD denominated emerging market sovereign bond portfolios. As far as the author knows, it is the first to study the effect of oil price innovations on portfolios of emerging market sovereign bond issuers. This research contributes to the understanding of sovereign bond market dynamics in emerging markets and builds on the earlier work of Aboura and Chevallier (2015) on commodity interaction with financial markets that showed asset managers need to understand shocks and volatility interactions to develop favourable hedge strategies. The results of this study will be immediately relevant to the academic and financial communities, given the importance of emerging market sovereign bond portfolio allocations to both opportunistic hedge funds and longer term strategic institutional investors such as pension fund managers and insurers.

Investor demand for emerging market sovereign debt instruments resulted in a fourfold increase in outstanding debt in 2014, from 1.3 trillion USD in 2000 to 6.2 USD trillion (Klingebiel, 2014). The growth of the emerging market sovereign bond market has provided an opportunity for governments to diversify funding sources. Most countries are directly exposed to energy price fluctuations in either an importing or an exporting capacity. This paper seeks to understand if the bond returns of energy exporters, such as Mexico and Russia, and importing countries, such as China and South Africa, react differently to oil price shocks. Recently, concern has arisen over the rapid decrease in oil prices first observed at the start of the fourth quarter 2014, and the impact on emerging market crude oil exporters' fiscal budgets and credit ratings. Specifically, the decrease in oil export revenues reduces foreign currency receipts, which puts servicing of foreign currency debt at risk and reduces fiscal revenues in state budgets. This increases the risk of servicing of both foreign and domestic currency debts.

Emerging market sovereign bond spreads or sovereign risk premia, the difference between an emerging market sovereign yield and the matching tenor US Treasury bond (the implied risk free base rate), measure a country's creditworthiness and an investor's required financial compensation for holding this sovereign risk. Remolona et al. (2007) described the sovereign spread as the summation of expected loss on the bond and a risk premium, and found that expected loss contributed very little to the sovereign yield. Investor risk perception will be influenced by recessionary concerns, interest rates and anticipated inflationary pressures, policy uncertainty, and additional idiosyncratic country factors, such as energy prices. Oil importing sovereigns are exposed to price shocks as an expenditure function, whereas oil exporting sovereigns are exposed to price shocks as a hard currency revenue function. This research studies market response to sovereign bond portfolios under oil price innovations and describes results in terms of investor risk perception.

Market sovereign bond spreads are assumed to be a more timely indicator of a country's creditworthiness than its credit rating, and more accurate for short horizon strategies. Altman and Rikjen (2004) noted that ratings agencies model sovereign default risk with a long-term horizon structure which does not reflect the risk of short-term bond investment strategies. This is relevant as improved market access and liquidity, combined with a changing fixed income investor profile to include fast-moving opportunistic traders, result in shorter holding periods for sovereign bonds, particularly around anticipated macroeconomic events.

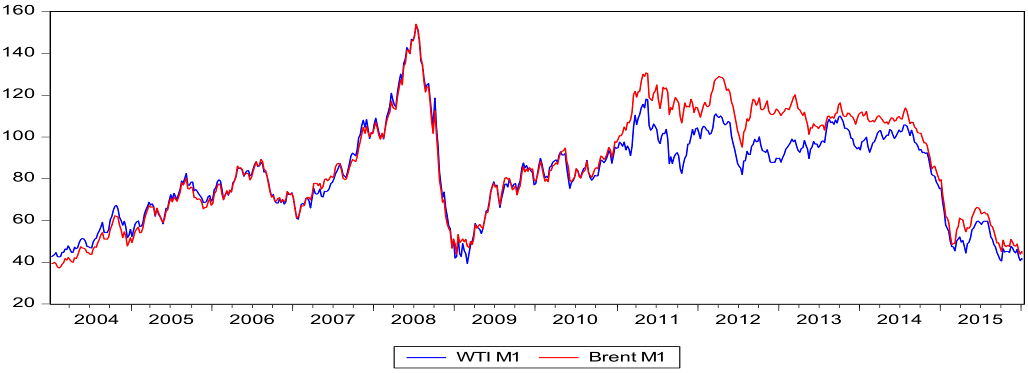
Bond demand curves in high income economies shifted higher during our sample period, 2007 to 2015, as a result of the policy of quantitative easing by central banks. The downward shift in the US Treasury yield curve from 2007 to 2009 led investors to redirect capital to foreign markets, seeking higher yields. Emerging market sovereign bonds were one of the beneficiaries of this flight of capital from developed economies. As the underlying risk free rate shifted lower, borrowing rates around the world also declined. With risk free borrowing rates now significantly lower than the expected rate of inflation, institutional investors, which are required to manage future payout obligations, purchased bonds in emerging market sectors to increase their portfolio returns. Emerging market governments seized this opportunity to launch successful large-scale bond issuance programs in both local and foreign hard currencies. Although many institutional portfolio managers are restricted to investment grade debt securities, several emerging market sovereigns are deemed investment grade by ratings agencies: China, Brazil, Mexico, Poland, Malaysia, and Thailand.[26]

All commodity markets exhibited a contemporaneous response to the 2008 global market liquidity shock, as did stock and debt markets. Prices tumbled across the entire commodity complex as investors withdrew capital from the market in response to liquidity contagion concerns and broad-based recessionary fears. In August 2008, the West Texas Intermediate nearby crude oil contract settled at 146.64 USD/Bbl (Figure 4.1). By March 2009, this nearby contract traded down to a low closing price of 37.23 USD/Bbl.[27] The oil price recovery, which started in late 2009, was attributed to growth in emerging market economies rather than advanced economies, which were still grappling with liquidity and debt rebalancing.

[26] Standards and Poor and Moody's rating agency, October 2014.

[27] High and low price data from the NYMEX WTI nearby futures contract. WTI is a trading location in Cushing, Oklahoma, and represents the US market. Brent and Dated Brent are trading locations representing a group of offshore platforms in the North Sea, and post-2009 is considered the global crude oil benchmark.

Figure 4.1: Historical Brent and WTI Nearby Futures Contract (USD/Bbl)



Source: Reuters DataStream

Despite geopolitical upheaval occurring in the Middle East and North Africa, global oil prices remained remarkably stable at low levels between 2011 and early 2014. Then, local political unrest disrupted Libyan oil production. The European Union and the United States placed embargos on Iran in order to halt nuclear advancement activities via economic channels. This resulted in restricted oil production due to lost customer accounts. As Libyan and Iranian oil production resumed, the extent of the US domestic tight oil[28] contribution to global oil production volumes became transparent (Arezki and Blanchard, 2014). US tight oil production led to a change in oil transportation patterns in the global physical market. Although the United States initially experienced a limited increase in crude oil exports, they did reduce oil imports from most key suppliers (Figure 4.2) in response to its growing domestic supply.[29] As a result, world crude oil supply growth from 2012 to 2014 was twice that of global demand growth.[30] This imbalance resulted in a steep decline in global oil prices commencing in Q4-2014, with prices below 28.00 USD/Bbl observed in January 2016.[31]

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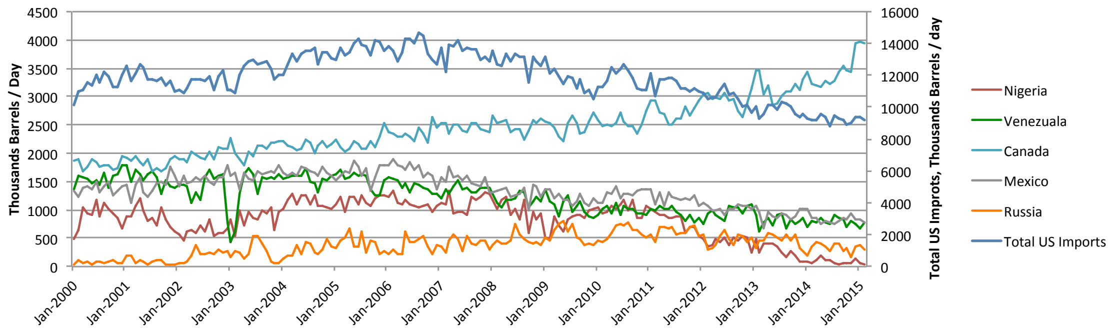
28 The US tight oil market is also referred to as shale oil extraction. Shale oil production has been commercially viable since 2009.

29 US oil exports increased from 250,000 BPD in Q1-2014 to 500,000 BPD in Q4-2015, EIA data, 2016.

30 International Energy Agency data, author calculations of 2015 supply growth (Q42012–Q42014) of 1.76% per annum vs. demand growth of 0.84% per annum.

31 CME NYMEX and ICE nearby WTI and Brent oil price contracts.

Figure 4.2: Oil Imports to the United States vs. US Domestic Production



Source: Energy Information Administration

Periods of extraordinarily high and unexpectedly low volatility have characterised global oil prices over the past decade. The time series sample period, from 2007 to 2015, was selected to isolate an important period of increased global investor participation in emerging market sovereign bonds during two distinct observed oil price trajectories. Understanding the possible exogenous drivers behind defined oil shocks during this time period is important for interpreting the influence of oil prices on emerging market bond yields. Although extensive research has addressed the significance of positive and negative oil price shocks on macroeconomic factors and stock markets, the relationship between oil prices and global bond markets and, in particular, emerging market sovereign bonds remains scant. Crude oil prices can have a significant impact on the fiscal budgeting and policy development for both emerging market oil exporting and oil importing countries. This underscores the importance of understanding the linkages between oil price and bond yield premiums.

The countries in the study group provide a sample of twelve emerging market economies with liquid secondary debt markets.[32] In studying the relationship between oil prices and bond returns, this paper examines the relationship between bond returns and changes in direct oil market price innovations and oil price shocks, as defined by global aggregate demand and global oil supply, as endogenous variables in a structural VAR model.

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[32] JP Morgan's EMBI bond return index uses only bond issues with minimum levels of secondary market activity.

The research is designed to determine if oil price innovations have a statistically significant relationship with emerging market sovereign bond returns. Its central hypothesis, based on standard priors, is that sovereign bond returns for oil exporting countries increase and oil importers' bond returns decrease when positive oil price innovations occur. The twelve countries in this sample include oil export, oil import, and neutral participants.[33] A SVAR model of oil shocks is utilised at the weekly frequency for the study time series, July 2007 to December 2015, for twelve selected countries over this period. Results will be evaluated using Granger causality tests, impulse response functions, and variance decomposition.

The remainder of this paper is organised as follows. Section 2 reviews the existing research work and outlines the contributions of this paper. Section 3 describes the data and empirical models and methodology used in the study. Section 4 reports the empirical results and discusses the robustness of the methodology. Finally, Section 5 summarizes the key findings.

4.2 Literature Review

Hamilton (1983) broke new ground on the impact of higher oil prices on macroeconomic factors, evaluating positive oil price shocks as a recession predictor in the US economy between World War II and 1980. Hamilton found there was an economic downturn that lagged oil price increases by approximately nine months, a relationship that disappeared after 1973. Since that paper, disagreement over the assessment that positive oil price shocks create a decline in economic output has been ongoing (Hooker, 1996, Hamilton, 1996, Bernanke et al., 1997, Jones et al., 2004, Balke et al., 2002, Kilian and Vigfusson, 2011).

Hooker (1996, 1999), as well as Hamilton in a later paper (2005), found no systematic relationship between oil prices and economic output. Mork (1989) and Hamilton (1996, 2003) evaluated the impact of negative energy price shocks in terms of changes in economic output. Kilian (2009) observed that as nations'

33 Neutral participating countries have balanced oil import to export exposure.

economies mature, oil price shocks become less important or have less impact on economic outcomes. This may reflect reduced energy share in consumer consumption patterns or a reduction in exposure to oil prices in the US automotive industry with the introduction of smaller, fuel-efficient car manufacturing. Kilian also presented net measures of oil shocks, in which he said that low or high prices were compared to the previously seen low or high price, which resulted in a different level of significance. In a study conducted in Nigeria, Iwayemi and Fowowe (2011) found no significant impact from positive oil price shocks on Nigerian macroeconomic variables, but did observe a statistically significant response of output and real exchange rates to negative oil price shocks.

Lee et al. (1995) reported that the magnitude of and the reason for the oil price shock predict potential economic relationships. Several oil price shocks have followed a similar pattern, while others depend on different contributing factors. They go on to state that price shocks must be classified as either regional or global, and instigated from either the demand or the supply side. Model output explanations require a strong understanding of the fundamentals that contribute to the generation of an oil price shock, as the oil shock itself perhaps should not be considered exogenous (Kilian, 2009). Dai and Serletis (2018) in their study on the influence of oil price shocks on the credit default swap (CDS) market found that the source of the oil shock was relevant and the impact of the oil shock was present over the long run in CDS markets.

Miller and Ratti (2008) found that oil price shocks were inversely correlated to long-run stock market returns from 1982 until 1999, but that the correlation disappeared in 2000. They credited this change to price bubbles in both stock and energy markets. More research is required to understand the variations in the relationship between the stock market and energy prices. Oil and stock markets currently exhibit a positive correlation (Mollick and Assefa, 2013). This has had a profound impact on portfolio managers, who must rebalance portfolios. Kilian and Park (2009) found the effects of US real stock returns depended on the source of the oil price shock.

Literature since the turn of the century, including Basher and Sadorsky's (2006), has expanded the focus on oil and stock markets to include emerging market economies. This research is important, as emerging markets will likely consume a greater portion of the oil supply in the future and will become a larger presence in financial markets.

The knowledge gained through research on energy price interaction with stock markets has provided motivation to understand the impact of oil price movements on debt markets, a global market twice the size of stock markets. Little research is available on the impact of energy price and energy price volatility on bond markets, in particular bond markets outside of the United States. Existing bond research has concentrated on understanding the response of bond returns to positive innovations in oil price. Kang et al. (2014) showed, using a structural vector autoregressive (SVAR) model, that a positive oil market demand-specific shock causes a significant statistical decrease in real returns of US bond markets. Previous research on emerging market debt did not include energy prices as a model variable, although researchers did note that the level of a country's commodity dependence does play a role, due to investor perceptions (Bunda et al., 2009). In a study of bond spread premiums, Ferrucci (2003) found that macro fundamentals for an emerging market sovereign are important for pricing sovereign risk. Factors that improve country-specific fundamentals, such as GDP growth, exchange rate policy, and political stability, were found to reduce the cost of external borrowing (Tebaldi et al., 2017). Ferrucci (2003) also noted that external market liquidity played a significant role. Access to data is a challenge in researching emerging economies' debt markets, as time series are shorter and price history can be fragmented due to the nonstandard nature of debt products. Eichengreen and Mody (1998) cautioned that emerging market debt risk models should use secondary market yields, rather than primary market yields, due to bias factors associated with primary market yields.

This paper adds to the emerging market bond literature by contributing knowledge on the interaction of oil price innovations and emerging market bond risk premiums, represented by real bond total returns. It also provides further information on the significance of a country's commodity dependence on the variability of market-based borrowing costs.

4.3 Methodology

4.3.1 Model Approach

The emerging market sovereign bond market is an active asset class for institutional investors and portfolio managers. Investor risk aversion and market liquidity fears result in capital extraction from high beta return markets and reallocation to safer risk free securities (Kang et al., 2014). The test hypothesis is that oil price shocks have statistically significant effects on emerging market bond portfolio returns. A secondary hypothesis is that the effects on total portfolio returns include effects with opposing signs for oil exporting and oil importing sovereigns.

A sovereign bond's return has an inverse relationship with the sovereign bond yield, which is determined by the investor's perception of risk premia for bearing the sovereign risk. Emerging market sovereigns are exposed to oil price innovations through oil price effects on their public finance. An oil exporting sovereign's revenue is the sum of revenue from crude oil production (direct taxes, dividends, royalties, and other payments) plus all other government revenue. Negative oil price innovations will result in lower revenue and could create fiscal budget imbalances, thereby forcing difficult economic and social tradeoffs. There could also be a concern regarding cash flow capability to service hard currency debt obligations. In this situation, investors will require a higher yield premium to compensate for the increase in perceived sovereign risk, resulting in lower bond returns. Oil importing sovereigns realise oil price fluctuations in their fiscal expenditures. Negative oil price innovations will lower expenditures, by a rate linked to the country's energy subsidy policy, increase available income, and possibly support economic growth. By applying the same risk approach above to sovereign importers, there is an expectation that the bond yield premium will narrow under negative oil price innovations. The model is designed to test the significance of oil price shocks as one factor that influences the expected risk for portfolios of exporting and importing emerging market sovereign bonds.

Understanding the source of an oil shock is critical to understanding how to interpret its interaction with a dependent variable (Kilian, 2009) and real total bond returns. Kilian (2009) identified three oil shocks based on global oil supply, aggregate global oil demand, and market-specific shock related to price innovations due to market concerns about future oil supply characteristics. Prior to examining the source of the price shock, stylised facts are used to identify price shocks in the sample period.

Structural Vector Autoregressive Models

A SVAR model of order (p) is used to study the impact of oil prices on real emerging market sovereign bond returns (Equation 1). Vector autoregressive models have been used extensively in the oil price shock analysis of economic and financial systems since Sims (1980) introduced them. This model includes as the endogenous variables bond total returns, change in global aggregate growth, change in global oil supply, and change in oil prices. Following Kang et al. (2014) and Kilian (2009), oil shocks are categorised as oil supply shocks, aggregate demand shocks, and oil market–specific shocks. The ordering of variables in the SVAR, also in keeping with Kang et al. (2014) and Kilian (2009), follows a Cholesky identification process whereby oil supply was the most exogenous and the oil market–specific shock the most endogenous. This applies economic theory to the SVAR model and limits the cointegration between independent variables.

$$Y_t = A_0 + A_1 Y_{t-1} + \ldots + A_p Y_{t-p} + e_t, e_t \sim N\ (0, \Omega) \qquad (4.1)$$

where: Y_t *is a* $4X1$ *vector of endogeneous variables*

A_0 *is the intercept matrix*

p *is the number of lags used in the* $SVAR(p)$ *model*

t *is the time index*

e_t *are residuals from the* $SVAR(p)$ *model*

Tests for unit roots in the endogenous variables used were performed. The null hypothesis of the Augmented Dickey Fuller test states that a variable has a unit root. The null hypotheses for all variables when using their first differentials was rejected (results in Appendix A), and hence first differentials for all variables were used in the model to ensure the data was stationary. The optimal lagged periods for the SVAR models of portfolio were determined using the Akaike information criterion, with the optimal number of lags for the global import and export portfolios both determined to be seven.

Several tests were conducted after completing the SVAR estimations using the restriction on coefficients to allow for orthogonality of endogenous variables. First, the Granger causality test was used to examine if the lag variables of change in oil price shocks have a direct impact on the total bond returns of the sample group. Second, the impulse response functions report the response of bond returns to a one-time, one standard deviation positive innovation to oil prices. Finally, variance decomposition shows the proportion of the forecast error variance of the variable that is attributable to all four SVAR participant innovations.

4.3.2 Data

Weekly frequency data were used to study the short-term relationship between real crude oil market price and real emerging market bond returns represented by the JP Morgan EMBI from July 2007 to December 2015.[34] Individual EMBI bond indices were selected for emerging market countries representing either importing or energy exporting nations that had balanced observations for the time period selected. The inclusion of Middle East sovereign producers was not possible, since countries such as Saudi Arabia, Oman and Kuwait had no international debt, during the study time period. Importer and exporter portfolios were created, each with six sovereign bond returns with equal-weight representation, of each participating constituent (Table 4.2). Countries were selected based on sovereign bond history availability.

[34] JP Morgan bond return data is a market-accepted benchmark for tracking emerging market debt returns and yields.

Countries were selected for the import or export category based on their overall oil and oil products import-export balance. Brazil was included in the export portfolio, although during this time series the country did observe moment of net importing of oil products. Increased oil exploration and production in Brazil during the later periods of this time series was believed to be relevant to investor and market expectations of sovereign bond response to oil price fluctuations. This portfolio construction methodology was used to represent an institutional investor approach to this asset class. Alternative construction methods, such as weighting by constituent supply of oil or a constituents' debt financing could be used. However, the accuracy of country level oil production data and the types of debt financing other than bonds, as is the case in this study, are a limitation. In order to create a weekly time series from daily frequency data, end of week observations were used. Monthly frequency global oil production data were converted to weekly observations using a uniform interpolation technique.

Table 4.1: Data Sources

Data	Source	Units	Frequency	Role
WTI Nearby Future settlement prices	DataStream / NYMEX	USD/Barrel	Daily	Proxy North American oil price, used in robustness testing
Brent Nearby Futures settlement prices	DataStream / ICE	USD/Barrel	Daily	Proxy for global oil prices
Baltic Dry Index	DataStream	USD	Daily	Proxy for global aggregate demand
Global oil production	EIA	Thousand BPD	Monthly	Proxy for global oil supply
US oil production	EIA	Thousand BPD	Weekly	Proxy for US oil production
EMBI	JP Morgan	USD	Daily	Total returns, USD debt by country
US 10-Year Treasury	DataStream	USD	Daily	Total returns in USD

Table 4.2: Portfolio Composition

EMBI Export	Brazil	Colombia	Kazakhstan	Mexico	Russia	Venezuela
EMBI Import	China	Chile	Philippines	Poland	Turkey	South Africa

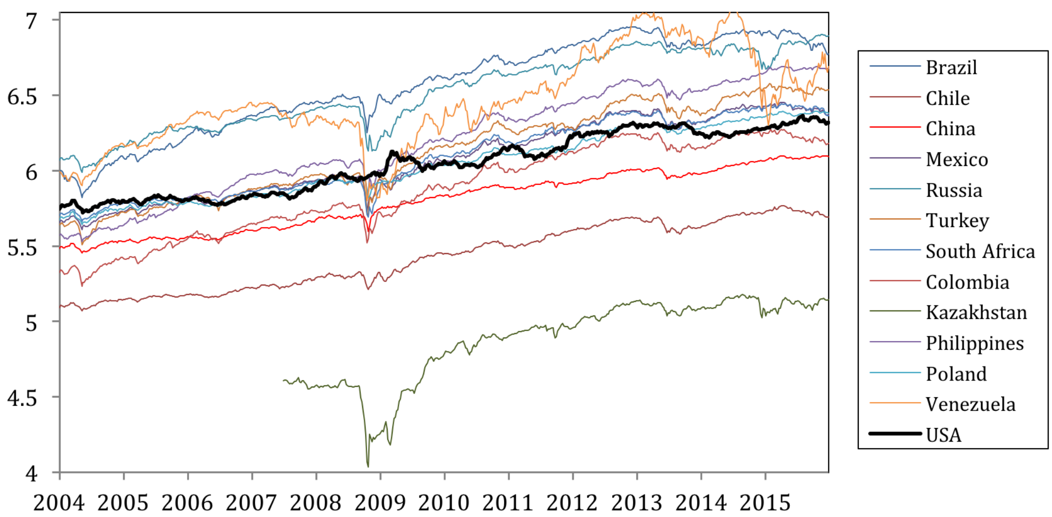
The real oil price is represented by nominal Brent nearby contract prices deflated by US CPI from the Bureau of Labour Statistics.[35] The Chow test confirmed a structural break in crude oil prices at the inflection point of the global liquidity

[35] United States Consumer Price Index provided by US Department of Labor, Bureau of Labor Statistics.

financial crisis at the start of the third quarter 2008 (Appendix C). Increased domestic production and slow economic recovery resulted in supply side surpluses in the US market. A transportation infrastructure constraint, combined with federal energy policy-limiting crude oil exports, resulted in the WTI benchmark price disconnecting from the rest of the world. Ex-US Brent replaced WTI as the global benchmark. Given the global nature of this analysis, Brent was used as the proxy for global oil prices. WTI oil prices were included for robustness testing on the data performance.

JP Morgan's Global Research team supplied the EMBI USD–denominated bond total return data.[36] Total bond returns for each portfolio are represented as an endogenous variable in the model. The significance of the SVAR results indicates the significance of this dependent variable. Figure 4.3 presents the time series of real emerging market total bond log returns for a subsample of the countries used against the US Treasury ten-year log total return. Flight-to-safety effects of the financial crisis can be observed in late 2008, as increased demand for low-risk debt securities increased the total returns of the US Treasury bond, against a universal decrease in emerging market bond total returns.

Figure 4.3: Selected EMBI USD Emerging Market Bond Total Return Index Countries (Log form)



Source: JP Morgan

[36] These indices include USD-denominated sovereign bonds that exceed an issue value of 500 million USD and maintain threshold liquidity requirement in secondary markets.

The proxy used to represent global aggregate demand is the Baltic Dry Index (BDI),[37] which is an index-weighted average of the cost to hire transportation on a cross section of dry bulk raw material routes. This is an accepted measure by market participants as it is a nonbiased leading economic indicator. Kang et al. (2014) suggested using a container shipments index (following the real global economic activity indicator model approach presented by Kilian [2009]), which would have a similar representation for global aggregate growth as the BDI.[38]

US oil production data was sourced from the Energy Information Administration's data page, on which it records and calculates weekly domestic US crude oil production. Global oil production was also sourced from the EIA database in monthly frequency. An interpolation technique was used to convert data into weekly frequency for model use.

4.4 Empirical Results

4.4.1 Oil Price Shock Description

Oil price data analysis of the sample time period identified the type of shocks following Kilian's (2009) three oil price shock definition categories: oil market–specific shocks, shocks to global aggregate demand, and shocks driven by increased oil supply. Kang et al. (2014) used these three shock definitions in their SVAR model.

Two oil shocks were identified during this time period study. The negative oil price shock defined during the global financial crisis is attributed to a sudden reduction in global aggregate demand (2008–2009). The second oil shock observed during the time series is attributed to increasing global supply (2014–2015).

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[37] The Baltic Exchange is an independent provider of maritime market information. The BDI index was established to allow for trading, hedging, and settlement of physical and financial derivatives on the cost of dry raw bulk shipping.

[38] The BDI represents a demand for dry commodity shipments capacity that is observed in advance of manufacturing demand and leading indicators of economic growth and provides market signals before a container shipment index such as HARPEX.

4.4.2 Descriptive Statistics

Table 4.3 provides descriptive statistics for the portfolios. A complete set of descriptive statistics for this study appears in Appendix B. EMBI import and EMBI export portfolios were constructed for countries that had a greater than 1% weighting in the EMBI index structure, if they met either the import or the export qualifications.

Table 4.3: Descriptive Statistics

	LNEMBI EXPORT	LNEMBI IMPORT
Mean	8.166	7.848
Median	8.192	7.841
Max.	8.412	8.161
Min.	7.654	7.518
Std. Dev.	0.171	0.193
Obs.	444	444

Descriptive Statistics for Log Normal total bond returns for EMBI export and import portfolios.

4.4.3 Granger Causality Tests

For each portfolio in the sample, the results of the Granger causality of the aggregate lags of each variable—LNGLOBAL, LNBDI, and LNBRENT—on total bond returns are presented (Table 4.4). The null hypothesis states that oil price innovations do not Granger-cause individual portfolio total bond returns.

Table 4.4: Granger Causality Test Results

		SHOCKS TO BOND TOTAL RETURNS:					
VARIABLE		LNGLOBAL	LNBDI	LNBRENT	LNWTI	BOILMAX[39]	BOILMIN
EMBI EXPORT	*chi-square*	17.6343	17.1554	21.4068	6.8760	4.2755	4.1472
	p-value	0.0137**	0.0164**	0.0032***	0.2300	0.5105	0.5284
EMBI IMPORT	*chi-square*	29.4055	17.1821	18.6316	13.0622	28.2666	15.7716
	p-value	0.0001***	0.0163**	0.0094***	0.1097	0.0002***	0.0273**
LNUSA	*chi-square*	19.500	21.837	10.267	17.9495	14.0757	11.7894
	p-value	0.0343**	0.016**	0.417	0.0558*	0.2288	0.3797

The values above represent Wald chi-square statistics and related p-values.
The Granger causality of these independent variables is documented in a model run with LNBRENT.
Significance: * at 10% level, ** at 5% level, *** at 1% level.

[39] BOILMAX and BOILMIN are the positive-only and negative-only innovations for oil market–specific shocks.

For the oil market–specific shocks represented by LNBRENT, the null hypothesis is rejected for both EMBI export and EMBI import portfolios, indicating that oil market–driven shocks do Granger-cause the portfolio returns. Brent oil prices do not Granger-cause US real bond returns. This result is consistent with Kang et al. (2014) as US-based oil prices also are not statistically significant under Granger causality.

Oil supply–based price shocks, represented by changes in global oil production, do Granger-cause bond total returns for these portfolios. LNGLOBAL does Granger-cause US total bond returns, indicating that US bond yields are sensitive to changes in global supply patterns, albeit on a long-term horizon.

The hypothesis that LNBDI does not Granger-cause bond total returns for all portfolios is rejected. It was anticipated that results would show Granger causality of global aggregate growth to bond returns of countries that have significant exposure to global aggregate demand, such as China and Turkey (Appendix E contains Granger causality results for individual countries). Global aggregate demand does Granger-cause US total bond returns. This result and the delayed nature of the US bond return response are in keeping with the results found by Kang et al. (2014).

4.4.4 Impulse Response Functions

Figures 4.4 and 4.5 present the impulse response functions for the SVAR model during forty one-week periods for each portfolio's total bond return. One additional impulse response function is included in Figure 4.6, indicating the total return on the ten-year US Treasury. This is used to compare and contrast advanced economy results with the emerging market impulse response functions results and to compare results with Kang et al. (2014), which is the only oil price and bond return research available. Each figure indicates the response of the log of the portfolio bond total return to a Cholesky decomposition one standard deviation shock in each of the explanatory variables: change in global oil supply, change in global aggregate demand, and change in oil price.

Increased global demand will provide more factory orders, stimulating the economic growth and creating more global demand for oil. The export portfolio had a positive response to this increase in aggregate demand. The global import portfolio had a smaller amplitude positive response, explained by the potential GDP growth and offset by higher oil costs.

There was a delayed significant response in all portfolio bond returns to the one standard deviation shock to global oil supply, as market participants need time to observe the trend of increased supply and expected impact. Export portfolios show a negative response to increased oil supply via cash flow channels, as more supply could result in lower export revenues. Import portfolios had a small positive response due to the expectation of lower oil prices from this increased supply.

Figure 4.4: Impulse Response Function LOG Bond Total Returns for Export Portfolio

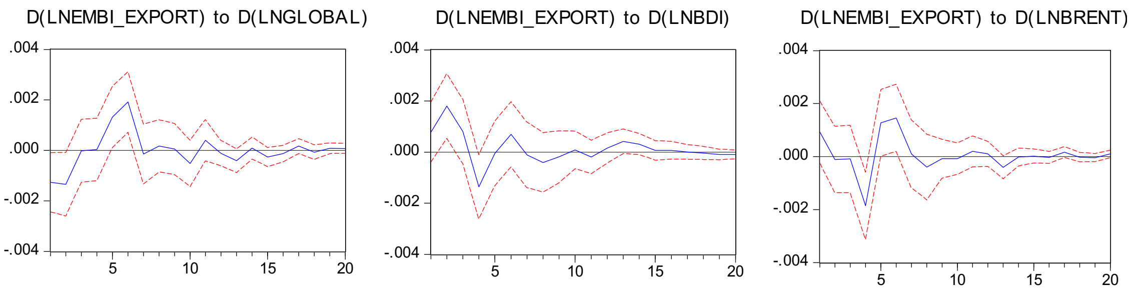
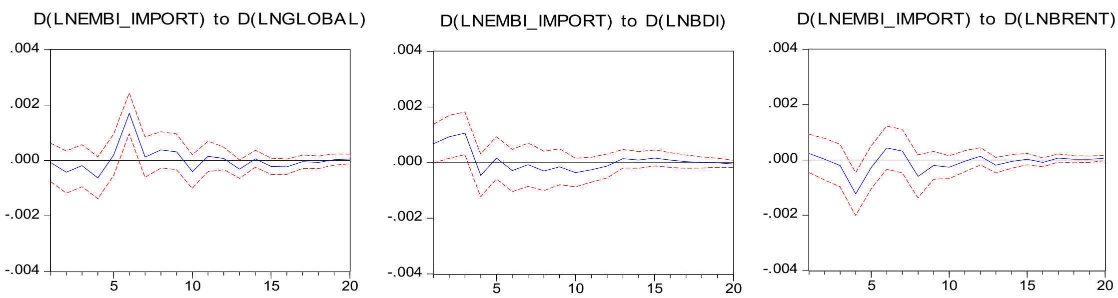
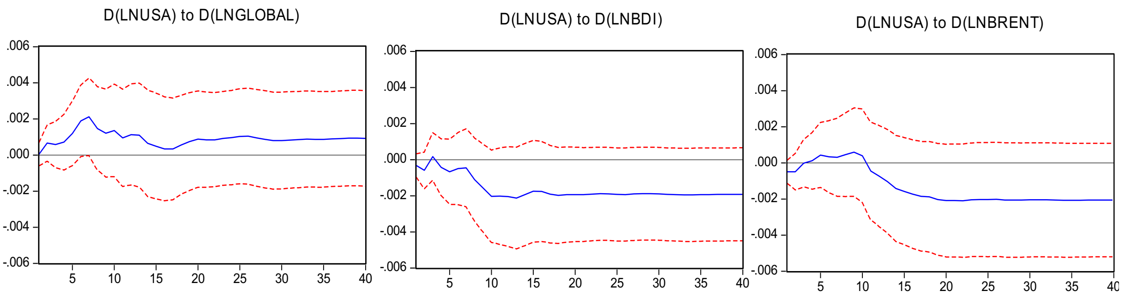


Figure 4.5: Impulse Response Function LOG Bond Total Returns for Import Portfolio



Impulse response functions for a one standard deviation positive innovation in oil market price show two important characteristics. The export portfolio has a significant positive response to a positive shock to oil prices. This is contrary to the finding in earlier research on Russian sovereign yield spreads, which were negatively correlated to oil prices (Duffie et al., 2003). Importer portfolios have delayed negative responses, that was lower in amplitude, in bond returns to the positive oil shock. Financial markets interpret increasing commodity prices, most significantly, increasing oil prices, as a warning of possible inflationary pressures. The bond market reacts to a positive innovation in oil prices by valuing all relevant inflationary expectation information into bond yields. Although this portfolio study treats Brazil as an oil exporting country, it was a balanced country for several years of this study period, as its refined products imports were equal to or slightly greater than its crude oil exports. This may explain in part the moderated exporter total bond return response to a shock in oil prices.

Figure 4.6: Impulse Response Function LOG Bond Total Returns US



Results from the US total bond returns show a delayed response, when compared to emerging market portfolios (Figure 4.6). Similar to the global import portfolios, the US portfolio responses are negative, while positive innovations result in higher oil prices. Albeit this research is focused on short-term responses of the SVAR model, this result is consistent with Kang et al.'s (2014) research on long-term responses of US bond returns. Appendix G presents impulse response functions for individual countries.

4.4.5 Variance Decomposition

Variance decomposition (Table 4.5) resulted in the confirmation of the immediate response of bond returns to changes in oil shocks driven by global aggregate demand. The exporter portfolio had an immediate response to a positive innovation in global oil supply, while the importer portfolio was slower to respond. Oil exporting countries should be concerned, as increased global supply would indicate more competition amongst suppliers. Importing countries tend to take a 'wait and see' approach to price implications for additional oil supplies to the global market.

Table 4.5: Variance Decomposition Results

Variance Decomposition									
Time Period 4, 8, 12	LNGLOBAL			LNBDI			LNBRENT		
Dependent Variable:	4	8	12	4	8	12	4	8	12
EMBI Export	1.9305	4.6586	4.8559	3.6340	3.7468	3.7769	2.4722	4.3645	4.3599
EMBI Import	0.9426	5.1849	5.4490	3.9868	3.9992	4.2111	2.4377	3.3117	3.3999
US	0.6070	2.2831	2.6328	1.6637	2.3627	2.8870	0.7061	0.8794	2.0419

Bond returns had a slower response, but a longer influence time period, to a positive innovation in global oil market price. At time period 8, the three model explanatory variables contributed an aggregated total combined variation of 12.8% and 12.5% to export and import portfolio total bond returns, respectively. The response of the US total bond returns was much slower across all three explanatory variables. This result is in keeping with Kang et al. (2014) and cannot be explored fully given the short-term nature of this SVAR analysis.

4.4.6 Strength of Results

The SVAR models were performed on the dataset in monthly frequencies. Granger causality, impulse response functions, and variance decomposition testing of the monthly results were consistent with the results found using weekly data time series (Appendix H). This confirms the quality of the data and the use of the data in the model. The model was performed on the time series data both prior to and after the structural break in crude oil prices. Bond portfolio responses were consistent with impulse innovations of the endogenous model variables. The model was tested with WTI as the proxy for global oil market–specific price shocks. Statistical inference was much lower across the export and import portfolios when the WTI oil price was used as an independent oil price model variable, which is attributed to the US market becoming disconnected from global pricing mechanisms.[40] Interestingly, US bond returns were statistically significant with WTI at the 10% level and found not

[40] Increased US-based production combined with a sluggish return to pre-2008 oil consumption resulted in a crude oil bottleneck on the US mainland and a dislocation from the global oil market.

to be statistically significant with BRENT pricing, confirming the oil price dislocation and the relevance of sovereign fiscal budget exposures to oil prices.

Individual countries were modelled in the SVAR structure to observe their idiosyncratic reactions to the three explanatory variables. Importer country results were consistent in their responses to the explanatory variables. Individual countries were modelled in the SVAR structure to observe their idiosyncratic reaction to the three explanatory variables. Importer countries results were consistent in their response to the explanatory variables. Individual exporting country results were less consistent with consolidated exporter portfolio results due to investor perception of sensitivity of global risk premia compared to sovereign fundamentals (Appendices C and D).

Investor sentiment was not included in the SVAR model methodology, emulating Kilian (2009) and Kang et al. (2014). VIX, OVX, and EMVIX measure the overall option volatility of US equity markets, the WTI oil options market, and the MSCI emerging market index options market,[41] respectively. Volatility, as a measure of investor sentiment, was used for model robustness testing. Positive innovations in the VIX indicate greater expected risk in equity markets, which influences investor perception of the broader global financial markets. All emerging market portfolios and country bond returns had the same immediate negative response to a one standard deviation positive innovation in the VIX during the first four periods. Bond returns decreased on this positive innovation, indicating that the global market riskiness was immediately priced into emerging market bond markets. The US total bond return had an inverse response to the VIX, confirming increased investor demand for lower risk US Treasury bonds during the volatile periods known as flight to safety. All three volatility measures were tested. The VIX and EMVIX

[41] CBOE expanded its volatility index product offerings to include an index on WTI oil volatility (time series from 2007) and an index on emerging market volatility (launched in 2012). This EMVIX index is calculated on options' implied volatility on the MSCI emerging market stock ETF. The OVX oil measure is based on options traded on the US Oil Fund ETF. The correlation between VIX and EMVIX was greater than 90% and increased foreign institutional investors in emerging market bond sectors strengthen the application of the VIX in this methodology.

were statistically significant across the portfolio samples, but the OVX did not exhibit statistical significance.

4.5 Conclusions

This research supports the initial hypothesis that oil prices innovations have a statistically significant influence on emerging market bond total returns from 2007–2015, when defined by the portfolio behaviour of importers and exporters.

Recent research efforts expanded the study of oil price and global macroeconomic interactions by examining the relationship of oil price shocks and financial markets. While there is a growing amount of research on oil price shocks and stock market returns, little research to date has focused on the interaction of oil price changes with debt markets generally or emerging market debt markets in particular. This paper tested the expectation that the emerging market sovereign debt risk premium would respond to changes in global oil prices, via cash flow channels. Export country portfolio bond returns increased when oil prices increased, while import country portfolios bond returns had an inverse relationship to positive oil price innovations. Information efficiency theory supports investors' response to market information and reallocation of risk. The investor perceives that higher oil prices will increase oil revenues. This provides fiscal stability for oil exporters, which in turn creates increased demand for sovereign debt. Demand for oil importer sovereign bonds will decrease as investors raise concerns over the country's fiscal budget with higher energy costs.

Global crude oil production is highly correlated to US production during the study period; in fact, the growth in US oil production is directly correlated to the growth in global oil production. Investor access to liquidity has supported corporate investment in US energy production infrastructure through the high-yield debt market, a similar demand profile to that observed for emerging market bonds. This subsequently resulted in a shift downward in the yield curve in both these debt markets. The result was a surprisingly low yield for what can be described as high-risk borrowers. The importance of market liquidity should never be overlooked. The announcement of Nigeria's return to the JP Morgan EMBI index in Q4-2012 sent the country's sovereign bond yield 200 basis points lower, as participation in the index would allow increased scope for institutional investors to trade Nigerian sovereign-issued bonds.

Oil market dynamics are an important factor in understanding emerging market sovereign debt market behaviour because many asset managers follow macroeconomic indicators, thereby changing their portfolio risk taking as required. This research would benefit from the addition of a country-specific risk variable. There is no timely unique risk measure in common use; therefore, the Bank of England has recognised the use of emerging market bond yields to indicate the level of country risk in its macroeconomic model (Ferrucci, 2003). An examination of the same group of portfolio structures over a longer time period will provide further insight. Expansion of this research to include more countries, as time series data becomes available, will allow for additional study of portfolio and country-specific bond return performance under oil price shock scenarios.

5.0 Do OPEC Quota Announcements Matter to Global Bond Markets?

5.1 Introduction

OPEC's decision-making process for production quotas is widely followed by all participants in the global energy market. The accepted final quota levels are announced after biannual OPEC conferences, with one of three possible quota adjustment outcomes: increase production, decrease production, or no change in production. These decisions have an immediate influence on global oil supply, and can possibly form a new market equilibrium. Oil market price shocks may occur when OPEC conference decisions come as a complete surprise to the market or are announced during periods of market stress with perceived undersupply or oversupply conditions.

Global physical oil supply network channels shifted between 2010 and 2014, when shale oil production in North America arrived on the market, which caused US net imports to plummet to negligible levels. This resulted in the collapse of short-term oil pricing and a shift lower of the crude oil futures market term structure in the second half of 2014. All eyes turned to OPEC and waited patiently for the market response from Saudi Arabia, the recognised swing producer. OPEC's response was a wait-and-see attitude up until the November 2014 meeting, at which time market participants were searching for some direction on OPEC's policy for quota modifications to ensure a fair and stable oil market. Led by the Saudi Arabian contingent, OPEC relinquished its role as a swing producer, standing by its existing production quotas. This response was not anticipated by the market, and sent analysts running to determine the ramifications of this change in strategy and sent oil market prices into free fall. Two years later, in November 2016, OPEC ultimately caved in and agreed to a production quota cut, supported by Russia, a key non-OPEC producer (Razzouk et al., 2016). Again market analysts were sent running to explain this new strategy while oil market prices climbed higher in renewed hopes of supply restrictions would create a new higher price market equilibrium. OPEC's role in oil markets and accepted influence in the market structure and pricing has been extensively debated in literature (Behar and Ritz, 2016, Ratti and Vespignani, 2015) and has intensified in recent years under an increasing presence from non-OPEC production levels and reserves.

As mentioned earlier in this thesis, global debt markets expanded considerably over the past ten years, supported by the growth of market liquidity from quantitative easing programs and an increase in investor demand for higher yielding debt instruments. Emerging market sovereign debt, as an asset class, expanded even quicker during this time period. Most emerging markets have exposure to oil or petroleum prices as net importers or net exporters. Oil importing countries stand to benefit from reduced expenditures if OPEC quota announcements result in lower oil prices, while oil exporting countries would experience lower USD revenues, which would have a negative impact on their fiscal balances. Vertical integrated and independent oil producers would realise a reduction in earnings under lower oil prices, which might create cash flow management issues for liability payments. This increase in capital allocation to debt products, with exposure directly or indirectly to oil prices, makes the study of bond market response to OPEC quota announcements highly relevant.

Event study analysis was first applied to empirical studies of stock price response to firm-specific actions such as stock splits, mergers, acquisitions, and earnings announcements. An extension of this technique was applied to controlled release of economic news, such as macroeconomic events that had broader reaching impact on securities markets, in the case of government announcements of payroll and unemployment data. Prior to the release of the information, the content of these announcements are unknown to the market. After such news, under efficient market theory the information content is quickly absorbed into asset prices (French and Roll, 1986). OPEC conference quota outcome decisions are important to global economic balances and are seen as exogenous events by commodity and capital market participants. There are several study papers applying the effects of OPEC announcements to oil markets and stock markets, but currently there is no literature addressing the effect that these announcements have on bond markets.

This chapter focuses on the empirical study of the reaction of bond portfolio total returns issued by sovereign and corporate entities with a known exposure to oil price risk. An event study model is created to observe the information flow of OPEC conference quota announcements into bond markets from 2011 to 2016, a period representing changing global crude oil production dynamics with the increasingly relevant contribution of shale oil. Portfolios of bond returns are created for emerging market sovereign importers and exporters, international oil producing major firms, and small- to medium-sized independent shale oil producers. The bond market response to the OPEC conference announcements in November 2014, in which quotas were maintained, and November 2016, when quotas were cut (both decisions occurring during low market oil price periods) is central to this study. My hypothesis is that portfolios composed of oil exporters have a statistically significant response to these two particular announcements. This research is relevant to current and future bond issuers and investors in global high-yield bond markets. Government officials, policy makers, and regulators will find this information helpful to understand bond market price dynamics under periods of oil price uncertainty.

The remainder of this chapter is organised as follows: Section 2 provides background on the OPEC organisation and describes recent changes to global crude oil physical supply channels. Section 3 presents determinants of the bond market and yields. Section 4 reviews existing literature on event studies and the application to bond returns and outlines this paper's contribution to literature. Section 5 describes the event study methodology and data. Section 6 reports the empirical results and discusses the robustness of the methodology. Section 7 summarizes the key findings.

5.2 OPEC and the Global Crude Oil Market

OPEC, an intergovernmental organisation, was founded in 1960 with five originating member states: Iran, Iraq, Kuwait, Saudi Arabia, and Venezuela. The organisation today has fourteen member states and contributes 44% of global production and holdings of 81% of global reserves.[42] OPEC's mandate is to coordinate a cohesive position on petroleum policies amongst its members. In doing so, OPEC can endeavor to secure reasonable and stable prices for producers and maintain efficient channels for an economic and secure supply of oil to global markets. OPEC has a publically available conference schedule, planned in advance, on a biannual basis, usually occurring in the spring and the fall. An unscheduled meeting is called when a situation demands attention and action. Such an meeting, called an extraordinary meeting, took place in September 2014 to discuss the rapid drop in oil price. A review of the market and decisions on quota adjustments are a central theme in each meeting. Representatives from member states, usually the state's oil minister or heads of national oil companies attend these mostly closed-door meetings. All OPEC members vote on quota decisions, with a majority vote making the decision. Once each OPEC conference is concluded, the public press is invited to attend the official release announcement.

OPEC has considerable power over oil market prices thanks to its considerable oil portfolio position, which allows it the ability to influence production quotas and spare operating capacity. Many believe there has been a tendency for OPEC members to exceed production quotas (Kaufmann et al., 2004). Colgan (2014) confirmed this notion by finding that OPEC has had little or no impact on the production levels of its members. This perhaps is not relevant today, as increased production (and proven reserves) from non-OPEC producers, such as Russia and the USA, pose a potential threat to OPEC's ability to further influence market equilibrium going forward.

[42] Data from OPEC Annual Statistical Bulletin 2016.

The global oil market supply demand structure has shifted in the past ten years. Demand from OECD countries has not returned—nor is it expected to return—to pre-2008 levels[43] due to the cumulative effects of energy efficiency and the use of renewable energy alternatives. Growth in energy demand, namely crude oil and petroleum products demand, is from non-OECD countries, particularly China and India, where peak demand recently exceeded OECD peak demand for the first time (Kemp, 2016). This growth pattern is expected to continue, although non-OECD oil demand is seen as more elastic than mature OECD markets, creating demand uncertainty. As mentioned previously, the global supply narrative has also changed in the past ten years due to the growth of non-OPEC production, but more specifically the arrival of an entirely different production method for finding and lifting crude oil, known as shale oil.

Shale oil production has an entirely different operating structure and a different set of economic incentives, compared to traditional conventional oil production. As with any fungible or exchangeable commodity, market price is set by the marginal production unit and the willingness to sell. OPEC defines itself as a market price maker as opposed to a price taker, as is the case with other oil market supply participants. For example, large conventional oil fields have rates of decline over decades; if producers don't invest in new production development, they still benefit from higher market prices due to production restrictions, in the form of revenue received for ongoing production. A large shale oil field will produce for up to a maximum of one year, meaning that producers do not benefit from higher market price equilibrium due to production restrictions resulting from lack of investment. Shale oil producers are incentivised to seek new fields and produce at maximum capability under profitable pricing regimes. If new fields are not constantly found to replace declining assets, producers will not profit from high prices under restricted global production supply. This turnkey type of operation is new to the industry and may cause challenges for OPEC's current and future decision-making processes since the market equilibrium dynamics have changed. Shale oil will produce at

[43] EIA, 'What drives crude oil prices' report, 2017

maximum capacity under profitable economics for the foreseeable future. This brings into question the long-term viability of shale oil production, discussed in Chapter 6.

5.3 Determinants of Bond Demand and Supply

Bond markets are a core component in financial economics and actively engage both corporate and sovereign borrowers. During normal periods, meaning those with no stress present in financial markets, bond supply and demand determinants can be confidently explained. Founded in asset pricing theory, there are four factors that determine demand for assets: investor wealth, expected return, risk, and asset liquidity. Investor wealth refers to the surplus income or capital available for investment. The expected return of an asset is evaluated against the uncertainty or risk attributed to the asset's characteristics. Liquidity describes the speed at which the asset can be converted to cash or a cash-like equivalent. For example, an increase in investor wealth and liquidity will shift the demand curve to the right, assuming that risk attributes remain unchanged. Each bond is considered under these four factors and compared with alternative investment choices. On the supply side, there are three generalised determinants that articulate the expansion or contraction of bond market supply: financing requirements, level of expected inflation, and expected potential rate of growth. These determinants must be further specified, as bonds are differentiated into corporate and sovereign. Financing requirements refers to requirements to balance a sovereign's public finances via borrowing mechanisms, while expected growth rate references the nation's forecasted economic growth rate. For example, if a sovereign foresees an increase in expected economic growth, the bond supply curve will shift higher as the sovereign accesses more capital for investments. In the application to a corporate, balance sheet finance capabilities dictate the demand for bond financing and the expected growth rate refers to growth of investment opportunities in the corporation's business activities. To illustrate this, a corporate will increase bond supply to the market if a new profitable investment opportunity is identified. Independent shale oil producers will seek to issue further debt if oil prices are attractive and further wells are available for development and production (see Chapter 6).

Asymmetric information concerns can arise in a sovereign with weak fundamentals such as governance and accounting systems, lack of transparency, and credibility. Political reputation can also contribute to asymmetric information, triggering bond market selling and having a contagion effect on broader market turmoil. The response to OPEC quota announcements resulting in lower oil market prices will have a more uncertain impact on Nigerian sovereign debt as compared to Canadian sovereign debt.

5.4 Literature Review

Event study analysis was first presented in the seminal paper by Fama, Fisher, Jensen, and Roll (FFJR) (1969), and immediately propelled a methodological advancement in accounting and finance for studying securities price behaviour around events such as earnings announcements, accounting policy changes, or the introduction of new tax or regulatory regimes. FFJR (1969) studied the effect of a stock split on stock prices. Event studies allow for the testing of two key aspects of securities pricing: the market efficiency hypothesis and the wealth impact to security holders of a specific event (Binder, 1998). The first wave of event study applications concentrated on firm-specific announcements on firm stock prices. Subsequently, event analysis applications were expanded to include the study of macroeconomic events on individual stocks and stock indices.

Literature using OPEC as a central theme initially focused on the classification of OPEC's role in oil markets, as cartel or dominant producer with fringe competition (Loderer (1985), Jones (1990), Gülen (1996), Alhajji and Huettner (2000)). More recently, the study of information content of OPEC conferences became a focal point in the application of event studies (Lin and Tamvakis, 2010). I have taken the position not to discuss the role or influence intensity of OPEC on international oil markets in this paper. Oil price movements have dominated the financial press in recent years. This has led to an increased debate on the role of OPEC and research into the interaction of oil markets with other financial markets and the economy (Lin et al., (2015), Ramady and Mahdi (2015), Loutia et al. (2016), Ratti and Vespignani, (2015), Klein, (2018)). In this paper, I focus on bond market response, using bond total returns, to the public announcement of OPEC conference quota decisions and discuss what this means for bond issuers and bondholders.

There are several papers that study oil market price interactions with stock markets, which were presented in Chapter 4. These include ; Kilian and Park, 2009; Miller and Ratti, 2009; Jones and Kaul, 1996; and Malik and Ewing, 2009. While there are different magnitudes and durations for information integration into the stock markets, consensus is that oil market prices are significant to stock markets. The impact of OPEC conference announcements on stock markets demonstrates that stock markets are influenced by factors that affect business conditions, although international stock markets did not incorporate information about oil market supply announcements with the same efficiency. Jones and Kaul (1996) report that the US and Canadian stock markets react rationally to oil price fluctuations that impact current and expected future real cash flows, while the UK and Japanese stock markets have an excess response when applying existing rational cash flow models.

Draper (1984) was the first to employ event study analysis for OPEC announcements, which he applied to heating oil futures returns. Draper found that investors correctly anticipated OPEC conference outcomes, and results were already priced into futures markets. Guidi et al. (2006), in an event study of OPEC announcements on crude oil market prices during conflict and non-conflict periods, between 1986-2004, found that oil prices responded more efficiently to announcements during non-conflict times. Lin and Tamvakis (2010a) observed in their application of energy study analysis that oil price responses between 1982 and 2008 had varying magnitudes of dependence on the OPEC quota decisions, according to the underlying price levels and trends. Demirer and Kutan (2010) found a positive significant cumulative abnormal return for oil prices during the post-event period when OPEC quota decreases were announced. Interestingly, they found the United States strategic production reserves announcements did not show any differences, meaning indifference in the oil markets. Brunelli et al. (2013) found a similar limited response on “fair price” talk or announcements by OPEC members from 2000 to 2009. More recently, Loutia et al. (2016) found that oil price response was more significant for OPEC quota cuts and no change decisions than quota increases, consistent with the findings of Lin and Tamvakis (2010a) and Demirer and Kutan (2010). Loutia et al. (2016) also found that OPEC decisions were less influential when oil prices were high and unconventional resources viable. All of the above studies incorporate a cumulative view of all OPEC meetings over the specific time series, out of concern that individual meetings might be influenced by other events during that time.

The relationship between OPEC conference announcements and the volatility of oil prices has also been studied with similar findings. Horan et al. (2004), employing an event study analysis from 1989 to 2001, examined crude oil option implied volatility, both before and after the announcement, and found an increase in implied volatility before the meeting and a drop after the meeting’s conclusion, therefore indicating uncertainty was reduced for market participants. Schmidbauer and Rösch (2012) used a GARCH model structure to analyse realised volatility on daily observations around OPEC decisions from 1986 to 2009. They found positive volatility effects before the announcement and asymmetric effects, based on expected returns linked to the quota decision, after the announcement. López (2018) studied the use of variance swaps on the OVX and the VXXLE indices[44] to exploit OPEC announcement day uncertainty and found that, after accounting for transaction costs, no profits could be obtained. Meeting announcements, regardless of realised outcome of “good” or “bad” news to the market participants, resulted in reduced uncertainty and hence lower volatility as measured by the OVX and VXXLE indices.

[44] Chicago Board of Options (CBOT) Exchange calculated crude oil volatility index (OVX) and the energy sector volatility index (VXXLE) measure the market's expectation of 30-day volatility of crude oil prices and energy sector returns, respectively.

Event study application to the bond market appeared in Kim and McConnell's (1977) analysis of co-insurance effects of firm mergers. They achieved their analysis on a firm level, using all of the firm's outstanding bonds. Other approaches used for bond event study methodology include bond level analysis (Warga and Welch, 1993) and representative bond selection (Hite and Warga, 1997),(Handjinicolaou and Kalay, 1984). Penas and Unal (2002) studied the reaction of nonconvertible bonds to bank mergers. Bond response indicated bank mergers were seen as default risk reducing events. This study used the risk and maturity adjusted bond returns presented in Warga and Welch (1993), which take the difference between monthly raw bond returns and the return on a bond index with ratings and maturity characteristics similar to the bonds under study. Bessembinder et al. (2008) summarised the methods used to calculate excess returns on abnormal bond returns since the late 1970s. Kothari and Warner (2007) noted that event studies continue to focus on the cumulative mean of abnormal returns around the time of the event, with the application of two important improvements: first, an increase in the data frequency used from monthly to daily; and, second, an improvement in the sophistication of the methods used to estimate abnormal returns. Bessembinder et al. (2008) noted in their study that monthly return frequency of bond data lacks the power to detect abnormal returns and advised use of daily return frequency to analyze bond market response to merger and acquisition events.

This paper's research will contribute to the existing literature on the information effect of OPEC quota announcements by analysing the response of bond returns, using an event study methodology. This is the first empirical study of the impact of OPEC quota announcements on asset pricing in bond markets. The magnitude of the bond market response to public OPEC quota decisions will be important information for current and future bond market investors. Oil producing firms will find this study helpful to manage investor relations and market timing of future debt issuances. Researchers and policy makers will be interested in the identification and information flow in bond asset pricing.

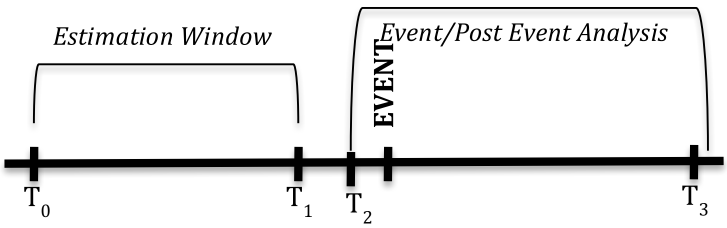
5.5 Methodology

5.5.1 Event Study Analysis

Event study is a powerful econometric model used to analyse the information content of an event, by examining the behavior of abnormal returns of the underlying security asset around the relevant event (Brown and Warner, 1980). The abnormal bond return is a direct measure of the unexpected change in a bondholder's wealth associated with an event. Information content from the event is learned and realised by bond market participants, resulting in a potential change to market risk perception. In this study, OPEC conference quota decisions are the events. There are several accepted methods for determining abnormal returns in bonds: mean-adjusted, portfolio matching, and risk-adjusted. Prior to determining abnormal returns for a bond portfolio, the normal returns for the bond portfolio are calculated (see Section 5.5.2).

The time components of an event study are defined as the estimation and event windows (Figure 5.1). These time periods must be carefully specified while keeping in mind the nature of the specific security and market characteristics. For example, a market that is known to be less efficient should have a larger event window in order to observe the potential market reaction to event information content. The estimation period generates the mean value for use in the mean-adjusted approach to abnormal return calculations. It is important that the estimation period does not include data points that are part of the event window. This ensures that the estimation period does not contain security return innovations caused by the event. The event and post-event windows are selected around the event date in a manner that provides the appropriate amount of time, based on characteristics of each market, to observe a reaction to the specified event. In my model, I have selected an event window that starts ten trading days prior and finishes fifteen trading days after each OPEC conference. Traders in global oil markets actively follow OPEC meeting schedules and quota decisions resulting in efficient information flow to the market. The defined event window will provide sufficient time to observe market speculation in advance of the OPEC conference date and will provide time to observe bond market response after the public announcement of quota decisions.

Figure 5.1: Event Study Time Line



The event study null hypothesis states that the cumulative abnormal returns during the event and post-event window are statistically insignificant, indicating that the OPEC quota announcements have no effect on the bond portfolio returns. The alternative hypothesis states that OPEC quota announcements do have a statistically significant impact on bond portfolio return performance.

H_0: Cumulative Abnormal Returns = 0

H_1: Cumulative Abnormal Returns ≠ 0

The cumulative abnormal returns (CAR) for each portfolio during the event window ($T_2 - T_3$) are computed by summing up daily abnormal bond returns, starting from ten days prior to the OPEC conference quota announcement and ending fifteen days after the conference date.

$$CAR_{iT} = \sum_{t=-10}^{+15} ABR_{it}$$

The CAR is determined individually for each of the four bond portfolios over OPEC conferences during the study period 2011 to 2016. This time period was selected to ensure sufficient bond pricing data for the small- to medium-sized independent shale oil producers. These companies started to issue bond products around 2011, once shale oil deposit growth projections supported increasing firm capital to capture future production growth.

The event study analysis will be conducted on individual portfolio responses to each OPEC conference during the sample. The small number of meetings during this time period allows for a detailed analysis of each response.

5.5.2 Measuring Normal Returns

I hand collected daily bond prices from Reuters EIKON and TRACE for straight bullet bonds issued by oil major corporations and small- to medium-sized independent producers. The bonds selected had maturities between one and five years with semi-annual bond coupons with outstanding principal greater than one million USD. No preferred shares or callable bonds were selected for portfolio construction. Bond prices extracted from Reuters and TRACE databases are "clean" prices, which are equivalent to the market quoted bond prices. Accrued interest was added to the clean price of each bond to reflect the full, or "dirty" price, which is paid on trade settlement, for each date observation in the study. Liquidity on some bonds was limited, and where no observable trade was made, the previous day's settlement clean price was used.

Daily bond returns are calculated by adding the accrued interest to the clean bond price to obtain the full, or dirty:

$$Bond\ Return_{Actual} = \frac{(P_t - P_{t-1}) + Accrued\ Interest}{P_{t-1}}$$

Where: P represents the clean price of the bond
t represents daily frequency.

Accrued interest denotes the sum of the accrued interest for the next scheduled coupon payment and the cumulative interest earned on the bond from date of issuance. Accrued coupon payments were invested under the assumption of a rate equal to the six-month US T-bill rate in order to match the bond's semi-annual coupon payment frequency.

5.5.3 Measuring Abnormal Returns

There are three accepted methods of calculating abnormal returns for bonds (Bessembinder et al., 2008). First, the mean-adjusted model, which creates a mean return for the asset during the study time period. The abnormal portion of the bond returns is the difference between the bond return and the mean return calculated. The cumulative abnormal return is the sum of all abnormal bond returns during the defined event analysis window. The second method is the portfolio matching model. This approach isolates the idiosyncratic response of the bond portfolio to the event by subtracting the returns of an analogous market sector portfolio, in terms of duration and risk concentration. Third is the factor model derived from Fama and French's capital asset pricing model. The foundation of this method has been historically applied to equity markets. For application to bond markets two additional variables are included: the slope and the intercept of the yield curve. Bessembinder et al. (2008) found that the results from the factor model were not significantly different than those of the portfolio approach. Keeping this information in mind, for my empirical analysis I use the mean-adjusted model and the portfolio matching model in the study of OPEC announcements and bond markets.

5.5.3.1 Mean-Adjusted Model

The mean-adjusted model, introduced by Handjinicoulaou and Kaley (1984), subtracts a similar maturity date Treasury bond, representing the risk free rate, from the bond's historical returns, creating what is known as a premium bond holding period return (PBR) (5.1). The mean expected excess bond return (EBR) is calculated by using an equally weighted average of all the PBRs during the observation period (5.2). For this study, the time period selected to calculate the reference mean excess return is the three-year time period 2011 to 2013. This time series represents an episode of relatively stable oil prices prior to the negative oil price shocks observed in mid-2014. The abnormal bond return is the difference between the PBR and the EBR (5.3).

$$PBR_i = BR_i - TR_i \quad (5.1)$$

Where PBR_i is the premium holding period return for a bond portfolio
BR_i is the bond return for the portfolio
TR_i is the treasury bond reference bond portfolio

$$EBR_i = \frac{1}{y}\left(\sum_1^y PBR_i\right) \quad (5.2)$$

Where EBR_i is the expected excess bond returns

$$ABR_i = PBR_i - EBR_i \quad (5.3)$$

Where ABR_i is the abnormal bond returns

5.5.3.2 Portfolio Matching Model

The second approach used to calculate abnormal bond returns is portfolio matching. For each of the portfolios used in my study, I selected a similar reference portfolio index to isolate the excess returns attributed to my bond portfolio with reference to the "market" for bonds with a similar risk profile and time to maturity. This results in the removal of systematic risk effects in my study bond portfolios (Kim and McConnell, 1977).

$$ABR_i = OBR_i - EBR_i \quad (5.4)$$

Where ABR_i is the abnormal bond returns
OBR_i is the observed bond portfolio return
EBR_i is the expected bond portfolio return (portfolio matching)

There has been extensive use of the Lehman Brothers Bond Database (LBBD)[45] in previous event study literature utilising monthly frequency. In this study, I have

[45] The Lehman Brothers Bond Database (LBBD) was acquired by Barclays Bank Analytics in 2009; subsequently Bloomberg acquired Barclays Risk Analytics and Index Solutions from Barclays Bank in 2016. The LBBD Bond Indices are now referred to as Bloomberg Barclays Bond Indices.

employed the S&P 500 bond indices[46] to calculate daily normal returns for the bond portfolios. Access to the Bloomberg (previously known as LBBD) indices data was not possible for this study and perhaps would not satisfy the daily frequency structure of this model. Bessembinder et al. (2008) studied the relevance and coverage of the LBBD and S&P databases to bonds issued by listed S&P 500 companies and reported that the two databases contained similar information regarding bond valuations across maturities. This supports the use of S&P bond indices in this study.

The S&P bond indices used for this study are the S&P 500 Investment Grade Corporate Index and the S&P US High Yield Corporate (1-5 Year) Index. The JP Morgan EMBI-D bond return index, first presented in Chapter 4, is used as the reference portfolio match for the emerging market sovereign importer and exporter portfolios (Table 5.1).

Table 5.1: Portfolios Used for Portfolio Matching ABN Return Analysis

Study Portfolio	Portfolio Match
Oil Majors	S&P Investment Grade Corporate Index
SME Independents	S&P High Yield Corporate Index
EM Sovereign Importers	JP Morgan EMBI-D
EM Sovereign Exporters	JP Morgan EMBI -D

5.6 Data

5.6.1 Data Sample

Sampling procedures in previous studies varied from bond level study to firm level study to a representative selection for use in the study. My sampling procedure is defined as creating portfolios of bonds representing entities with direct exposure to oil price innovations, in order to study their response to OPEC quota announcements. Four bond portfolios were created for this event study analysis. They represent emerging market sovereign oil importers, emerging market sovereign oil exporters, integrated international oil firms (oil majors) and small-to-medium (SME) independent shale oil producer firms (Table 5.1). Total bond returns

[46] S&P Dow Jones Bond Indices.

from the JP Morgan EMBI country indices were used to create the emerging market sovereign importer and exporter portfolios, using countries that are clearly identified as possessing oil exporting exposure or oil importing exposure. Ten large globally integrated producers were used to create an equal weight portfolio of bond returns. In a similar approach, six firms from the independent shale oil producers sample used in my empirical study of hedge production ratios and firm default (Chapter 6) were selected for this analysis[47]. Appendix J contains the list of producer firms.

Previous abnormal bond return literature has used both daily and monthly frequencies with the majority of literature using monthly returns due to a limitation in data availability. Historically, daily bond analysis required extracting data manually from *The Wall Street Journal*, while monthly studies used S&P and Moody's bond guides. From the mid-1990s, the LBBD, available in monthly frequency, became the benchmark index used for all bond returns research.

Table 5.2: Portfolio Construction

Study Portfolio	Composition
Oil Majors	10 Corporates
SME Independents	6 Corporates
EM Sovereign Importers	Chile, China, Turkey, South Africa
EM Sovereign Exporters	Malaysia, Mexico, Russia

5.6.2 Firms with Multiple Bonds

Previous literature has taken three different approaches for dealing with firms that have multiple bonds outstanding. The first approach is to select one representative bond for each firm. This method could bias the results, as one bond may be more sensitive to an event than other bonds. For example, bonds with longer dated maturities have a higher duration, and hence a higher sensitivity to events impacting trading in the bond. Second, all outstanding bonds issued by a firm could be included in the portfolio construction. This could create a problem where some firms have a larger presence than other firms, thereby biasing the portfolio weighting of firms. The third approach is to create one portfolio of bonds for each

[47] There were only six firms from the forty-four firms used in the fixed effect panel study of independent shale oil producers in Chapter 6 that had public bonds trading in the secondary market meeting my selection criteria.

firm that has multiple bonds issued, to generate a firm level representation for the bond. This approach removes the firm level bond bias that is present in the first method and removes the portfolio level bias in the second method. For each firm in my sample that has multiple bonds issued for the time period used in the study, I selected one bond with a maturity between two and five years to represent the firm bonds in the study. Each bond is then normalised during the portfolio construction to ensure equal weight representation of all the bond constituents.

5.6.3 Descriptive Statistics

Descriptive statistics are presented in Table 5.3 for the time period (2011-2013) used for the mean-adjusted return time period and in Table 5.4 for the entire time series of bond return data (2011-2016). Over both sample periods, all bond portfolio returns exhibit a positive mean return. It is interesting to note the large negative skew and kurtosis present in the emerging market portfolios during the mean-adjusted sample time period, revealing risk spillover from the Arab spring protests in North Africa and the Middle East. In the complete time series, the major and SME independent producer portfolios exhibited a negative skew and a large kurtosis statistic, stemming from the negative oil market price innovation in 2014. The seemingly kurtosis statistic of these bond portfolio returns indicates that investors are exposed to extreme returns, in either a positive or a negative direction.

Table 5.3: Daily Returns Statistics for Mean Adjusted Time Series, 2011-2013

	Obs.	Mean	Median	Std. Dev.	Min.	Max.	Skew	Kurtosis	Jarque -Bera
UST	744	0.00005	0.00008	0.00083	-0.0033	0.0033	-0.036	5.392	177.5
EM IMP	744	0.00014	0.00033	0.00341	-0.0284	0.0152	-1.509	17.223	6554
EM EXP	744	0.00022	0.00037	0.00282	-0.0249	0.0099	-1.923	17.124	6643
MAJOR	744	0.00022	0.00025	0.00283	-0.0102	0.0118	0.043	4.308	53.2
SME	714	0.00024	0.00023	0.00335	-0.0176	0.0148	-0.432	7.597	651

UST, EM IMP, EM EXP, MAJOR and SME denote US Treasury, Emerging Market Sovereign Importers, Emerging Market Sovereign Exporters, Oil Majors, and Small Medium Exploration and Producers respectively.

Table 5.4: Descriptive Statistics Daily Returns Portfolios and Reference Portfolio Indices

2011-2016	Obs.	Mean	Median	Std. Dev.	Min.	Max.	Skew	Kurtosis	Jarque-Bera
UST	1493	0.00005	0.00006	0.0009	-0.0039	0.0038	-0.043	4.584	156
EM IMP	1493	0.00018	0.00033	0.0033	-0.0284	0.0152	-1.226	13.928	7254
EMBI	1493	0.00023	0.00036	0.0030	-0.0278	0.0141	-1.509	16.324	1105
EM EXP	1493	0.00020	0.00031	0.0032	-0.0249	0.0222	-0.080	11.701	4703
MAJOR	1493	0.00017	0.00019	0.0023	-0.0103	0.0118	0.080	5.752	476
SME	1463	0.00022	0.00026	0.0051	-0.0578	0.0309	-2.248	34.049	5300
SP500 IG	1493	0.00018	0.00030	0.0028	-0.0143	0.0082	-0.397	4.099	109
SP500 HY	1493	0.00023	0.00036	0.0017	-0.0129	0.0076	-1.486	12.599	6125

UST, EM IMP, EMBI, EM EXP, MAJOR, SME, SP500 IG, SP500 HY denote US Treasury, Emerging Market Sovereign Importers, JP Morgan EMBI Index, Emerging Market Sovereign Exporters, Oil Majors, and Small Medium Exploration and Producers, S&P500 Investment grade bond index and S&P 500 High Yield bond index respectively.

5.6.4 Events Under Study

The OPEC conferences (Table 5.5) during the analysis time period (2011-2016) represent two distinct oil market equilibrium intervals. The first seven conferences occurred during a low volatility, strong oil market price setting that provided a comfortable profitability situation for oil producers. The remaining five conferences during the sample time period transpired under low oil market prices with high levels of uncertainty, represented by oil option implied volatility and a difficult environment for some oil producers to continue profitable operations.

Literature has divided OPEC quota decisions into the categories of increased quotas, decreased quotas, or unchanged quotas. This identification process allows for a study of underlying security responses to a specific expected change in global supply supported by the OPEC decision. Additional classification has been conducted to further identify the prevailing market equilibrium and market sentiment in the event study. Price bands were created by Lin and Tamvakis (2010) to isolate prices on OPEC conference dates in categories of high, low, and average as compared to a six-month high-low price band that evolved through time. This approach provides a good structure to understand if the quota decision is occurring during a perceived high price or low price period in the market. Applying the same approach used by Lin and Tavmakis to the thirteen OPEC meetings that occurred during this study time series, all but one conference fell into the average-price time band. The November 2014 conference took place during a low-price band. This is the OPEC conference that motivated my event study research, as OPEC publically announced a fundamental shift away from its previous strategy as market equilibrium swing producer. The small number of OPEC conferences contained in this event study period allows for individual event analysis to occur. The above-mentioned conference and the November 2016 conference are highlighted, as these conferences represent significant decisions during prevailing low oil price under the high levels of market implied volatility and the continued weight of North American shale oil production. Market price environment and prevailing market sentiment are important to crude oil market participants, as noted by Lin and Tavmakis. The response of bond portfolio returns in this study are discussed and compared to oil and equity market results presented in previous OPEC event study literature.

Table 5.5: OPEC Meeting During Time Series, 2011-2016

Date	OPEC Conference	Meeting Outcome
June 8, 2011	159th	Quota unchanged
December 14, 2011	160th	Quota increased
June 14, 2012	161st	Quota unchanged
December 12, 2012	162nd	Quota unchanged
May 31, 2013	163rd	Quota unchanged
December 4, 2013	164th	Quota unchanged
June 11, 2014	165th	Quota unchanged
November 27, 2014	166th	Quota unchanged
June 5, 2015	167th	Quota unchanged
December 4, 2015	168th	Quota unchanged
June 2, 2016	169th	Quota unchanged
September 28, 2016	170th (Extraordinary)	Discussion, no official change
November 30, 2016	171st	Quota decreased

5.7 Empirical Results

The OPEC conferences analysed during this study time period occurred during two distinct oil market price environments. During the first segment of the time series, 2011 to 2013, prices were generally stable with relatively low volatility, while the second portion of the time period exhibited significantly lower prices with high levels of uncertainty present in observed oil price volatility (Figure 5.6).

Bond market response to OPEC announcements varied in amplitude and response time directly linked to the concentration of risk to oil price fluctuations in each bond portfolio. Event study results were consistent with previous literature showing an asymmetric response to OPEC quota decisions that impacted oil market prices. Bond portfolios responded significantly to perceived ‘bad news’ but responded less significantly to ‘good news’. This asymmetric response pattern in bond portfolios is supported by previous bond research. Bondholders are entitled to receive the fixed coupon payment and return of initial principle (face value of the bond). Unlike equity participants, bondholders do not benefit further, in a financial cash flow sense, if the bond issuers increase profitability. However, if a bond issuer performs poorly with lower cash flow available for bond liability management, this becomes a risk for bondholders. Therefore, bondholders will react to information that has negative implications to the bond issuer’s cash flow, while remaining somewhat indifferent to positive news that bolsters cash flow, unless this positive news negates previous negative news. Information content that has negative implications for oil market prices that arrives during low oil market price scenarios has a much stronger amplitude of response than news with negative oil price implications during perceived neutral or high oil market price moments.

5.7.1 November 2014 Conference

CARs for the bond portfolio response to information content from the OPEC conference event in November 2014 are contained in Figure 5.2 and Figure 5.3 for the mean-adjusted and portfolio matching CAR methods respectively. OPEC announced that the organisation, and in particular Saudi Arabia, would not adjust production quotas, thereby relinquishing the swing producer role. Oil markets would have to find a new price equilibrium independently of supply side influence from OPEC. The oil markets responded with a shift lower in the term structure.

Figure 5.2: CAR Mean-adjusted OPEC Conference November 2014

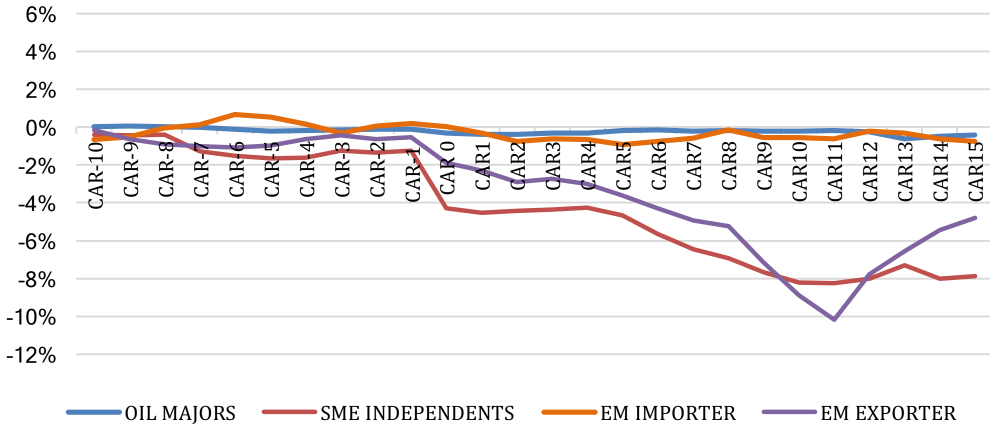
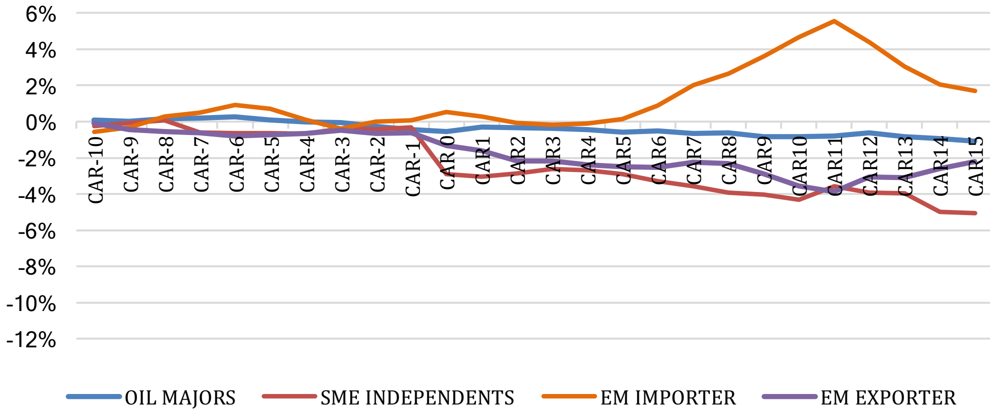


Figure 5.3: CAR Portfolio Matching, OPEC Conference November 2014



Bond portfolios of SME shale oil independents and emerging market oil exporters had statistically significant[48] negative responses in portfolio returns in both the mean-adjusted and the portfolio matching models (Table 5.6 and Table 5.7) at the moment of information availability at the OPEC news conference. The oil majors bond portfolio had no reaction to this event, indicating that the diversification of business activities in downstream channels limits bond market response to negative crude oil price news. The emerging market oil importer bond portfolio had a delayed statistically significant positive returns response under the portfolio matching model (Table 5.7). Lower oil prices reduce fiscal expenditures for oil product imports, thereby freeing cash flow for other purposes. The delayed response by the bond market supports the fragmentation theory. Bond market participants in sovereign

[48] Parametric t-statistic tests are used in this study, which is supported by the previous literature. The events are studied uniquely rather than as a cross-sectional analysis, as with most of the previous OPEC event study literature.

debt products focus on fixed income returns for their investment and perhaps are not readily watching and responding to every commodity market fluctuation in real time. Financialization of commodity markets has been suggested to contribute to stronger direct correlation with other financial markets. This might explain why the positive response of the importer group was only observed by removing the portfolio matching model. As a group sovereign bond returns had a delayed negative response to the OPEC announcement, but within this group the importer portfolio of sovereigns had a positive reaction supported by the above explanation.

Table 5.6: CAR Mean Analysis for OPEC Conference November 2014

N	OIL MAJORS	SME INDEPENDENTS	EM IMPORTER	EM EXPORTER
CAR-10	0.02%	-0.39%	-0.65%	-0.16%
CAR-9	0.05%	-0.44%	-0.52%	-0.60%
CAR-8	0.00%	-0.41%	-0.05%	-0.83%
CAR-7	-0.01%	-1.28%	0.12%	-0.92%
CAR-6	-0.12%	-1.53%	0.65%	-0.97%
CAR-5	-0.22%	-1.66%	0.52%	-0.84%
CAR-4	-0.19%	-1.61%	0.17%	-0.49%
CAR-3	-0.15%	-1.24%	-0.32%	-0.27%
CAR-2	-0.12%	-1.34%	0.06%	-0.45%
CAR-1	-0.11%	-1.25%	0.20%	-0.34%
CAR 0	**-0.34%**	**-4.30%*****	**0.02%**	**-1.66%**
CAR1	-0.39%	-4.52%***	-0.32%	-2.04%
CAR2	-0.38%	-4.42%***	-0.75%	-2.64%**
CAR3	-0.32%	-4.34%***	-0.63%	-2.44%**
CAR4	-0.34%	-4.26%***	-0.65%	-2.70%**
CAR5	-0.21%	-4.66%***	-0.92%	-3.29%**
CAR6	-0.16%	-5.65%***	-0.75%	-3.93%***
CAR7	-0.23%	-6.45%***	-0.59%	-4.57%***
CAR8	-0.19%	-6.92%***	-0.14%	-4.83%***
CAR9	-0.24%	-7.66%***	-0.56%	-6.75%***
CAR10	-0.24%	-8.20%***	-0.55%	-8.45%***
CAR11	-0.19%	-8.25%***	-0.62%	-9.72%***
CAR12	-0.26%	-8.01%***	-0.20%	-7.29%***
CAR13	-0.62%	-7.30%***	-0.30%	-6.07%***
CAR14	-0.52%	-8.00%***	-0.63%	-4.93%***
CAR15	-0.44%	-7.89%***	-0.75%	-4.28%***

Note: t-statistic significance at 10%, 5%, 1% levels => */**/***

Table 5.7: CAR for Portfolio Matching, OPEC Conference November 2014

N	OIL MAJORS	SME INDEPENDENTS	EM IMPORTER	EM EXPORTER
CAR-10	0.09%	-0.25%	-0.55%	-0.08%
CAR-9	0.03%	-0.08%	-0.32%	-0.43%
CAR-8	0.17%	0.08%	0.29%	-0.54%
CAR-7	0.19%	-0.60%	0.48%	-0.61%
CAR-6	0.26%	-0.64%	0.92%	-0.79%
CAR-5	0.09%	-0.64%	0.72%	-0.73%
CAR-4	-0.03%	-0.66%	0.11%	-0.65%
CAR-3	-0.06%	-0.39%	-0.40%	-0.48%
CAR-2	-0.28%	-0.44%	0.00%	-0.65%
CAR-1	-0.43%	-0.32%	0.09%	-0.61%
CAR 0	**-0.53%**	**-2.90%****	**0.52%**	**-1.33%****
CAR1	-0.29%	-3.05%**	0.29%	-1.61%***
CAR2	-0.33%	-2.85%**	-0.09%	-2.18%***
CAR3	-0.37%	-2.63%**	-0.17%	-2.19%***
CAR4	-0.44%	-2.67%**	-0.09%	-2.37%***
CAR5	-0.57%	-2.92%**	0.14%	-2.49%***
CAR6	-0.53%	-3.28%**	0.90%	-2.54%***
CAR7	-0.64%	-3.57%**	2.01%	-2.24%***
CAR8	-0.61%	-3.93%**	2.66%	-2.32%***
CAR9	-0.82%	-4.03%**	3.59%**	-2.90%***
CAR10	-0.85%	-4.31%***	4.67%**	-3.55%***
CAR11	-0.79%	-3.59%**	5.57%***	-3.87%***
CAR12	-0.62%	-3.93%**	4.39%**	-3.05%***
CAR13	-0.82%	-3.98%**	3.04%*	-3.10%***
CAR14	-0.95%	-4.98%***	2.06%	-2.62%***
CAR15	-1.07%	-5.06%***	1.70%	-2.22%***

Note: t-statistic significance at 10%, 5%, 1% levels => */**/***

5.7.2 November 2016 Conference

After two years of low crude oil market prices, OPEC members, in conjunction with Russia (a non-OPEC member), agreed at the November 2016 conference to lower production quotas, in an attempt to support oil market prices. This news was greeted positively by the oil market with a shift upward in oil market futures prices. CARs for the bond portfolio response to information content from the OPEC conference event in November 2016 are contained in Figure 5.4 and Figure 5.5 for the mean-adjusted and portfolio matching CAR methods respectively.

SME independent producers had a statistically significant positive reaction to this quota reduction news, while the other oil producer portfolios, oil majors and emerging market oil exporters, had no significant response to the news (Table 5.8). Emerging market oil exporter portfolio had reacted negatively to the November 2014 ‘bad news’, but had no reaction to this ‘good news’ implying higher future oil market prices. This reaction falls in line with the asymmetric response described earlier in this section. The question that arises is, why does the SME independent oil producer bond portfolio have a significant response to this news, contrary to the emerging market sovereigns oil exporter bond portfolio? I believe that SME independent oil producers exhibit a strong improvement in bond portfolio returns because many firms in this sector were near solvency thresholds during 2016. Bondholders had already priced in some level of loss given default valuation (or expected recovery rate under default conditions) into these bonds, after the OPEC quota decision to leave production unchanged in November 2014. This is because high yield debt holders of firms in cyclical commodity markets have learned from previous commodity price troughs that firms with weak cash flow profiles have a high probability of default. Higher expected oil prices mean that bond default probabilities were less of a concern for this oil producer group. Emerging market sovereign oil importers, once again, had a delayed response to this news under the portfolio matching method, again supporting market segmentation. Diversification characteristics of the oil majors explain the lack of response by their bondholders.

Figure 5.4: Mean-adjusted CAR for November 2016

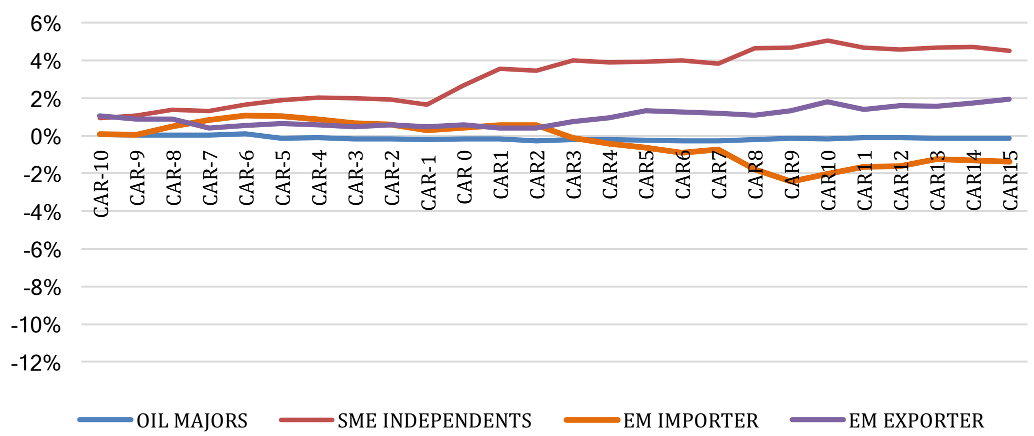


Figure 5.5: Portfolio Matching CAR for November 2016

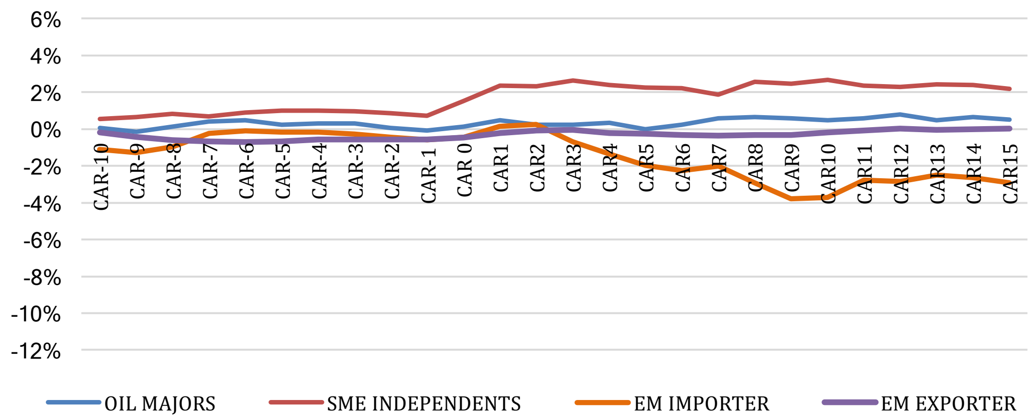


Table 5.8: Event Analysis CAR for November 2016

	Mean-Adjusted CAR				Portfolio Matching CAR			
N	OIL MAJORS	SME	EM IMPORT	EM EXPORT	OIL MAJORS	SME	EM IMPORT	EM EXPORT
CAR-10	0.08%	0.92%	0.11%	1.06%	0.07%	0.55%	-1.12%	-0.18%
CAR-9	0.04%	1.06%	0.04%	0.90%	-0.16%	0.67%	-1.27%	-0.44%
CAR-8	0.02%	1.37%	0.48%	0.89%	0.13%	0.82%	-0.98%	-0.62%
CAR-7	0.04%	1.32%	0.83%	0.43%	0.39%	0.69%	-0.23%	-0.69%
CAR-6	0.11%	1.66%	1.07%	0.54%	0.48%	0.89%	-0.09%	-0.70%
CAR-5	-0.13%	1.91%	1.06%	0.66%	0.24%	0.99%	-0.17%	-0.66%
CAR-4	-0.10%	2.02%	0.89%	0.60%	0.30%	0.98%	-0.18%	-0.58%
CAR-3	-0.16%	2.01%	0.67%	0.49%	0.29%	0.97%	-0.27%	-0.57%
CAR-2	-0.16%	1.94%	0.61%	0.60%	0.07%	0.87%	-0.43%	-0.58%
CAR-1	-0.20%	1.67%	0.30%	0.49%	-0.09%	0.72%	-0.60%	-0.56%
CAR 0	**-0.18%**	**2.67%***	**0.44%**	**0.58%**	**0.14%**	**1.50%**	**-0.45%**	**-0.48%**
CAR1	-0.15%	3.56%**	0.58%	0.41%	0.49%	2.35%	0.14%	-0.22%
CAR2	-0.25%	3.48%**	0.57%	0.42%	0.24%	2.32%	0.25%	-0.10%
CAR3	-0.20%	4.00%**	-0.12%	0.76%	0.22%	2.64%*	-0.70%	-0.04%
CAR4	-0.19%	3.91%**	-0.42%	0.94%	0.33%	2.39%*	-1.34%	-0.21%
CAR5	-0.25%	3.95%**	-0.64%	1.34%	0.00%	2.25%*	-1.99%	-0.26%
CAR6	-0.27%	4.00%**	-0.91%	1.26%	0.22%	2.22%*	-2.24%	-0.33%
CAR7	-0.26%	3.84%**	-0.72%	1.20%	0.58%	1.88%*	-2.01%	-0.37%
CAR8	-0.18%	4.65%***	-1.79%	1.08%	0.67%	2.58%*	-2.90%*	-0.33%
CAR9	-0.13%	4.69%***	-2.44%*	1.33%	0.59%	2.44%*	-3.79%*	-0.33%
CAR10	-0.18%	5.06%***	-2.02%*	1.81%	0.49%	2.65%*	-3.70%*	-0.20%
CAR11	-0.10%	4.69%***	-1.65%	1.40%	0.58%	2.37%*	-2.79%*	-0.08%
CAR12	-0.09%	4.60%***	-1.62%	1.59%	0.78%	2.27%*	-2.83%*	0.02%
CAR13	-0.13%	4.67%***	-1.25%	1.58%	0.48%	2.44%*	-2.52%	-0.05%
CAR14	-0.12%	4.73%***	-1.31%	1.73%	0.65%	2.40%	-2.65%	0.01%
CAR15	-0.14%	4.50%***	-1.39%	1.93%	0.52%	2.17%	-2.91%	0.01%

Note: SME* = SME Independents, t-statistic significance at 10%, 5%, 1% levels => */**/***

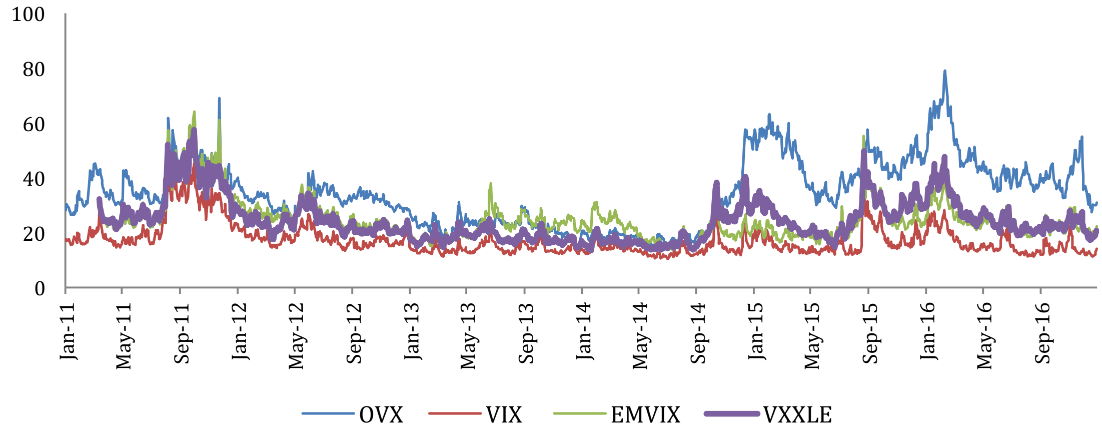
5.7.3 Market Volatility Indices and Market Segmentation

Volatility indices are used by the market to signal investor fear about future expected market volatility. The Chicago Board Options Exchange (CBOE) market volatility index (VIX), launched in 1992, is a market research tool that represents the S&P 500 stock market expectation of volatility. It is referred to as the 'fear index' and is widely followed by all investors. Flight to safety capital flows are almost always preceded by a significant upward shock in the VIX. This relationship favours the study of volatility indices and bond portfolio returns in my event study research.

After the successful launch of the VIX combined with market demand, CBOE created several additional market volatility indices. Relevant indices to my empirical study include the crude oil market volatility index (OVX), the oil markets exchange traded fund VIX (VXXLE), and the emerging market VIX (EMVIX). OVX is the NYMEX WTI crude oil market expectation of volatility. The VXXLE, which references the XLE ETF product, is an index representing the expectation of future volatility for the US energy sector. The third index, EMVIX, which uses the MSCI emerging market ETF, is the future expectation of volatility for the emerging market sector.

The oil futures volatility index, called the OVX, is not statistically significant with the total bond returns for all four bond portfolios. This result supports market segmentation which explains why markets do not respond similarly to news that could be perceived as relevant due to the characteristics of investors who participate in various markets. Energy markets, namely oil markets in our study, have completely different investor participation than bond markets. Bond markets are usually populated with investors, such as pension fund and insurance institutions, who manage passive strategies. These types of investors will not respond, by changing their portfolio via capital reallocation, to each price shock in oil markets. Instead these type of investors have a larger top down strategy that demands a certain capital diversification in bond markets.

Figure 5.6: Volatility Indices



The other three volatility indices studies, the VIX, the oil majors VIX, and the emerging market VIX, are statistically significant with total bond portfolio returns. These indices follow investor sentiment, or investor risk concerns, broadly in the global markets rather than focus on the commodity (oil) sector. This supports my suggestion that the bond investor composition group looks to equity-based VIX metrics when analyzing the bond market or an individual bond instrument. Sovereign debt markets are influenced by the market perception of systematic riskiness.

5.8 Robustness and Future Testing

The equivalent equity portfolio was constructed using the same firm composition as in the oil majors and SME independent oil producer bond portfolios. Equity portfolio reaction to OPEC conference quota decisions was immediate, with a significant amplitude to the portfolio response. There were still some signs of asymmetric response present in the equity portfolio response, albeit at a much lower level than observed in the bond portfolio responses. The results from the equity portfolio response to these OPEC conferences support the observations presented for the bond portfolios.

Different estimation periods were used to test the robustness of the mean-adjusted abnormal bond return model results. The CAR response was consistent with estimation periods of 2011, 2011-2012, 2013, and 2011-2014. Robustness testing for reference portfolios used in the portfolio matching model was not possible due to lack of appropriate alternative portfolios.

The event study structure selected for model application was a ten day estimation period prior to the OPEC scheduled meeting and fifteen day post event analysis period. Two additional event study structures were selected to test robustness of results to the selection of number days used in the event study window structure. First a shorter period of days, five days prior to the OPEC scheduled meeting and ten days following the meeting, were tested and results were consistent with results of the selected event window in this paper. Second a longer period of days, twenty days prior to the OPEC scheduled meeting and thirty days following the meeting, were tested and results were consistent with the study results presented in this paper. Robustness results are presented in Appendix K.

The number of bonds used to create the corporate producer and independent producer portfolios is small due to the limited number of firms qualified for the portfolio definitions and the limited number of firms that have issued bonds. This is an inherent weakness of the model. This situation is more prolific for the SME independent producer portfolio, as many independent producers rely on bank financing mechanisms in lieu of issuing market trade debt products. Future research should return to this study with the benefit of more bond pricing data for the smaller independent producer groups. There is no current signal, such as active monetary policy tightening, that will end the current growth trajectory of bond markets. In fact, with changes seen in firm IPO structures with dual class common shares, more investors may be interested in debt financing rather than equity financing, particularly for high-yield corporates. Investors are being offered equity participation with no voting capabilities, so that start-up entrepreneurial management teams can maintain voting control regardless of percentage equity capital ownership in the firm. This new trend will be presented further in the future research suggestions section of Chapter 7.

The large kurtosis statistic of the bond portfolio returns indicates that investors are exposed to extreme returns, which increases the uncertainty of possible bond return outcomes. The risk inherent in these portfolios warrants further research into bond market performance and response under exogenous events. A future research study that includes investor composition will be useful to identify the bond market reaction under active investor participation versus passive investor participation.

5.9 Conclusions

This event study analysis provides a focused approach for observing bond market investor reaction to oil price information obtained from OEPC quota decisions on bond portfolios of oil producers and emerging market sovereigns with exposure to oil prices. Findings show that bond portfolios for undiversified oil producer groups have an asymmetric response to news, with a statistically significant negative reaction to information content that has a negative impact on oil market prices and a muted response to information content that implies higher oil market prices. The magnitude of the CAR was directly related to the prevailing level of oil market price. The negative pricing news from the November 2014 meeting arrived during a low price cycle, resulting in a strong negative response of bond portfolios of undiversified producers.

Oil major corporate bondholders understand that these firms are integrated diversified operations that are not dependent solely on primary energy crude oil pricing. Unlike many smaller independent oil producers, these large firms benefit from strong credit ratings which follow and indicate financial resiliency, reducing bondholder credit concerns during low oil price cycles.

This empirical research contributes to the limited literature of event pricing on bond markets and is immediately relevant to bond market participants, policy makers, and sovereign officials responsible for balancing fiscal budgets. Historically, investor investment strategies have limited the information flow and supported market fragmentation theory, resulting in virtually no bond market response to commodity market price shocks. While this view remains valid, this may be changing as discussed in this thesis. This research launches the discussion of the changing investor characteristics from passive institutional approach to active fund management style and considers the resulting implications to bond prices and issuer borrowing rates.

6.0 Independent Shale Oil Producers: The Impact of Hedging on Firm Value and Firm Default Distress

6.1 Introduction

The growth in exploration and production between 2010 and 2015 by tight oil producers in North America surprised all but the most knowledgeable industry insiders. Shale and tight oil production grew from 0.8 million to 4.9 million barrels per day (BPD) during this period, going from 15% to 52% of total US crude oil production.[49] This exceptional growth pattern spurred many long-term forecasts predicting the United States would be oil independent by 2017. The addition of this production caused the global supply curve to shift left under a constant demand pattern, resulting in lower prices. The price of crude oil declined dramatically in the second half of 2014, and as of May 2016, sixty independent producers had filed for bankruptcy or reorganisation protection (Hals, 2016). This includes twelve of the forty-four firms in this study, which filed in 2016. Small- to medium-sized shale producers (private and public) contribute an estimated one million BPD or more to domestic production, making them important contributors to domestic production.[50] Given this assessment of such producers' resilience warrants further investigation of operational characteristics, strategies, and financing. The time period under study, during a severe negative price innovation, proved an excellent opportunity to observe firm performance, default probabilities, and the characteristics of effective hedge programs.

The hedging strategies of the US-based independent tight oil producers under study here over a five-year period that includes both stable and volatile crude oil price periods will shed light on a crucial question: Does the magnitude of a hedge program make a positive contribution to firm value and reduce default probabilities and the likelihood of bankruptcy? The literature review did not reveal any other comprehensive, hand-collected data study of domestic, undiversified shale oil firm

[49] US Energy Information Association, 2015.

[50] Ed Morse, Citigroup Global Head of Commodity Research, Reuters interview, November 2015.

financing and hedging strategies and their impact on firm value and default probability. The findings of this paper will contribute important information on a new independent producer group to existing research, in the area of hedging strategies and their effect on firm value and financial distress metrics. The research will provide the investor community with information that will help it consider the allocation of debt and equity structured funding to this specific E&P segment. Bank lenders, who require minimum production hedging in their covenant structures, will benefit from an empirical study of hedging programs and firm default risk.

The research hypothesis suggests that a study sample of independent, domestic, non-diversified shale oil producers, with higher levels of hedging ratios, have superior firm value and greater distance to default than those producers with lower hedging ratios. To test this hypothesis, I created a sample of non-diversified independent shale oil producers, with and without credit ratings, with market capitalization values between 100 million and 11 billion as of June 30, 2015. A fixed effect panel model with quarterly frequency is used to evaluate the impact of hedging on firm value and distance to default, while controlling for firm size, leverage ratio, profitability, investment, and production costs. Publically traded companies were selected, as comprehensive data are available on the Securities and Exchange Commission (SEC) Electronic Data Gathering, Analysis and Retrieval (EDGAR) website and in quarterly financial reports mandated by SEC market risk[51] disclosure requirements. While E&P producers extract a combination of crude oil, natural gas, and natural gas liquids (NGL), this study selected firms with more than 50% of their revenue derived from crude oil sales. This allows for a homogeneous, controlled evaluation of the effects of a firm sample, in both a period of price stability and a period of a negative price shock in global oil prices during Q3-2014.

As Jin and Jorion (2006) note, the study of hedging policies on oil and gas producer firm value allows for a focused approach to a strong homogeneous group. By selecting domestically focused tight oil producers, this research further emphasizes

[51] Since 1997, SEC Financial Reporting Release 48 requires all publically traded companies to disclose on an annual basis possible and actual risk exposures, all derivatives products used for hedging and speculation.

the homogeneous nature of the study. The companies selected are focused on E&P and commodity sales only in North America and are registered corporations in the United States. This ensures that tax and federal subsidy programs[52] are consistent across the sample group.

Hedging activity and the sophistication of hedging strategies correlate to the corporate leverage ratio (Domanski, 2015). Aretz and Bartram (2010) found 65% of all US-based firms used derivatives. The current study focuses on producers which had commodity price risk hedging programs during the study period. Corporate hedging strategies also have a link to debt borrowing structure obligations and covenants. This demands minimum hedge volumes to ensure stable cash flow streams are available to service outstanding debt, and maximum hedge volume limits to discourage speculation.

The high-yield corporate bond market, and in particular the US E&P sector, is attractive to investors seeking higher yields with a known risk exposure. Since 2009, when government interest rate policy resulted in a downward shift in the term structure of interest rates, investor demand for high-yield returns has supported the growth of the corporate high-yield bond market. These channels of high-yield funding and strong global oil prices have supported E&P tight oil drilling and production growth activity. Crude oil is a cyclical commodity with high price peaks and low price troughs. Low prices can create financial stress for producers and default risk for debt obligations. Distance to default is a measure of a firm's probability of default by observing the face value of debt outstanding and comparing this value to the firm asset value adjusted by the volatility of the firm's assets. This approach measures default by determining the asset value compared to the debt outstanding and re-payment schedule. Distance to default measured using Moody's KMV model,[53] based on Merton's 1974 bond valuation model, has been applied extensively to corporate firms and is a forward-looking measure of how far a firm is

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52 State level industry or government subsidy information could have a varied effect across producer sample group, albeit the firms are concentrated in six states.

53 The KMV model (Kealhofer, McQuown, Vasicek) is a proprietary model and database owned by Moody's Analytics.

from bankruptcy by comparing asset net worth to firm market volatility. Empirical estimates of default probability via this model structure out-perform accepted benchmarks such as agency debt ratings (Kealhofer, 2003). This approach is particularly useful for firms with no credit ratings and no credit default trading products.

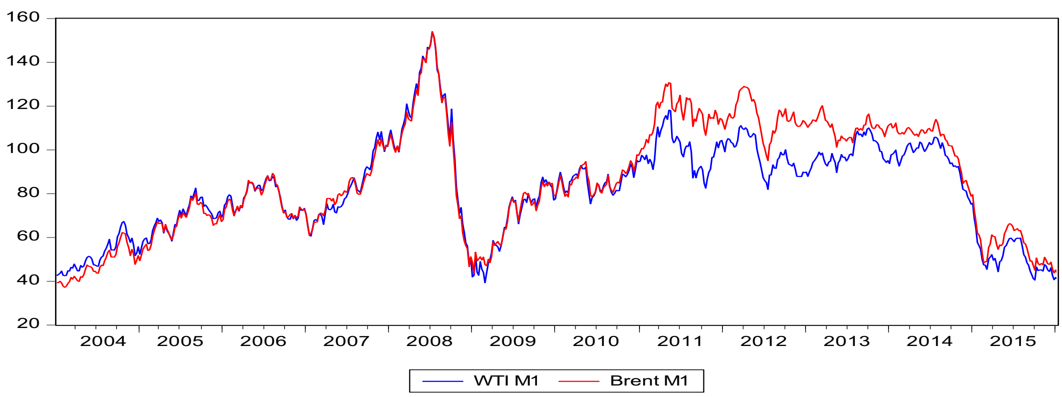
The remainder of this chapter is organised as follows: Section 2 provides background information on the global oil market price history, independent domestic E&P shale oil producers, and E&P borrowing mechanisms. Section 3 reviews existing research and outlines this chapter's contribution. Section 4 describes the data and empirical models and methodology used in study. Section 5 reports the empirical results and discusses the robustness of the methodology. Finally, Section 6 summarizes the key findings.

6.2 Background

6.2.1 Oil Market Characteristics

Economists have attributed the Q3-2014 oil price decline to a combination of an oil supply shock and a change in Saudi policy (Figure 6.1). Baumeister and Kilian (2015), on the other hand, have argued that neither of these factors is empirically significant. Their research indicates oil market-specific developments that precede the second quarter of 2014 led to the decline. Currently, there continues to be broad support for supply side shock contributions to this negative oil price innovation.

Figure 6.1: Historical Brent and WTI Nearby Futures Contract (USD/Bbl)



Source: Reuters DataStream

The recent drop in oil and natural gas prices has resulted in the need to understand the sustainability of tight oil production in a lower energy price environment. Researchers suggest technological innovations will continue to lower the cost of finding and lifting,[54] and could reduce the detrimental effects of oil production on the environment and human health (King, 2011). Combined with producer cost efficiencies, drilling viability is likely to continue on existing field operations (Gulen, 2015).

6.2.2 E&P Producer Risk Exposure and Valuation

Independent producers have been important contributors and a constant presence in the North American oil and gas sector since a wildcatter named Edwin Drake drilled the first oil well in Pennsylvania in 1859.[55] Independent oil companies focused exclusively on upstream exploration and production[56] tend to monetize their discoveries through sales of their proven reserves to large established producers, in order to continue to focus on small-scale exploration efforts. These producers tend to have lower cost structures compared to the large multinational integrated players. Independent producers seem more risk assertive, as there are no guaranteed discoveries, in the exploration phase of oil deposit development. Shale oil extraction characteristics have changed the relationship and arrangement between independents and large integrated players. The time period for shale and horizontal discovery to commercial production can be as short as six weeks; this process also has a much shorter production life cycle than that of conventional wells (Lutz, 2016). As a result, many more independent producers are taking on a larger portfolio of shale plays, thereby becoming larger corporate entities, and consequently requiring even more external funding. Access to debt markets varies based on the size and credit rating of the independent producer. Larger firms with credit ratings can access the

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[54] *Lifting price* refers to the price of extracting tight oil from the ground. *Finding price* refers to exploration efforts.

[55] EIA, March 2016. 'Tight oil discovery and extraction in the Marcellus shale play have returned the economic benefits to Pennsylvania'.

[56] Independent oil companies are undiversified, not vertically integrated; thus they tend to be smaller in size than integrated players.

public debt capital markets, assuming there is investor demand for these types of debt products. Many firms have no credit rating due to their size or their financial health, thereby limiting their borrowing channels to banking relationships and private placement.

Oil producers are exposed to two types of risk which contribute to cash flow and earnings volatility: market price risk and exploration risk. Market price risk, which is the impact of price volatility on an independent producer's earnings before interest and tax (EBIT), can be hedged under the assumption that market access and cost of hedging is not prohibitive. There are no direct hedges for the operational risks of unsuccessful drilling or dry wells. Each resource well contains some combination of oil, natural gas, and natural gas liquids. This means that oil producers also extract natural gas and natural gas liquids during the crude oil lifting process. These can be considered primary or secondary products, depending on volume and the prevailing market price, resulting in a positive impact for firm cash flow and earnings. After 2011, many producers shifted their focus to crude oil extraction based on favourable pricing, as opposed to natural gas.

Standard E&P corporate valuation is based on net present value of fixed assets, which are always a function of both proven reserves[57] and, occasionally, unproven reserves. More complex corporate valuation methods use an option pricing mechanism which includes some percentage of unproven reserves in the valuation. Corporate lending analysts consider proven reserves paramount in determining borrowing authorisation amounts. The firm asset valuation process uses proven reserve volumes multiplied by a banker-generated price deck, which references the market futures price curve. A shift lower in the energy futures price curve will move the price deck lower, and result in a reduction in proven reserve valuation. This, in turn, reduces the asset value backing or collateralising the debt instruments (Figure 6.2).

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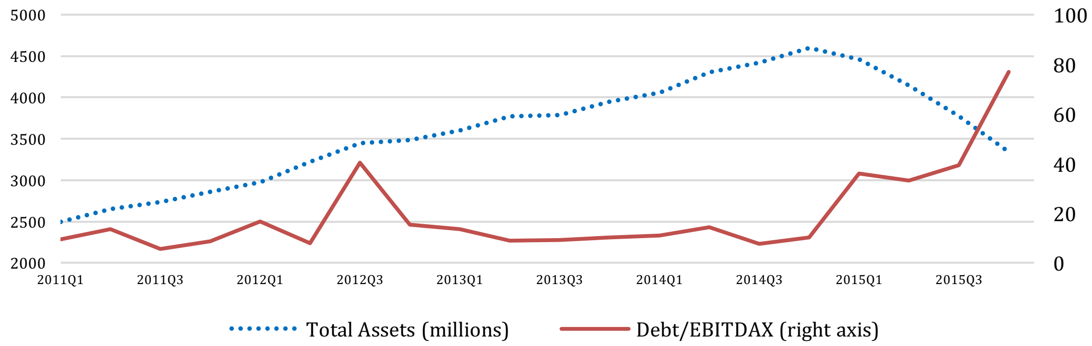
[57] Total reserves consist of proven developed, proven undeveloped, and unproven undeveloped reserves. Proven reserves include proven developed and proven undeveloped. Market futures prices are a factor in determining the viability of reserves designated proven.

Figure 6.2: Total Assets and D/EBITDAX: Firm Study Sample Average



Oil producers implement hedging policies to limit downside price risk exposure, using derivative instruments such as forwards, futures, options, and collars.[58] Producer price hedging strategies are based on expected annual production in future years. The US oil futures and options markets have superior liquidity and transparency, which provides low transaction costs for implementing a hedge. To access oil futures markets, non-investment grade companies tend to transact directly with their lending banks, which reduces costly collateral agreements for credit risk and allows for right way risk[59] between the producer and the lending bank. The early termination of hedging has occurred in the past, driven by a firm's desire to lock in profit margins from hedge transactions in order to support operating profits. Due to recent price declines, lenders have required tight oil producers in financial distress to terminate in-the-money hedges, to direct cash flow for mandatory debt repayments.

6.2.3 Borrowing Vehicles

Several funding channels are available to small independent producers based on their credit rating and balance sheet. The majority of small-to-medium independent producers, if they are rated, are classified as sub-investment grade by the rating agencies. In this study sample, at the start of the time series five out of the forty-four

58 Collars are option structures that combine a put and a call to create floor and ceiling prices for the producer. The long put option provides a lower price limit for the producer. The short call option creates a price cap for the producer and is used to finance the long put position in an ideally net costless structure. Costless collars are difficult to structure due to the skewed shape of the crude oil option volatility surface.

59 Right way risk refers to risk that goes against the client book but in favour of the derivative or debt issuer.

firms had investment grade ratings. By the end of the study time series, all of the participants that still participated in rating practices were rated sub-investment grade. Without a credit rating to provide transparency to public investors via agency oversight, producers must rely on a banking relationship to secure funding for projects.

Resource-based financing (RBF),[60] the most common form of funding for small-to-medium sized independent producers, first appeared in United States in the mid-1940s. The Houston-based banks led this development (Fox et al., 2010). Resource-based lending (RBL) facilities are sized by calculating the net present value of producing assets, as well as the use of a discounting mechanism to represent asset and firm risk. Many of the independents use RBF structures to finance E&P operations, as opposed to bonds and term debt products. The primary users of the US-based RBL market are independent producers, and all sizes of commercial banks, some with a regional focus, also provide support. An administration agency leads the RBF loan syndication process and manages the semi-annual redetermination process.[61] Other banks, as members of the lending syndicate that provide funding, are referred to as participating banks. Redeterminations that lower borrowing limits require approval of a quorum of greater than two-thirds of the syndicate.[62]

Historically, commercial banks have accepted upstream producer risk exposure via issuing RBF instruments. Bankers decline to lend to unproven independent producers, but are willing to consider asset-backed lending against proven developed and producing reserves. Project finance borrowing structures are collateralised by specified producing assets[63] that generate cash flow, which is channelled directly to the lender. An independent producer with a strong balance

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60 Sometimes referred to as RBL: resource-based lending.

61 Bank RBLs have redetermination twice per year, a process that revalues PDPs with an updated price deck. RBLs are secured by reserves and all personal property assets of the borrower and subsidiaries. US RBL facilities are pre-tax because of continual investment assumption to offset corporate taxes.

62 One hundred percent syndicate approval is required to increase borrowing line limits.

63 Specified producing assets sometimes include non-producing, non-proven assets.

sheet and an established credit rating may be able to move from asset-backed lending instruments to traditional corporate facilities, where 'look back' financial covenants such as D/EBITDA or D/EBITDAX determine the borrowing capacity.[64]

Independent E&P producers characteristically have resource plays, which are on-shore and shale conversions that have a strong correlation of proven undeveloped reserves with proven developed reserves (PDP). Bank lending syndicates determine RBF base borrowing amounts by valuing the PDP at a price deck, a lending bank-generated forward curve usually discounted to the actual futures market, and obtaining bank syndicate approval. If the producer has implemented a comprehensive hedge program, the price deck can be updated to capture this information, which results in a higher base borrowing amount (BBA). Borrowers (producers) want the BBA to be set high, which leads lenders to demand a certain minimum for a forward hedge portfolio. Lenders have historically been concerned about producers over hedging in the event production volumes are lower than forecast, which leads them to use covenants to limit producers to 80% to 90% of annual production volume (Anderson, 2012). Loan covenant leverage tests utilise the D/EBITDA ratio from quarterly reported financial statements.

The unilateral decision of the syndicate to modify the assumptions in the reserve valuations used for redeterminations can limit borrowers' ability to access funds, especially in moments of distress. This feature of RBF facilities means this type of borrowing is a weak form of liquidity, compared to traditional fixed term asset lending, and can increase company default risk.[65] An overreliance on RBF structures creates financing vulnerabilities in a volatile, low oil price environment. In 2015, all independent producer RBF redeterminations resulted in a lower borrowing base, up to 50% for some borrowers (Dai, 2015).

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64 Debt divided by earnings before interest, tax, depreciation, and amortization and debt divided by earnings before interest, tax, depreciation, amortization, and capital expenditures. Debt is usually referred to as total debt minus cash.

65 Standard and Poor's oil and gas industry credit analysis report, May 2012.

Cash flow is the important variant for a firm's debt holders, both bondholders and loan providers. The cash flow for liability coverage measurement ratios, such as fixed charge ratio or interest coverage ratio, are important monitoring tools. Given the capital-intensive nature of the E&P sector, debt versus equity ratios react too slowly to signal a sharp reduction in cash flow, resulting in a potential debt service challenge. The empirical debt and default model structures used in this study capture both debt/equity and interest coverage ratios. Lenders with asset-based loan agreements have first claim on firm assets under default conditions. The timing of a default or request for protection while restructuring occurs has spurred much debate. This raises the questions, do lenders' contract rights or management strategies drive this process? and, can strategic conversations with lenders save a firm from bankruptcy? Equity holders normally receive no reimbursements in default situations, and with the ease of asset transfer and restructuring mechanisms in the US corporate legal system, a firm can relaunch out of bankruptcy with a new IPO or equity issue with no repercussions from former shareholders. The firm survival question could be very important for equity holders, as debt participants normally have some recourse.

6.3 Literature Review

There is an abundance of literature analyses on channels in which hedging policies can contribute to firm value and firm distress. The majority of this literature has focused on financial hedging mechanisms, rather than operational hedging programs, which researchers describe as a firm's global or revenue diversification measure.

An economic theory derived from Miller and Modigliani's irrelevance proposition,[66] states that a corporate financing policy that includes hedging policy should have no effect on a firm's economic performance or value under a perfectly efficient market. Based on this theory, implementation of hedging programs should not affect the

[66] According to Miller and Modigliani's (1958) research article on capital structure, under the assumption of no tax, bankruptcy costs, agency costs, or asymmetric information, in a perfectly efficient market the value of a firm is unaffected by its corporate finance policy.

determination of firm value. Shareholders may prefer that a corporate firm does not hedge so that they can participate in the risk exposure that a firm incurs, such as oil price risk for an oil producer (Smith and Stulz, 1985). The literature has noted market imperfections such as financial distress and bankruptcy costs, corporate tax, external financing (Hubbard and Palia, 1999) that is costlier that internal WACC,[67] information asymmetry between managers and shareholders, and agency problems. These market imperfections provide the rationale for considering risk management programs.

Firm risk falls into two categories: asset price risk, such as commodity, interest rate, or foreign exchange, and firm operation risk, such as geographic and product diversification as described by Allayannis et al., (2001). This study focuses on a homogeneous undiversified group of oil producers and therefore does not consider operational risk. Guay and Kathari (2003) studied the scale of impact. They found that implementation of hedging programs for secondary risk factors, such as interest rate or foreign exchange exposure, add firm value, but hedging programs focused on primary risks had little to negative effect. Derivative positions were found to be small with respect to firm-wide risk exposures; Guy and Kathari (2003) therefore concluded the effects of hedging programs are minimal. Using a broad non-financial firm study sample, Allayannis and Weston (2001) found that financial hedging programs contributed approximately 5% to firm value.

Géczy et al. (1997) found that foreign exchange hedging reduced external financing costs and reduced cash flow volatility to ensure future capital investment projects. Subsequently, in a study of oil producers, Haushalter (2000) noted that corporate risk management can reduce the unexpected costs of financial distress and underinvestment in capital projects. The use of hedging is directly related to the firm's financing costs and reduces bankruptcy costs (Haushalter et al., 2002). The greater the financial leverage, the more apt managers are to manage price risk.

67 WACC, or weighted average cost of capital, refers to the cost of firm funding.

Economies of scale, hedging costs, and basis price risk[68] are all relevant to the hedging structures selected. Companies with production located in areas where commodity prices have high correlation to prices on exchange-traded derivatives markets are more likely to manage hedge risks. This tends to happen because there are no market hedge tools to protect the basis price risk, or the market cannot or is unwilling to price this risk into a hedging product. Contrary to this finding, Hahnenstein and Roder (2003) suggest that hedging does not reduce the probability of bankruptcy. Full-coverage hedging is not required or sufficient to minimise a company's probability of bankruptcy, thereby indicating that cash flow variance minimising hedging is different from strategies to reduce the probability of bankruptcy.

The debate on the contribution of hedging activities to the enhancement of firm value continues. Carter et al. (2006) studied the airline industry, a homogenous group with a single large volatile input cost of jet fuel, and found that jet fuel hedging programs were a source of value and contributed up to 10% of firm value, via the hedge premium. Building on Carter et al.'s work, Lin and Chang (2009) found that jet fuel hedging was positively linked to firm market value.

Literature on producers' hedging policies and firm value has consistently indicated that hedging does not improve firm value and can, in some cases, erode firm value. Tufano's (1998) study of American gold producers was the first to find no evidence that risk management policies can maximise shareholder value and firm value. Supporting this research, Jin and Jorion (2007) found that hedging does not influence the stock price for gold producers and that there is no positive interaction between hedging activity and firm value. The authors suggest that if a firm's price risk is transparent and the commodity hedging in the marketplace is simple and accessible, such that investors can hedge risk with the same cost and effort as the firm, a firm's hedging is not likely to generate higher firm values. The same authors' earlier study on oil and gas producers (Jin and Jorion, 2006) found that

68 *Basis price risk* is used to describe the difference in the producer facilities location and the market trade location for a commodity.

hedging reduces the firm's stock price sensitivity to energy prices, but that hedging does not contribute in any manner to firm value in this sector. Lookman (2004) found that undiversified E&P firms whose primary risk exposure related to energy lowered firm value when using hedging programs.

Mnasri et al. (2013) presented an empirical study for North American oil and gas producers on the impact of maturity term structure of hedging programs on firm value and firm risk. Their results showed a non-monotonic relationship between maturity structure and financial distress. This supports the research of Fehle and Tsyplakov (2005), who found that firms do not initiate or modify existing risk management policies when they are far removed from financial distress or deeply in financial distress. They also found that transaction costs are an important determinant of a firm's risk management decisions. The popularity of three-way collars[69] in recent years allows E&P firms to access hedging products at little cost, albeit adding significant tail risk to their portfolios, which may not be fully understood (Mnasri et al., 2013).

Distance to default literature commenced with Merton's seminal paper (1974) on methods to price corporate liabilities. Merton treats corporate debt as an option like financial instrument based on the Black-Scholes model structure (1973). This provides a real-time credit measure of a firm's liabilities, thereby reducing reliance on quarterly or annual corporate reviews. As a firm's asset value evolves over time, debt obligations are honoured when the cumulative asset value remains above the promised payout; if not, default occurs. KMV Corporation extended Merton's model to calculate expected default frequency, using a distance to default measure for each firm (Kealhofer, 2003). The primary focus of the KMV model is probability of firm default, rather than valuation of debt as per Merton. Bharath and Shumway (2008) found that the KMV distance to default approach was not a sufficient statistic for firm default probability, but serves as a good functional predictor for forecasting

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[69] A three-way collar is a standard costless collar incorporating a short put. Producer exposure is defined as short call option, long put option and short put option (further out of the money compared to the long put option).

defaults. Distance to default structural form continues to be a relevant input in firm default research (Duffie et al., 2007), (Duan et al., 2012). The common use of cross default provisions in debt covenants means that default is a company-wide event, not debt obligation-specific (Crosbie and Bohn, 2002). Moody's KMV model and the Altman Z score model (Altman, 1968), the industry-accepted credit risk modelling tools, are broadly disseminated in risk management departments and used in conjunction with other tools in the risk analysis process, such as traditional ratio analysis. Both the KMV and Altman Z score models provided insight into the Enron default in advance of the credit ratings agencies (Altman, 2002).

Oil option market volatility has always been skewed to the downside risk direction, due to a large magnitude of producer hedging activity combined with an absence of equivalent consumer hedging activity (Hain et al., 2018). Between 2011 and 2014, the put skew steepened, perhaps supported in large part by increased producer hedging (Cortazar et al., 2017). A steeper volatility curve for out-of-the-money put protection results in a higher cost for hedging. The growth of independent producers participating in the shale oil sector could explain the amplification of the put skew, as lenders demand a minimum level of hedging to ensure cash flow for debt servicing. To reduce hedging costs, producers may select strike levels that provide less protection (Mnasri et al., 2013) or inadvertently put on speculative positions (three-way collars or bull put spreads[70]). In the current study, 36% percent of the firms used three-way collars to hedge oil and gas production. The delta equivalent exposure for these three-way collars eroded to near zero after the oil price break in Q3-2014, showing this product does not guarantee downside price protection.

This paper's research will contribute to the existing literature by analysing the use of hedging strategies among US-based, shale-focused independent oil producers. The effectiveness of these hedging strategies will be benchmarked against the existing literature. This will provide important insight to a new industry, where project scale and duration make shale producers appear similar to manufacturing companies,

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[70] A bull put spread consists of a short sale put and a long put purchased at a lower strike price. The strategy of the bull put is to collect option premiums with the expectation of a rising price market.

unlike the historical model of E&P companies. Future stable domestic shale oil production depends on the resiliency of these small- to medium-sized independent producers.

6.4 Methodology

6.4.1 Model Approach

6.4.1.1 Statistical Properties of Stock Price Returns and Hedging

Independent crude oil producers' revenues and subsequent earnings are exposed to significant market risk. Prior to including hedging programs in this sample, the relationship between stock price returns and energy price returns will be analysed (as per Jin and Jorion, 2006).

The firm's stock returns were modelled as a dependent variable using a two-factor model, with S&P 500 futures market returns as a control variable: first, with oil price returns (6.1), and second, with gas price returns (6.2). Sample selection criteria limited the sample to firms that secure the majority of their revenue from oil production sales. During the study time series, oil prices experienced a significant negative innovation commencing in Q3-2014. I expect oil price returns to have a statistically significant influence on stock returns and have no expectation that gas prices will be statistically significant. Finally, a three-factor model was used to observe the firm's stock return interaction with oil and gas futures price returns simultaneously, again using SP-500 returns as a control variable (6.3).

$$R_{i,t} = \alpha_i + \beta_{mkt,i} * R_{mkt,t} + \beta_{oil,i} * R_{oil,t} + \varepsilon_{i,t} \quad (6.1)$$

$$R_{i,t} = \alpha_i + \beta_{mkt,i} * R_{mkt,t} + \beta_{gas,i} * R_{gas,t} + \varepsilon_{i,t} \quad (6.2)$$

$$R_{i,t} = \alpha_i + \beta_{mkt,i} * R_{mkt,t} + \beta_{oil,i} * R_{oil,t} + \beta_{gas,i} * R_{gas,t} + \varepsilon_{i,t} \quad (6.3)$$

Next, the firm stock returns were regressed against the hedging ratio and the ratio of proven reserves to the market value of equity (6.4), as per Rajpogal (1999). This will indicate the importance of the hedge ratio and the level of proven reserves on firm stock returns.

$$R_{i,t} = \alpha_i + \beta_{mkt} * R_{mkt,i} + (\gamma_1 + \gamma_2 * \Delta_{oil,i} + \gamma_3 * \frac{Oil\ Reserve_i}{MW\ Equity_i}) * R_{oil,t} + \beta_{gas} * R_{gas,t} + \varepsilon_{i,t} \quad (6.4)$$

6.4.1.2 Fixed Effect Panel Model: Tobin Q

Previous literature has considered the importance of hedging or not hedging on firm value represented by the Tobin's Q,[71] a unit-less measure, usually described as a ratio of market value to replacement value of assets, usually measured by book value, for a specific industry or firm, as the dependent variable. The basic theoretical proposition motivating the "q" ratio by Tobin (1969) was that a key determination of private sector fixed investment is the ratio of the market valuation of capital to its replacement costs. If capital is more highly valued in financial markets than its cost to produce it, then this "q" theory suggests that investment in fixed capital will be encouraged. This is because a value of "q" that exceeds its equilibrium value (which should in theory be equal to one) implies that the returns that might be expected from building new fixed capital exceeds the expected returns from purchasing existing capital in the stock market. In other words, if it is cheaper to build new capital than to buy existing capital in the stock market, fixed investment will be encouraged. This 'buy or build' arbitrage implies that, in the long run, competition will ensure that the market value of corporations should equal the cost of their creation. Arbitrage should ensure that over the long-run term, the expected returns from investing in equity markets equals the expected return from building new corporations (Hayashi, 1982). Tobin's Q measures whether there is a difference between the expected returns of shareholders and expected real returns of corporations from their assets.

[71] Tobin's Q was developed by James Tobin in 1969 and it can be interpreted as the ratio between the market value and replacement value of the total assets of a company. Tobin's initial model defined marginal Q (market value of an additional unit of capital to it's replacement cost), but in practice average Q for a firm can be observed. The simple approximation of Tobin's Q is developed by Chung and Pruitt (1994) and has the advantages of computational efficiency and data availability.

The hedging ratio is the primary RHS independent variable. Control variables include firm size, firm profitability, firm investments, leverage, and production costs (6.5). Allayannis and Weston's (2001) seminal paper provided the framework for this study. Jin and Jorion (2006) noted that the model structure Allayannis and Weston used could have several sources of endogeneity. To address this, they concentrated on the homogenous market of oil and gas producers while maintaining the model structure of RHS control variables. I believe that Jin and Jorion (2006) did not entirely eliminate endogeneity. However, after analysis it appears that the LHS and RHS variables in their study still exhibit similar sources of endogeneity, although I proceed to use the same model structure to compare results to the previous literature. The second panel model will replace Tobin Q on the LHS with a distance to default variable for each firm (6.6). This dependent variable limits endogeneity concerns in the model structure because RHS variables are not employed in the distance to default function form.

$$Tobin\ Q_i = \alpha_i + \beta_i * Hedge\ Ratio\ Prod_i + \sum_j \gamma_j\ Control\ Variable_j + \varepsilon_{i,j} \quad (6.5)$$

$$Distance\ to\ Default_i = \alpha_i + \beta_i * Hedge\ Ratio\ Prod_i + \sum_j \gamma_j\ Control\ Variable_j + \varepsilon_{i,j} \quad (6.6)$$

Where:

$$Hedge\ Ratio\ Prod = \frac{Delta\ Hedge\ Volume_{i,t}}{Annual\ Prodution_{\ i,t+1}} \quad (6.7)$$

$$Hedge\ Ratio\ Reserves = \frac{Delta\ Hedge\ Volume_{i,t}}{Annual\ Reserves_{\ i,t+1}} \quad (6.8)$$

$$Tobin\ Q = \frac{[(Total\ Assets - BV\ Equity) + MV\ Equity}{Total\ Assets} \quad (6.9)$$

Control Variables Used:

1. *Firm Size: Log Total Assets*
2. *Leverage Ratio: Total Debt/Market Value Equity*
3. *Profitability: Return on Assets % ttm (trailing 12 month value)*
4. *Investment Growth (CAPEX / Total Assets)*
5. *Expense Cost per Share (selected instead of production cost to account for impairment charges)*

Jin and Jorion (2006) used credit rating and access to financial markets as control variables, which are not relevant for this study as the majority of firms have no credit rating and all the firms access hedging products through their lending relationships and the broker dealer market.

6.4.1.3 Fixed Effect Panel Model: Distance to Default

Distance to default, using the KMV model, is a normalised ordinal measure of default risk for an individual firm based on Merton's (1974) debt valuation model, which estimates the number of standard deviation moves required to bring a firm to default within a specific time horizon. It uses a structural approach to calculate expected default probability, providing a real-time view of the credit monitoring process, as opposed to quarterly or annual ratio analysis. Distance to default measures compare a firm's net worth, based on market equity valuation, to the firm's market volatility (6.10). Distance to default is similar to bond ratings, in that it does not indicate the exact default probability. The KMV model provides actual expected default frequency (EDF) by comparing distance to default results to a proprietary database of historical default observations. This database, and hence the EDF valuations, is not available for this research due to funding restrictions. The key assumption in the distance to default structural model is that all relevant information for determining default risk is contained in the expected firm market value of assets, default point, and asset volatility, which requires efficiency in liquid markets. Nevertheless, distance to default application for this study of firm hedging is appropriate, as all firms are publically traded in liquid markets and balance sheet statements provide transparency on the short-term and long-term debt obligations for each firm. One critique to be made is that the distance to default structure does not distinguish between types of debt such as seniority, collateralisation, covenants, and convertibility. I believe that this critique will in no way hinder the results of this study as the majority of debt structures issued are similar, in that, they are asset backed by the proven reserves.

$$d_f = \frac{E(V_t) - d^*}{\sigma_V} \qquad (6.10)$$

where: $E(V_t)$ *is expected firm value*

σ_V *is firm asset market volatility*

$$d^* = short.term\ debt + \frac{1}{2} * long.term\ debt$$

In order to manage the challenges of calculating σ_V , I implemented the naïve distance to default measure (6.11) presented in Bharath and Shumway (2008), defined as:

$$Naïve\ dd = \frac{ln\frac{E+F}{F} + (r_{i,t-1} - 0.5 Naïve\ \sigma_v^2)T}{Naïve\ \sigma_v\ \sqrt{T}} \quad (6.11)$$

Where E represents the value of the market equity calculated as the product of the stock price at the end of each quarter and the number of shares outstanding; *F* is the face value of debt; $r_{i,\ t-1}$ is the return of equity of the firm, *i*, in the previous period

$$\sigma_v = \frac{E}{E+F}\sigma_e + \frac{F}{E+F} Naïve\sigma_d \quad (6.12)$$

and $Naïve\ \sigma_d = 0.05 + 0.25 * \sigma_e$ and *T* is the forecast horizon of one quarter. The inputs for the distance to default model of Bharath and Shumway (2008) are sources from financial statements and equity market historical data.

6.4.2 Data

6.4.2.1 Sample Description

This study examines the impact of financing strategies and hedging on firm value and firm distress on a homogenous undiversified group of forty-four independent, domestically focused shale oil producers from 2011 to 2015. The study is the first to focus on smaller sized US domestic independent producers and benefits from quarterly frequency, as opposed to annual observations used in previous literature. This testing should provide a comprehensive understanding of the effectiveness of hedging as a risk management tool with good statistical properties. To support the homogeneous and undiversified sample criteria, firms were selected from the SEC

Standardized Industry Classification (SIC) classification 1311 (Crude Petroleum and Natural Gas Production),[72] with oil sales contribution of more than 50% of firm revenue during 2013-2014 and market capitalisation between 100 million and 11 billion USD during the study time period. Total crude oil production volume for this sample was approximately 2% of global production during this time period, amounting to 2.2 million BPD in 2014 and 2.5 million BPD in 2015.[73] Quarterly data was meticulously hand collected, reviewed, and cross-referenced for accuracy from 10-K financial reports in the SEC EDGAR system and from the Thomson Reuters EIKON database. Data include key financial statement metrics and commodity price hedge programs, in the form of annual production, proven reserves, and financial hedges. Data validation is satisfied as SEC regulations mandate that public firms disclose corporate risks, such as credit, market, and operational and proven developed and undeveloped reserves. Firms have a choice of reporting market risk in tabular, sensitivity, or value at risk forms. All firms in this sample provided tabular data, allowing for detailed delta equivalent hedge volume to be determined for each quarter of the study time period. The list of firms is presented in Appendix I.

During the extraction of crude oil, producers also extract natural gas and natural gas liquids (NGL) as either primary or secondary products. The overall hedge ratio includes natural gas and NGL hedges with oil hedges since all three products contribute to producer earnings. A specific crude oil-only hedge ratio is also used to test the robustness of the overall hedge ratio and to determine if the oil production-specific firm selection will respond by a superior level to oil-specific hedge ratios (Figure 6.3). Hedge ratios were calculated by summing the linear exposure products to the option positions on a delta basis using the modified Black-Scholes model (Black and Scholes, 1973), by using the historically implied third nearby month option volatility.[74] Hedge position and forward sales with no guaranteed fixed

[72] SEC SIC for Crude, Petroleum and Natural Gas producers.

[73] Data from 10-K company reports cross references with Reuters EIKON data, author's calculations.

[74] The use of third month volatility, sufficiently removed from short-term market stress situations, to calculate options positions of all tenors is believed to be sufficiently precise for the hedge deltas.

prices, such as basis hedges or volumetric forwards, were not included in the delta equivalent hedge calculation because a fixed floor price is not guaranteed.

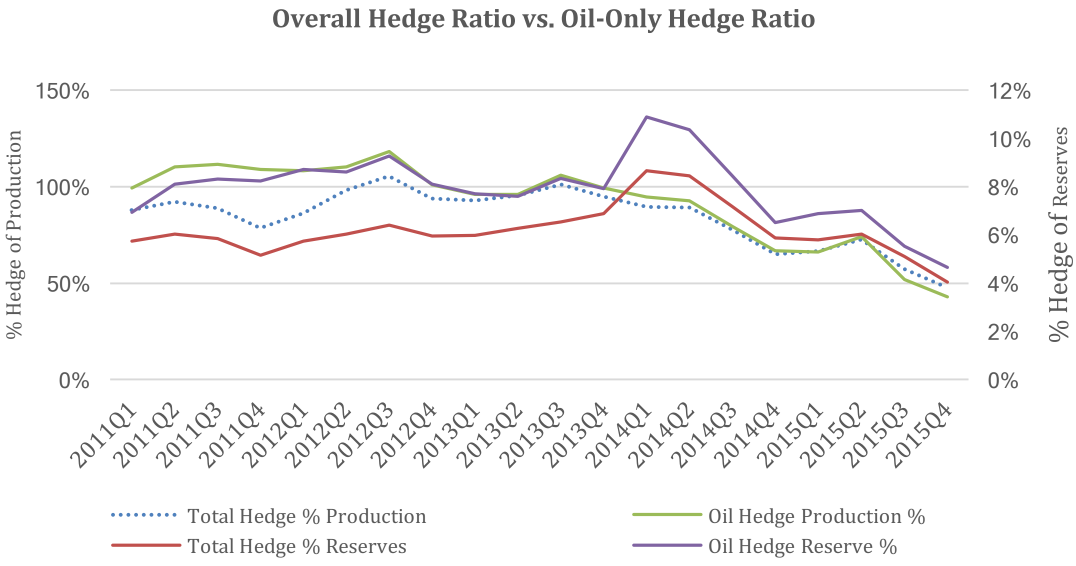
Table 6.1: Summary of Firm Characteristics

	Observations	Mean	Std. Dev.	Min.	Max.
Company	880			1	44
WTI Oil	880	84.42	21.90	37.04	109.62
WTI_Vol_3M	792	0.2813	0.1180	0.1304	0.5496
Bankruptcy*	880	0.2727	0.4456	0	1
Market Cap	849	2,659.86	3,600.00	4.06	29412
Total Assets	859	3,692.50	4,051.69	2.8	18927
ROA	840	0.1172	2.4200	-29.1	35.9
Revenue	868	292.95	732.33	-126.5	13601
Ops. Exp.	868	323.86	740.91	-332.8	12729
Hedge_Prod.	824	0.8653	0.8206	0	5.46
Hedge_Dummy_150+	839	0.1585	0.3654	0	1
Hedge_ Dummy_0+	839	0.9261	0.2618	0	1
BV Reserve/MV Equity	849	2.0850	4.7653	0	97.29
Permian Basin	880	0.4318	0.4956	0	1
TobinQ	859	1.4100	0.7203	0.304	6.866
Capex_TA	859	0.0776	0.0805	0	1.202
Distance to Default	839	4.131	2.155	0.156	14.95
D/E	848	2.4060	12.6900	0	339

* Observed December 2016, twelve months after sample period, as percentage.
+ Binary variable for hedging dummy based on 150% production, 0% production.

Hedge activity was found in 92.6% of the firm time periods (Table 6.1). All firms had some form of hedge activity during the five-year time series. Hedge ratios greater than 150% were found during 16% of the firm quarterly time periods. This does not necessarily indicate that 150% of hedges were in the current or the following year. Rather, this figure represents the aggregate delta hedge volume over all future years. Some firms hedge forward one year, while other firms hedge forward in a declining volume pattern over multiple years. Crude oil-only hedge ratio and reserves were calculated to compare the significance of crude oil-specific hedging as this study sample focused on firms with majority oil production revenue exposure.

Figure 6.3: Average Firms' Delta Hedge Ratio Volume vs. Next Year Production and Proven Reserves



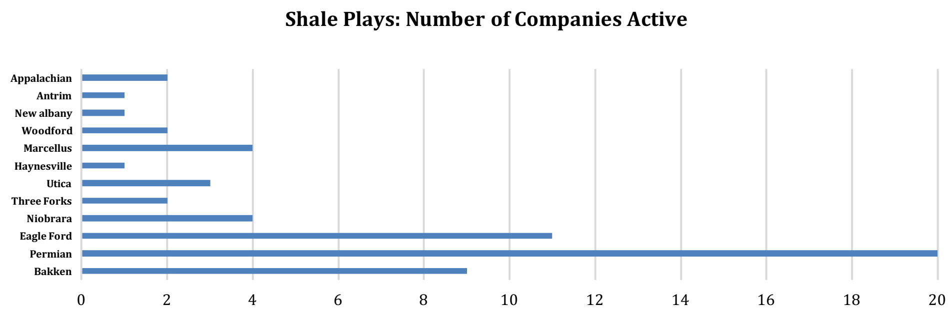
Where:
Total Hedge % Production = Total Hedge Volume divided by Expected Annual Production$_{t+1}$,
Total Hedge % Reserves = Total Hedge Volume divided by Proven Reserves,
Oil Hedge Production % = Total Oil ONLY Hedge Volume divided by Expected Annual Production$_{t+1}$,
Oil Hedge Reserves % = Total Crude Oil ONLY Hedge Volume divided by Proven Reserves

Oil producers have two choices for exploration cost accounting under US accounting rules: a full cost approach or a successful efforts approach. Full cost allows firms to capitalise all costs incurred in the exploration, regardless of the operability of the well. Successful efforts means that only costs associated with a successful well are capitalised, a more conservative method. To manage this different accounting structure, this study uses EBITDAX[75] as a comparable measure in the leverage ratio.

Independent producers in the sample are mainly focused on tight oil extraction and are present in all the major shale play regions in the United States, with the highest firm presence in the Permian Basin[76] (Figure 6.4). The Permian Basin is known to have among the lowest exploration and lifting costs (Maugeri, 2013).

[75] EBITDAX is equal to EBITDA for full cost method firms. Firms in this study are evenly split between their selection of full cost or successful efforts accounting. Adjusted EBITDAX was calculated for all firms.
[76] Some firms are present in more than one shale production region.

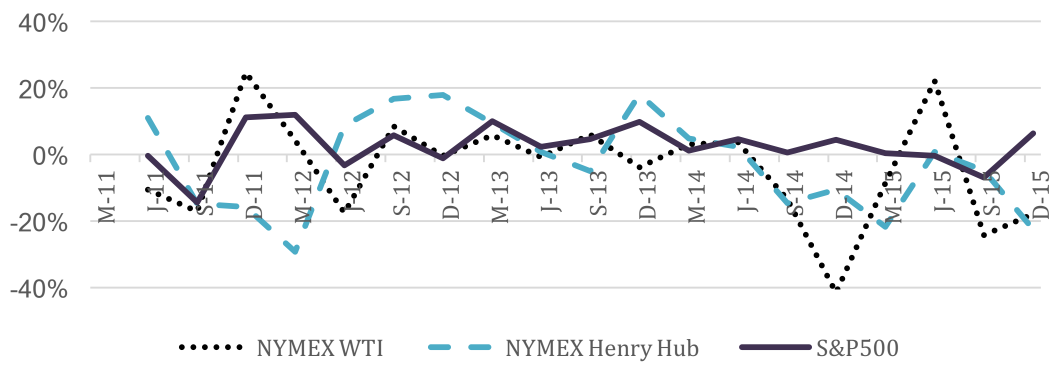
Figure 6.4: Number of Sample Firms Active in each Shale Geographic Area



6.4.2.2 Descriptive Statistics

Figure 6.5 plots the quarterly returns for the nearby futures contracts of S&P 500, WTI crude oil, and Henry Hub (HH) natural gas nearby futures during the study time period.

Figure 6.5: Quarterly Returns S&P 500, NYMEX WTI, & NYMEX HH Nearby Contract



6.5 Empirical Results

6.5.1 Firm Stock Returns Sensitivities to Oil and Gas Prices

Tables 6.2 and 6.3 provide results for the two-factor models and the three-factor mode, respectively. Results indicated that there is a highly significant interaction of S&P 500 future returns and WTI oil returns on a firm's stock returns in both a pooled OLS and an FE panel approach. The coefficient of S&P 500 return is 1.15, indicating that the firms' stock returns are more volatile than their market returns. If the market returns increase by 1%, the average of firm stock returns increases by 1.15%.

Table 6.2: Two-Factor Model with WTI Oil Returns and HH Gas Returns

Two-Factor Model		WTI_Return	HH_Return
WTI_Return		0.8160	
	t-stat	5.1800	
	P>|t|	0.0000***	
HH_Return			0.3317
	t-stat		2.1000
	P>|t|		0.0360**
SP500_Return		1.1541	2.0352
	t-stat	2.9800	5.7500
	P>|t|	0.0030***	0.0000***

** Significance at 5% level, ***Significance at 1% level

The three-factor model shows that firm stock returns increase by 0.78% if WTI oil price returns increase by 1%. This is a strong, significant relationship. For HH gas prices, a 1% increase in gas prices results in a 0.17% increase in stock returns with good significance with a small coefficient level. This result is consistent with the sample selection criteria, which focused on firms with strong revenue from oil production.

Table 6.3: Three-Factor Model with WTI Oil Returns and HH Gas Returns

Three-Factor Model		WTI_Return	HH_Return	SP 500_Return
Coefficient		0.7802	0.1668	1.2037
	t-stat	4.8700	1.0500	3.1000
	P>|t|	0.0000***	0.2950	0.0020***

** Significance at 5% level, ***Significance at 1% level

6.5.2 Firm Stock Return: Hedge Ratio Production and BV Reserve/MV Equity

The fixed effects panel model (table 6.4 below) and the OLS pooled regression (Appendix L) provide consistent results showing that hedge ratio production is not statistically significant and book value of reserves is statistically significant. S&P 500 and WTI returns continue to exhibit statistically significant patterns in this model. The insignificance of the hedge ratio inverts the findings of both Jin and Jorion (2006) and Acharya et al. (2013). However, the proven reserve valuation interaction with stock return valuation accords with the findings of Acharya et al.

(2010) and Boyer and Filion (2007). Equity market participants make investment decisions based on several sources of firm information, such as future revenue streams. This market dynamic is confirmed with t-stat significance between WTI price returns and firm natural resource reserves. Limited investor access to updated hedge volumes and a time constraint on aggregation and analysis of this data from annual reports may explain why hedge ratios do not statistically predict firm stock return resulting in a market inefficiency. Regression diagnostics are presented in Appendix L.

Table 6.4: Panel FE Results: Hedge Ratio Production and BV Reserve/MV Equity

Stock_Return	SP 500_Return	WTI_Return	Hedge_Prod._Roil	BVRES_MVE_ROIL	HH_RETURN
Coefficient	1.2302	0.5237	-0.1526	0.0497	0.1400
t-stat	3.1300	2.2700	-0.6600	2.1500	0.8700
P>|t|	0.0020***	0.0240**	0.5080	0.0320**	0.3840

Hedge_Prod._Roil is the hedge ratio of production multiplied by WTI Oil Return, BVRES_MVE_ROIL is book value reserves divided by market value equity multiplied by WTI oil return.
** Significance at 5% level, ***Significance at 1% level

6.5.3 Fixed Effect Panel Model: Firm Value and Naïve Distance to Default

Model results with log Tobin Q, as the dependent variable find that hedging ratios are statistically significant with a low magnitude of influence in the coefficient. This result is contrary to the findings of Jin and Jorion (2006) and supports the findings of the earlier literature (Bessembinder (1991), Allayannis and Weston (2001), Carter et al. (2006)). As previously mentioned, the concern of endogeneity in the model structure reduces its relevance. Figure 6.6 presents four different hedge ratio relationships with log of Tobin Q; overall hedging to production, overall hedging ratio to reserves, oil hedges to oil production and oil hedges to oil reserves. Conditional scatter plots of oil hedges to oil production are presented for firm bankruptcy results and firm debt to equity ratios.

The magnitude of the hedge is statistically significant for distance to default with a coefficient value of 0.8931, indicating a 0.89% increase in the number of standard deviations in distance to default with a 1% increase in hedge ratio. The number of standard deviations that represent distance to default values plotted against hedge ratio to annual production confirms that higher hedge ratios result in a larger distance to default metric (Figure 6.7). Conditional graphs of oil hedges to production and distance to default are presented for firm bankruptcy outcome and firm debt to equity ratio.

Figure 6.6: Hedge Ratios vs. Log Tobin Q

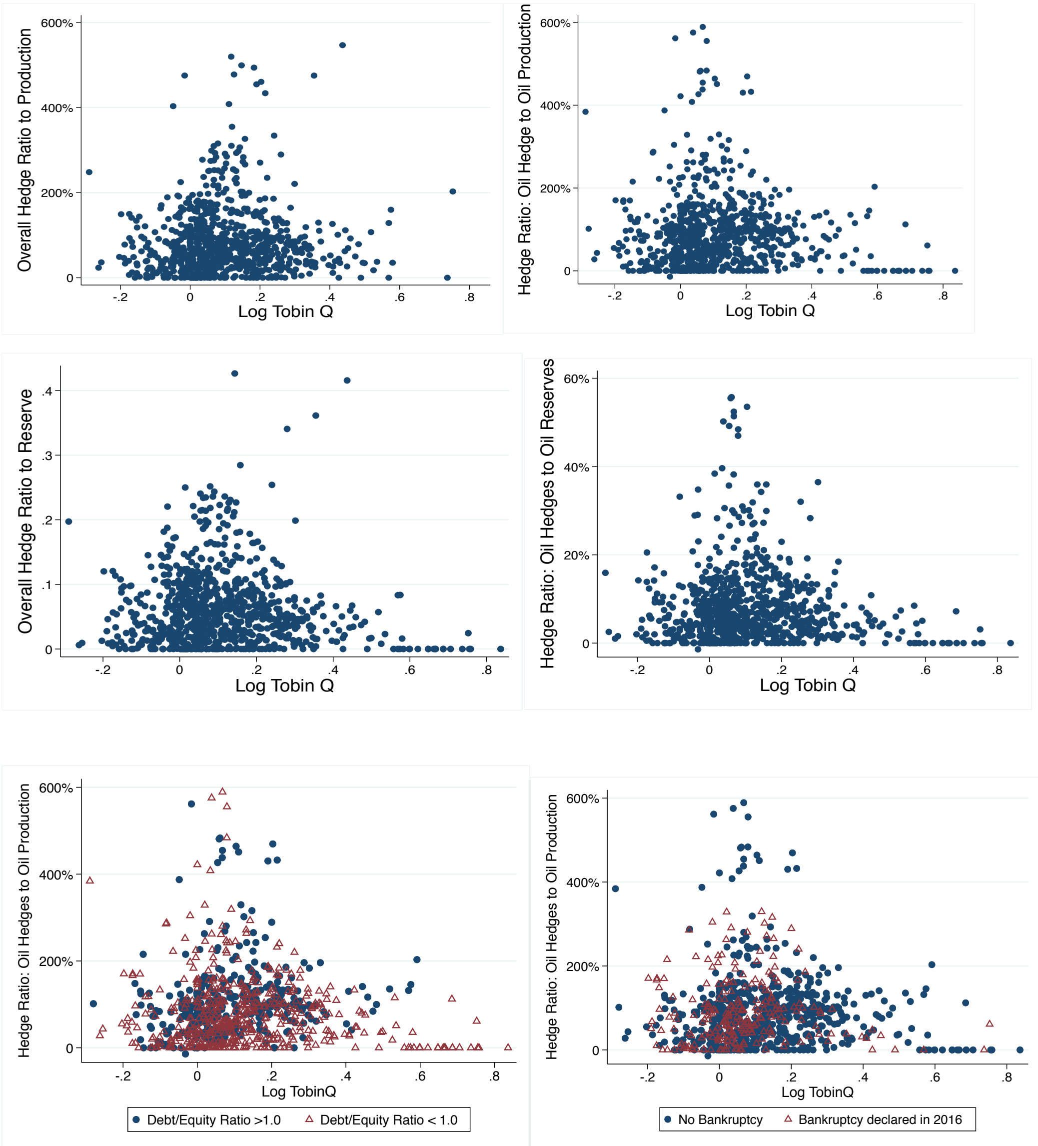


Figure 6.7: Hedge Ratios vs. Distance to Default

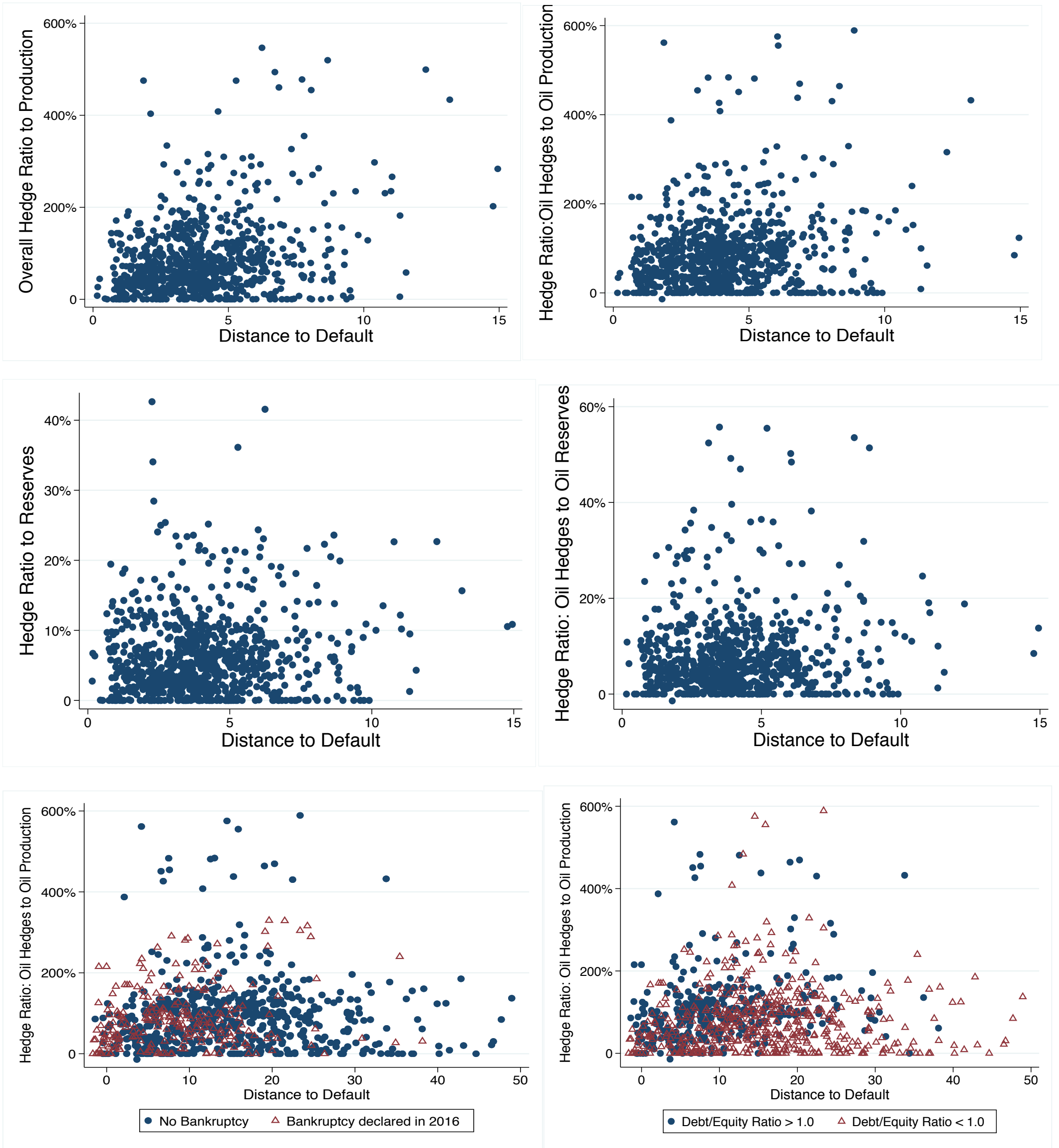
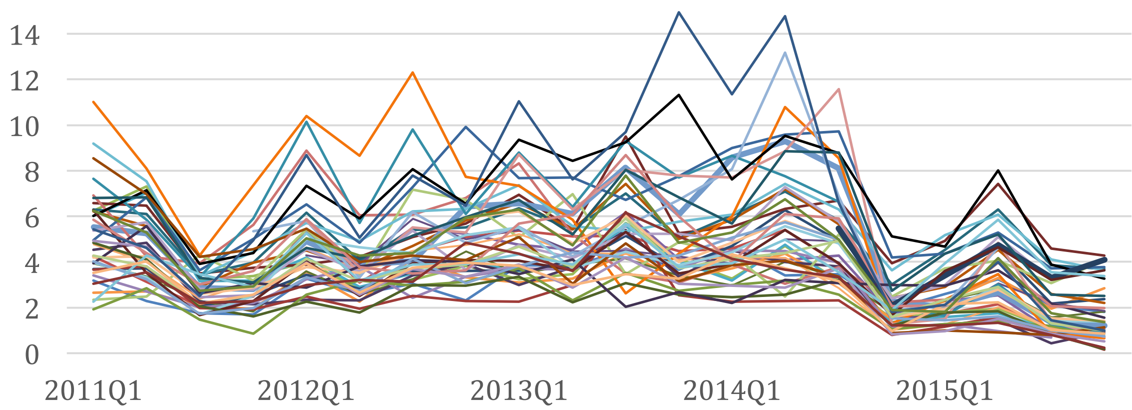


Figure 6.8: Quarterly Distance to Default Ratio for the Sample Firms



This is relationship between hedge ratio volume and larger distance to default is highly relevant in this particular study time period, given the exposure to a large negative innovation in global oil prices. In the twelve months after the study time period, twelve of the forty-four firms declared some form of default or bankruptcy protection and two firms were acquired by the same independent oil producer (Appendix I).[77] This provides for a unique study opportunity of a database of firm hedging and financial metrics immediately prior to a known default event, which can allow for investigation into the contributing factors to the erosion of distance to default for these firms (Figure 6.8).

Table 6.5: FE Panel Firm Value and Distance to Default

	Log Tobin Q			Naïve dd		
Observations	783			783		
# Groups	44			44		
	Coefficient	t-Stat	P>|t|	Coefficient	t-Stat	P>|t|
LOG_TA	-0.2787	-14.6500	0.0000***	0.3718	--1.0700	0.2850
ROA	-0.0024	-0.8200	0.4100	0.0448	0.8500	0.3980
HEDGE_PROD	0.0335	4.5700	0.0000***	0.8931	-6.6800	0.0000***
CAPEX_TA	0.0937	1.7600	0.0780*	0.4843	0.9705	0.6180
OPSEXP_SHARE	-0.0027	-2.9300	0.0030***	-0.0763	-4.5800	0.0000***
D_E	-0.0006	-2.1200	0.0340**	-0.0140	-2.6500	0.0080***
Cons	1.0044	15.7200	0.0000***	4.8468	4.1500	0.0000***

Hedge_Prod. is the hedge ratio: delta hedge position divided by next year annual production; LOG_TA is the natural log of firm's total assets, ROA is the trailing twelve-month return on assets, CAPEX_TA is the capital expenditure divided by total assets, OPSEXP_SHARE is the operating expense divided by number of shares, D_E is the debt equity ratio.

* Significance at 10% level, ** Significance at 5% level, ***Significance at 1% level

Tobin Q ratio is used to represent firm value, as it makes comparisons possible among different sized firms possible, as noted in previous studies (Allayannis and Weston 2001; Jin and Jorion 2006). Jin and Jorion used three different calculations for the Tobin Q ratio structure with modifications focused on the denominator, based on different methodologies for calculating the replacement cost of assets, in this case the replacement cost of oil and gas reserves. The numerator remains constant across their three Tobin Q calculations. In my analysis, one Tobin Q variable structure will be used, in line with Jin and Jorion's (2006) assertion that

[77] The two firms acquired both had hedge ratios in the top 10% of the sample. Acquisition occurred at the end of 2015, indicating that these firms were acquired for their hedge books rather than their proven reserves or operating efficiency.

replacing total assets with book and market values of reserves had little impact on the results.

6.5.4 Strength of Results

The regression model for WTI oil returns and S&P 500 returns against stock returns was analysed with monthly, quarterly, and annual data frequencies with consistent model results. The coefficient magnitude and sign were consistent for all independent variables under a pooled OLS and FE panel models to evaluate oil price and market returns significance to individual stock returns.

The FE panel models for firm value and distance to default were executed on an annual frequency and were consistent with quarterly frequency results. Several representations of leverage were used for independent model variables, including D/EBITDAX and LTD/MV CAPITAL, to support and interpret the similarities and differences with the debt/equity selected independent leverage variable.

6.5.4.1 Probit Model Results

As an extension to the distance to default model results, I ran a Probit model with bankruptcy, surveyed at the end of December 2016, one year after this study time period, as the binary dependent variable. This is an alternative approach to observe the interaction of hedge ratio magnitude and bankruptcy outcomes for firm sample database.

The database created for this research allows for a rare opportunity and an earlier analysis potential to identify contributions to bankruptcy for this specific E&P group. Some may argue that the overall sample is small, as is the subset of firms ultimately declaring bankruptcy; nevertheless, the data provide an opportunity for detailed analysis of these firms from a homogeneous sample. This model does not contain an independent variable that captures management structure; this is the weakness in the model. Further work on this model will include a variable to identify managerial ownership. The strategy and timing of the bankruptcy is not under consideration here, as there are many reasons for the actual timing of an announcement. Any future model should give further consideration to identifying the model parameters to represent this aspect. In this study, I take a follow-up snapshot of all firms, one year later, in an ongoing low global oil price environment, to observe the number of firms that have used some form of bankruptcy protection. This is relevant for both debt and equity investors. It could be argued that equity investors have more to lose, and data have shown that although the firms in this sample are sub-investment grade, many large institutional investors have been allocating equity funding to these firms.

Model results (Table 6.6) indicate that firm capital structure and a hedging dummy variable representing overall hedging, equal to 150% of next years' production, are statistically significant contributors to a firm's bankruptcy. Lender covenants typically require firms to hedge at 50% of next year's production (Anderson, 2012). A threshold of more than 150% implies a future three years of 50% hedge ratio, assuming constant production. From my model observations, higher hedge ratios are key to larger distance to default positions and firm value. This begs the question, Is there a constraint that limits firms' capability to increase their hedge ratios? Experts suggest lender covenants can limit speculative activity if they have upper limit hedge ratios at 80% to 90% per production year (Anderson, 2012). None of the firms with lender borrowing instruments had hedge ratios near this level, on a per annum basis over several years. It may be argued that three-way collars and put spreads are themselves speculative, as the lower price protection is removed during large negative price innovations.

In this model, I added a variable to represent Permian Basin production exposure[78] to capture the lifting and producing costs for a barrel of oil. This is a different metric than the operating expenses per share independent variable. Permian is a binary independent variable, equal to 1 if a firm is present in the Permian Basin and 0 if a

[78] Shale oil lifting and producing costs are known to be lower in the Permian Basin compared to other shale plays (Maugeri 2013).

firm has no operations in the basin. While this is a statistically significant and interesting result in the Probit model, more research is required to confidently conclude that Permian operational presence is central to minimising the probability of bankruptcy. Appendix M contains a graph of hedge ratio: oil hedges to oil production versus distance to default under conditional Permian Basin production activity.

Table 6.6: Probit Model Results with Marginal and Overall Significance

Observations	805		Correctly Classified =		70.51%
Pseudo R2 =	0.1942				
	Coefficient	z-Stat	P>|z|	means	dy/dx
LOG_TA	-0.1062	-1.0800	0.2800	3.3432	-0.0343
TIE	-0.0011	-0.9500	0.3400	7.0737	-0.0004
D_E	0.0149	2.2000	0.0280**	2.0286	0.0048
PERMIAN	-1.0510	-9.0300	0.0000***	0.4194	-0.3396
OPSEXP_SHARE	-0.0126	-1.1100	0.2670	3.5909	-0.0041
ROA	-0.0128	-0.2700	0.7867	-0.0460	-0.0041
HEDGE_DUMMY_150	0.3063	2.2100	0.0270**	0.1704	0.0989
Cons	0.1170	0.3600	0.7220		

** Significance at 5% level, ***Significance at 1% level

6.6 Conclusions

Overall sample firm stock price returns have a beta greater than the market beta of one. A 1% increase in stock market returns will result in a return of 1.15% for the sample firm stocks. This is consistent with investors' perception of a firm's riskiness. WTI oil future price returns are statistically significant with stock price returns, and with a coefficient of 0.78. A 1% increase in WTI returns contributes to a 0.78% increase in stock returns. Hedge production ratio size did not have a statistically significant relationship with stock returns, which is contrary to previous literature. Proven reserves were statistically significant with stock returns, which is consistent with previous literature. Future work should include utilisation of a binary hedge independent variable (hedge: Yes = 1, No = 0) to verify the result and create a direct comparison with model structures in previous literature.

The hedge production ratios are statistically significant to the Tobin Q, as were the distance to default variables. The Tobin Q result adds to the growing evidence that hedge ratio and firm value relationship are not consistent across study samples. In this application, the Tobin Q, while still a concern for endogeneity, is highly significant, with hedge ratio volume on a strong homogeneous sample selection. This in itself is interesting, as the firms in this sample have no external activity that could create disturbances in the sample data, unlike larger international or integrated oil producers. Distance to default provides an alternative measure for the importance hedge ratio to firm financial resilience and default probability (distance to default is the primary input to the default probability calculations used by ratings agencies[79]). As the hedge volume decreases the distance to default narrows. The twelve firms declaring default in 2016 all experienced erosion of distance to default valuation towards the terminal period of the study time series.

Firm capital structure is statistically significant at the 1% level in the distance to default panel model and in the Probit bankruptcy model. This paper focused on the hedge ratio importance for firm value and default distress. I believe that capital structure plays an equally important role. Further model analysis focused on the debt structure, based on firm size and earnings volatility, will be valuable to future research.

The discussion of bankruptcy as a key tool in a firm's risk management strategy will contribute to the growing conversation on understanding why firms declare pre-organised bankruptcy terms and how they use bankruptcy as a heavy-handed tool in negotiations with creditors.

My empirical study establishes that hedging requirement inclusions in debt covenants are relevant and effective to reduce revenue volatility and support greater distance to default metrics. While important for debt holders, it is equally important for equity holders, as institutional investors are active participants in this sector.[80] Further discussion is warranted on the impact of capital structure and distance to

[79] From Moody's website on KMV model structure.

[80] Study sample firms, 50.3% of outstanding common equity owned by traditional investment managers, 8.73% by inside company members/individuals, 2.25% by government pension funds, 0.53% by corporate pension funds.

default. Many firms liquidate their hedge positions during adverse price environments, to increase operating revenues or to satisfy lender cash flow requests. If hedges remained active during the negative price innovation, the number of firms defaulting may well be lower. Any future research could support these findings by researching another highly homogenous sample group in the commodity production sector to test the robustness of my results.

7.0 Conclusion

At the outset, the motivation for my research was to study the importance of oil price innovations on debt markets. During my doctoral studies, much to my surprise, global debt markets doubled in size to more than 200 trillion USD (Curran, 2018). This meteoric growth found support in all segments of the debt market: public, investment grade corporate, and high yield corporate. Many credit market analysts and global policy makers have become concerned about the sustainability of these high debt levels, in what is described as a benign credit cycle over the last eight years since the global financial crisis (Altman, 2018). The potential default risk and a possible contagion across markets support a more in-depth examination of bond market characteristics and response to shocks from other markets.

This thesis presents three essays analysing the impact of oil price shocks on emerging market countries and the behaviour from independent oil producing firms in dealing with these shocks. Emerging market sovereign bond returns are studied in the first two essays. In the first empirical study, the interaction of oil price innovations with emerging market sovereign bond returns for oil importers and oil exporters was studied. This study finds that oil prices have a statistically significant influence on portfolio total bond returns for globally focused oil exporters and importers. Exporter bond returns increased and importer bond returns decreased under positive oil price shock conditions, implying that sovereign governments are exposed to changes in investor risk perception and cost of borrowing under oil price shock scenarios. In the second empirical study, the response of bond returns to OPEC conference quota decision events are studied. Findings show that bond portfolios for the undiversified oil producer groups, independent shale oil producers and emerging market oil exporters, have an asymmetric response to news, with a statistically significant negative reaction to information content that has a negative impact on oil market prices and a muted response to information content that implies higher oil market prices. The bond portfolio of diversified international oil majors did not react to either positive or negative news impacting oil market prices.

The third essay examines the effect of firm commodity hedging on firm value and distance to default for independent oil producing firms. In order to complete this empirical study, I constructed the first comprehensive database on independent shale oil producers' financial metrics, production and reserves data, and hedging ratios on a quarterly frequency. Model results conclude that hedge volumes exhibit a small positive interaction with firm value, adding to the diverging literature on hedging and firm value, and more significant positive interaction with firm distance to default, supporting previous research.

The findings reported in the previous three chapters provides original research contributions that are immediately relevant to current and future bond investors and commercial lenders, academics and policymakers. Knowledge gained from my research will afford a better understanding of the influence of energy prices on debt risk premiums and hedging strategies for both oil producing emerging market nations and independent oil producer firms. Researchers and policy makers will also be interested in the information flow in bond asset pricing and market fragmentation results found in my research.

7.1 Recent Events in Global Affairs

Since the 2008-2009 financial crisis, significant attention has been given to the implementation of financial regulations to remove any possibility of another global liquidity emergency. The Basel Committee on Banking Supervision set out a series of regulatory requirements, seen as global best practices, for prudential bank operations and oversight. So far three phases of Basel regulations have been rolled out since the first Basel accord in 1988, requiring banking institutions to ensure sufficient capital provisions are met to limit liquidity problems during tail-risk volatility market events. The banking community has pushed back on these capital requirements, declaring that its financial performance will be vulnerable, thereby leading to lower lending available to customers (Berger and Bouwman, 2013). The most recent regulation, Basel III, requires banks designated as Tier 1[81] to hold as much as 13.5% capital for investment activities with high-risk adjusted weightings. In response to these regulations, many banks have focused on "capital light" activities, which results in less trading and lending (Noonan, 2015). Because energy markets have more volatile price patterns than most other financial markets, they are more capital intensive under the Basel III regulations. A report by the UK Financial Conduct Authority found reduced trading activity by banks, due to tighter regulations and capital requirements, and more commodity trading and investment taken on by commodity trading houses (Hume, 2014).

American and international banks with a presence in the United States are seeing significant changes to business activity in order to be in compliance with the Volker rule and Dodd-Frank regulations. The Volcker rule bans banks from proprietary trading in securities and futures products, which reduces the quality and capacity of market making services that the banks provide to their customers (Duffie, 2012). This is problematic for independent shale oil producers seeking financial instruments for commodity hedging programs. Not only are banks less active in the market due to limitations on proprietary trading, the banks also do not want exposure to client commodity risk because the capital requirements limit the profitability, resulting in higher hedging costs for customers. This situation is actively discussed by all participants in the commodity hedging sector and is particularly pertinent for PEMEX, which annually fulfils the largest oil hedge program in the world. Historically, PEMEX hedged with one Wall Street bank,

[81] Global banks' capital requirements are determined according to Global Systematically Important Institutions criteria.

Goldman Sachs. In recent years, under the current banking regulation environment, PEMEX has employed up to four different Wall Street banks to execute its hedging requirements. The current American government is making waves to roll back some banking regulations, but at this time, the extent of these initiatives is unknown.

7.2 Emerging Market Sovereign Bond Market

There is a combination of endogenous and exogenous forces powering the growth of global debt markets. Exogenous factors include large investor capital inflows to each segment of the global bond market and broad macroeconomic stabilisation efforts. Quantitative easing programs initiated by developed countries in response to the financial crisis have caused the "risk free" treasury yield supply curve to shift to the right, thereby lowering base borrowing rates. Public and private debt issuers have access to capital at lower borrowing rates because of the intersection of investor demand and lower risk free base borrowing rates. The endogenous factors fuelling bond market growth include financial services innovations, improvements in risk management products, and investor portfolio adjustments to new and riskier debt instruments. Emerging market specific endogenous forces included development of institutional structures and bond markets, growth of financial markets, and financial market liberalisation allowing bond issuers to compete for a larger group of investors.

The prospect has been raised that future Basel regulations remove the zero risk weighting exemption that is currently applied to sovereign exposures under Basel III. The implementation of this modification in Basel IV regulations could reduce banking investment participation in the emerging market bond markets. This would reduce the demand for emerging market bonds, resulting in lower prices and higher required yields, in order to convince other investors to fill the gap left by banking organisations. The likelihood of this change and the proliferation of global political uncertainty represent a significant risk of increased costs for sovereign bond borrowers that depend on international capital inflows.

7.3 Independent Shale Oil Producers

Shale oil production survived the crude oil price collapse in the second half of 2014 and is expected to return to pre-collapse levels in 2018, thereby allowing the US oil supply to reach 10 million BPD. This return to an exceptional growth pattern implies that the United States will soon be independent of crude oil imports. Underpinning this resilience is a combination of four key factors: operational efficiency gains, lower service contractor prices, stable oil market prices, and technological innovation. Shale oil suppliers are dominated by a combination of private and publically traded independent oil producers with sub-investment grade ratings or a zero rating. Investors and lenders, while optimistic about the future of improved producer financial performance, continue to be undecided on the future financial returns of these firms. Producers continue to outspend their cash flows, which in turn is problematic for long-term operations and investor confidence.

Oil producers are exposed to two types of risk which contribute to cash flow and earnings volatility: market price risk and exploration risk. Market price risk can be hedged with the assumption that market access and cost of hedging are not prohibitive. Oil producers implement hedging policies to limit downside market risk exposure, using derivative instruments such as forwards, futures, options, and collars. These producer price hedging strategies are based on expected annual production in future years. In the run up to 2014, while some firms had prudent hedging strategies in place, many other firms were exposed to riskier hedging strategies such as three-way collars, which do not provide floor price protection under large negative oil price innovations. Early termination of hedging has also occurred, driven by a firm’s desire to lock in profit margins from hedge transactions, in order to support operating profits. After the 2014 negative price innovations, lenders required oil producers in financial distress to terminate in-the-money hedges and to direct cash flow to mandatory debt repayments. This action exposed producer cash flows to further market price decreases.

Oil producers achieved improved efficiency from drilling optimization complemented with horizontal well operational experience. This has reduced the time from well identification to crude oil extraction from the ground. Improved communication processes mean that experienced workers, laid off during the oil price collapse, can readily return to active employment, minimizing hiring and additional training costs. Producers took advantage of the market price collapse to re- negotiate lower prices and more flexible contract terms with service providers. Rigid take-or-pay service provider contracts were one of the contributors to producer financial difficulties. Technological advances throughout the supply chain have improved decision processes, communication, and engineering practices. Since information and data flows from all projects can be analyzed remotely, this centralises decision making and increases efficiency.

Artificial intelligence applications in horizontal well drilling are undergoing rapid growth. Sceptics who still prefer the "old way" of basic geological data surveys and gut feel are now considering the merits of large-scale applications of data analysis and machine learning models output. Large volumes of data from an unconventional well can now be gathered, stored, and utilised to increase the speed of analysis of future drilling opportunities (Martin, 2015). There is a transition away from the current industry standard of using soft data sources such as fracture length, width, height, and conductivity to access probability and size of a potential well, to a model that utilises hard data sources. These sources include field measurements obtained during the fracking process such as fluid and proppant type, injection pressure, injection rate, and volume. An advantage of this new generation of modelling is finding new viable wells, thereby reducing exploration operations risk. These models also provide guidance on optimisation of actual hydraulic fracturing processes for specific wells.

The majority of small- to mid-cap independent producers use RBL structures to finance exploration and production operations, as opposed to bonds and term debt products. Commercial banks have accepted upstream producer risk exposure via issuing asset-backed RBL facilities, which are sized by calculating the net present value of producing assets and applying a discounting mechanism to represent asset and firm risk. RBL lenders have unilateral authority to modify the producing asset valuation and associated redetermination of borrowing lines of credit. This feature means that RBLs are a weak form of liquidity, compared to traditional fixed term lending, and can increase company default risk. Lenders place maximum and minimum production hedging ratios on borrowers to ensure cash flow availability to service RBL debt instruments.

After numerous bankruptcies during 2015 and 2016, the Shared National Credit (SNC) Program,[82] a federal group that monitors credit risk and risk management practices, reviewed the RBL structures and associated risk reporting on lender balance sheets. This was seen as imperative given that by year-end 2016, in excess of 90 private and public independent producer firms filed for bankruptcy protection or restructuring,[83] representing more than 70 billion USD in secured and unsecured debt (Jensen, 2017). In 2017, SNC announced new provisions on loan underwriting, risk evaluation, and covenant maintenance. Lenders must now analyse loan risk on the timely repayment of all outstanding secured debt rather than an individual loan agreement. Attempts by independent producers to add further capital via debt can be highly scrutinized. There must be strict adherence to loan covenant terms in lending agreements for a firm's capital profile, debt/total capital, and performance ratio debt/EBITDA (Jensen, 2017). The resulting impact to borrowers is higher interest rate costs assigned to RBL structures and more rigorous monitoring of financial covenants. Lenders have also discussed implementing policies for excessive cash balances on producer balance sheets, in such a manner that liquidity above a specified threshold must be allocated to reducing the loan principle, putting constraints on a management's ability to plan for future capital investments.

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[82] Shared National Credit Program is governed by the Board of Governors of the Federal Reserve System, the Federal Deposit Insurance Corporation, and the Office of the Comptroller of the Currency.

[83] Haynes and Boone, LLP Oil Patch Bankruptcy Monitor, 31 October, 2017.

Cash flow remains the important variant for a firm's debt holders, both bond holders and loan providers. Prudent cash flow and capital structure decisions are important, as market prices are unlikely to climb back to pre-2014 levels. Russian and OPEC curtailments have established a market observed floor around 50 USD/Bbl. As oil prices increase, Russian and OPEC constituents will take advantage of higher market prices by increasing production output. This means that independent shale producers need to operate on a positive cash flow basis within an oil price range of 50-60 USD/Bbl. Recently, at these levels of market prices, shale producers are actively hedging, which demonstrates profit margins are positive. My research results indicating the importance of hedging ratios to distance to default metrics showing that hedging programs are important for these producers.

The effect of recent changes to US tax reform remains unknown. Corporate tax reductions from 35% to 21% of net income could stimulate acquisition activity in the E&P sector. The large global oil corporations may decide to increase their presence in the United States shale oil sector to complement existing portfolios of longer term drilling and production resources. In the equity market run-up during the Trump presidency, small- to mid-cap producers have lagged the S&P 500 equity index performance. Investor return on equity demands are becoming relevant as this horizontal drilling and production sector matures. Regardless of what the future holds, independent shale oil producers should be mindful of the reticence of investors to weather another wave of bankruptcies. The oil market price collapse in 2014 resulted in many solvency issues and has some analysts and investors questioning the business model. Independent shale producers collectively need to demonstrate a positive cash flow performance for this industry to preserve and grow capital investment.

7.4 Future Research

In the progress of my research and thesis preparation, four categories for further enquiry surfaced: (1) the impact of regulatory changes to market access for hedging programs on borrowing costs for risky bond issuers, (2) further analysis using the independent shale oil producer database for firm performance created for this study, (3) the challenge of attaining information on hedging by emerging market sovereign oil exporters, and (4) the preference for debt or equity investment choice for a sub-investment grade firm by investors.

The financial regulatory landscape, along with accounting best practice requirements, has evolved since the collapse of Enron and the Arthur Andersen accounting firm in 2001. While financial and accounting requirements were intended to create more transparency and ensure prudent firm operations on behalf of investors, an unintended consequence has been a reduction in trading activity by the banking system, thereby reducing market liquidity and increasing transaction costs. Bond markets continue to be fragmented, with some secondary markets delivering limited transparency and liquidity. The impact of these financial regulations, in particular, to bond markets and specifically high yield bond markets, needs further study under the current trend of covenant light structures. Commodity hedge programs depend upon access to financial energy markets directly or via banking intermediaries. Increased capital requirements have resulted in the addition of higher margins to customer hedging structures. Research into the role of commodity trading houses, as a replacement to banks for commodity hedging strategies, could provide better insight into the future availability and costs of hedging programs for less credit-worthy oil producers.

My doctoral thesis has produced the first comprehensive database of financial, production, and hedging information for independent shale oil producers. This database provides a myriad of opportunities for further study of this new important producer group. An extension of this database with the addition of firms with exposure limited to North American markets would provide research supporting the hedging ratio and distance to default results found in this research. Bondholders and lending banks are the groups most concerned about default possibilities. Further research into the metrics that are relevant predictors of high yield bond default would also be valuable to market participants and policy makers.

Currently, there is no comprehensive literature on the usage and contributing effect of hedging programs to the cost of borrowing for emerging market sovereign oil exporters. Many of these countries are highly reliant on oil revenues to balance fiscal budgets. Commodity hedging programs provide a guaranteed income stream for physical oil sales, which would reduce revenue volatility for fiscal budgeting. Other than the case of PEMEX, Mexico's state oil company as described in this thesis, very little information is available about hedging programs used by emerging market commodity exporting countries. My research has shown that for a study of independent shale oil producers, hedging production ratios have a direct relationship to distance to default. The higher the rate of production hedging, the greater the firm's distance to default. Research on hedging programs for emerging market commodity exporters will provide valuable insight for government treasury decision makers, the academic community, and sovereign bond investors.

The final research suggestion came to light in the final months of preparing this thesis document. Over a full market cycle, will investors have a preference for the debt or equity instruments of high yield firms? High yield bonds are typically less volatile than the firm's equity because the income component of the return is typically greater and therefore more stable. If a high yield firm is seen as nearing default, its equity valuation will fall to near zero, while the price of debt will fall to a level representative of the market's expectation of loss given default. Debt issuers normally have some financial payout when default is confirmed, while equity holders are usually left with nothing. This is an important question as there is a trend by start-up companies to issue common equity with reduced or no shareholder voting rights, which means equity investment in the firm provides no chance for participation and no obligations for payout. Research into investor risk return exposure and potential investor responses to this trend will be important in order to understanding investor preference for equity or debt participation in firm financing.

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Appendix A: Unit Root Test Results[84]

VARIABLES	ADF LEVELS		ADF DIFFERENCES		
	Constant	Constant+Trend	Constant	Constant +Trend	Model
LNEMBI_EXPORT	-1.5055	-1.3746	-15.20***	-15.228***	I(1)
LNEMBI_IMPORT	-0.6845	-3.1742	17.145***	-17.136***	I(1)
LNBRL	-1.5335	-0.9413	18.400***	-18.456***	I(1)
LNCLP	-0.6946	-2.635	17.743***	-17.729***	I(1)
LNCNY	-0.1844	-3.2373	19.59***	-19.588***	I(1)
LNCOP	-1.2084	-1.7628	16.833***	-16.844***	I(1)
LNKZT	-1.0665	-2.2108	10.346***	-10.335***	I(1)
LNMXN	-0.9375	-2.3832	17.279***	-17.268***	I(1)
LNPHP	-0.4449	-2.9629	20.401***	-20.385***	I(1)
LNRUB	-0.7764	-2.5875	19.797***	-19.783***	I(1)
LNPLN	-0.2162	-3.3833	18.342***	-18.343***	I(1)
LNTRY	-0.6586	-3.1771	19.694***	-19.679***	I(1)
LNVEF	-1.7699	-1.9888	20.962***	-20.951***	I(1)
LNZAR	-1.4191	-2.5744	11.65***	-11.647***	I(1)
LNGLOBAL	0.6326	-1.3598	-7.31***	-7.399***	I(1)
LNBDI	-2.2875	-2.8369	14.538***	-14.572***	I(1)
LNBRENT	-1.8606	-1.2759	19.999***	-20.103***	I(1)
LNWTI	-2.0513	-1.7249	20.927***	-21.003***	I(1)
BOILMAX	22.159***	-22.195***	13.561***	-13.554***	I(0)
BOILMIN	-8.372***	-8.451***	19.235***	-19.219***	I(0)

** 5% Significance level, *** 1% Significance level

84 Phillips-Perron unit root test conducted to confirm ADF results.

Appendix B: Descriptive Statistics

	BRL	CLP	CNY	COP	KZT	MXN	PHP	RUB	PLN	TRY
Mean	797.57	251.30	362.84	398.17	141.99	484.19	556.26	754.12	464.45	511.99
Max	1070.56	320.25	445.18	533.20	176.49	635.03	804.82	988.32	597.16	721.95
Min	424.81	200.41	294.04	235.91	61.86	333.46	317.49	501.84	355.58	310.23
Std. Dev.	178.62	37.30	46.23	89.31	28.12	90.24	149.38	138.15	72.98	116.75
Obs.	626	626	626	626	444	626	626	626	626	626

All Descriptive Statistic on total bond returns based on level values.

	USA	VEF	ZAR	LNEMBI_EXPORT	LNEMBI_IMPORT
Mean	466.09	721.53	487.51	8.17	7.85
Max	578.08	1175.33	628.15	8.41	8.16
Min	374.51	359.81	324.55	7.65	7.52
Std. Dev.	61.65	187.46	86.96	0.17	0.19
Obs.	626	626	626	444	444

Country level descriptive statistic on total bond returns based on level values.
EMBI portfolio descriptive statistics on log total bond returns

	WTI	BRENT	BOILMAX	BOILMIN	GLOBAL	BDI	VIX	EM VIX	OVX
Mean	82.07	86.36	1.15	-1.04	88176.6	3327.5	19.39	36.90	24.87
Max	153.77	154.01	9.68	0.00	97355.0	12837.5	72.98	96.19	58.88
Min	39.32	37.19	0.00	-12.12	82030.0	473.1	10.21	15.22	14.43
Std. Dev.	22.10	25.76	1.60	1.84	3662.3	2765.1	9.23	14.36	7.52
Obs	626	626	626	626	626	626	626	453	252

Descriptive Statistics indicated in log values for total bond returns, oil production, aggregate demand, oil prices (not oil price shocks)

Appendix C: Chow Test Results for Crude Oil Time Series

Chow Test for Break in Crude Oil Time Series in October 2008

. regress IMPORT BDINOADJ BRENTADJ GLOBALPROD

Source	SS	df	MS			
				Number of obs	=	625
				F(3, 621)	=	3586.76
Model	212571550	3	70857183.3	Prob > F	=	0.0000
Residual	12267973.5	621	19755.1908	R-squared	=	0.9454
				Adj R-squared	=	0.9452
Total	224839524	624	360319.749	Root MSE	=	140.55

IMPORT	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
BDINOADJ	-.0515917	.0028417	-18.16	0.000	-.0571722	-.0460112
BRENTADJ	4.006962	.2331676	17.18	0.000	3.54907	4.464855
GLOBALPROD	.1304206	.0019636	66.42	0.000	.1265645	.1342767
cons	-9101.95	172.3597	-52.81	0.000	-9440.428	-8763.471

. regress IMPORT BDINOADJ BRENTADJ GLOBALPROD if d2==0

Source	SS	df	MS			
				Number of obs	=	243
				F(3, 239)	=	202.05
Model	4993255.21	3	1664418.4	Prob > F	=	0.0000
Residual	1968770.02	239	8237.53145	R-squared	=	0.7172
				Adj R-squared	=	0.7137
Total	6962025.22	242	28768.6993	Root MSE	=	90.761

IMPORT	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
BDINOADJ	.0026971	.0031633	0.85	0.395	-.0035344	.0089287
BRENTADJ	1.618959	.5261428	3.08	0.002	.5824899	2.655429
GLOBALPROD	.089365	.0104985	8.51	0.000	.0686836	.1100465
_cons	-5752.436	860.5114	-6.68	0.000	-7447.592	-4057.281

. regress IMPORT BDINOADJ BRENTADJ GLOBALPROD if d2==1

Source	SS	df	MS			
				Number of obs	=	382
				F(3, 378)	=	1575.19
Model	67243151.2	3	22414383.7	Prob > F	=	0.0000
Residual	5378792.06	378	14229.6086	R-squared	=	0.9259
				Adj R-squared	=	0.9253
Total	72621943.2	381	190608.775	Root MSE	=	119.29

IMPORT	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
BDINOADJ	-.0690838	.0047909	-14.42	0.000	-.078504	-.0596636
BRENTADJ	3.417935	.2575894	13.27	0.000	2.911447	3.924422
GLOBALPROD	.111907	.0021955	50.97	0.000	.1075901	.1162239
_cons	-7312.972	206.7072	-35.38	0.000	-7719.412	-6906.532

Appendix D: SVAR Model results

	EXPORTER PORTFOLIO					IMPORTER PORTFOLIO			
VAR use diff	LNGLOBAL	L N B D I	LNBRENT	LNEMBI_EXPORT		LNGLOBAL	L N B D I	L N B R E N T	LNEMBI_IMPORT
LNGLOBAL(-1)	0.8236	0.587	-0.5567	-0.9179	LNGLOBAL(-1)	0.8154	0.7982	-0.776	(0.3654)
standard errors	(0.0493)	(3.653)	(1.829)	(0.6348)	standard errors	(0.048)	(3.588)	(1.833)	(0.3704)
t-statistics	[16.702]	[0.1606]	[-0.305]	[-1.446]	t-statistics	[16.83]	[0.223]	[-0.423]	[-0.987]
p-value	*0.0000*	*0.8720*	*0.7607*	*0.1484*	p-value	*0.0000*	*0.8240*	*0.6723*	*0.3240*
LNGLOBAL(-2)	0.00134	-4.583	1.5512	0.9777	LNGLOBAL(-2)	0.0084	-6.1799	0.5256	0.3178
	(0.0609)	(4.512)	(2.258)	(0.784)		(0.062)	(4.614)	(2.357)	(0.4763)
	[-0.897]	[0.807]	[-0.936]	[0.0415]		[0.135]	[-1.339]	[0.223]	[0.6674]
	0.9826	*0.3290*	*0.5090*	*0.2308*		*0.893*	*0.1806*	*0.8236*	*0.5046*
LNGLOBAL(-3)	-0.0546	3.644	-2.113	0.0325	LNGLOBAL(-3)	-0.0432	6.647	-0.7607	(0.5860)
	(0.0609)	(4.513)	(2.258)	(0.784)		(0.060)	(4.451)	(2.274)	(0.459)
	[-0.8968]	[0.808]	[-0.936]	[0.0415]		[-0.718]	[1.49]	[-0.335]	[-1.275]
	0.3699	*0.419*	*0.3494*	*0.9669*		*0.4728*	*0.1360*	*0.7380*	*0.2023*
LNGLOBAL(-4)	-0.4283	0.7099	1.2311	1.2324	LNGLOBAL(-4)	-0.4506	-0.147	1.226	0.9737
	(0.05700)	(4.221)	(2.113)	(0.734)		(0.056)	(4.160)	(2.126)	(0.4295)
	[-7.515]	[0.168]	[0.583]	[1.679]		[-8.019]	[-0.035]	[0.577]	[2.267]
	0.0000	*0.8665*	*0.5600*	*0.0932*		*0.0000*	*0.9717*	*0.5642*	*0.0235*
LNGLOBAL(-5)	0.3375	1.9039	-0.357	0.0843	LNGLOBAL(-5)	0.3357	0.9142	-1.222	0.9032
	(0.0604)	(4.474)	(2.239)	(0.7775)		(0.060)	(4.474)	(2.2867)	(0.4618)
	[5.587]	[0.426]	[-0.159]	[0.108]		[5.557]	[0.205]	[-0.535]	[1.956]
	0.0000	*0.6705*	*0.8730*	*0.9137*		*0.0000*	*0.8380*	*0.5930*	*0.0507*
LNGLOBAL(-6)	0.0183	-4.1487	0.4157	-1.5749	LNGLOBAL(-6)	0.0419	-5.0314	0.137	(1.6056)
	(0.063)	(4.613)	(2.309)	(0.8017)		(0.063)	(4.650)	(2.376)	(0.475)
	[0.293]	[-0.899]	[0.180]	[-1.964]		[0.6684]	[-1.083]	[0.058]	[-3.345]
	0.7692	*0.3686*	*0.857*	*0.0497*		*0.5040*	*0.2793*	*0.9540*	*0.0008*
LNGLOBAL(-7)	-0.1095	1.0648	-0.2647	0.7594	LNGLOBAL(-7)	-0.13	2.7532	1.2314	0.6500
	(0.048)	(3.564)	(1.7837)	(0.6195)		(0.048)	(3.587)	(1.832)	(0.3702)
	[-2.275]	[0.2987]	[-0.148]	[1.226]		[-2.68]	[0.7678]	[0.672]	[1.756]
	0.0230	*0.7652*	*0.8820*	*0.2204*		*0.007*	*0.4427*	*0.5016*	*0.0793*
LNBDI(-1)	-0.00003	0.6004	0.0469	0.02202	LNBDI(-1)	-6.00E-06	0.5651	0.0520	0.0094
	(0.0007)	(0.0498)	(0.0249)	(0.0087)		(0.0006)	(0.049)	(0.0252)	(0.0051)
	[-0.048]	[12.049]	[1.882]	[2.543]		[-0.009]	[11.442]	[2.059]	[1.8364]
	0.9610	*0.0000*	*0.0600*	*0.0110*		*0.9930*	*0.0000*	*0.0398*	*0.0665*
LNBDI(-2)	3.2E-05	-0.0982	0.0552	-0.0072	LNBDI(-2)	0.0002	-0.0648	0.0468	0.00538
	(0.0007)	(0.058)	(0.029)	(0.0101)		(0.0008)	(0.057)	(0.0289)	(0.0058)
	[0.041]	[-1.689]	[1.899]	[-0.709]		[0.241]	[-1.142]	[1.617]	[0.920]
	0.9670	*0.0914*	*0.0577*	*0.4786*		*0.81*	*0.254*	*0.106*	*0.3577*
LNBDI(-3)	-0.0001	0.0608	-0.049	-0.024	LNBDI(-3)	-0.00014	0.0495	-0.032	(0.0179)
	(0.0008)	(0.056)	(0.028)	(0.0097)		(0.0008)	(0.055)	(0.0282)	(0.0057)
	[-0.1376]	[1.082]	[-1.742]	[-2.4585]		[-0.187]	[0.8965]	[-1.132]	[-3.148]
	0.8905	*0.2798*	*0.0816*	*0.0141*		*0.852*	*0.37*	*0.2578*	*0.0017*
LNBDI(-4)	0.0009	0.1003	0.0047	0.01915	LNBDI(-4)	0.0009	0.0975	-0.0066	0.01427
	(0.0008)	(0.056)	(0.028)	(0.0098)		(0.0008)	(0.0559)	(0.0285)	(0.0058)
	[1.295]	[1.777]	[0.169]	[1.952]		[1.189]	[1.745]	[-0.2314]	[2.4743]
	0.1957	*0.0758*	*0.8665*	*0.0511*		*0.235*	*0.081*	*0.8171*	*0.0135*
LNBDI(-5)	-0.0013	-0.314	0.0336	0.00114	LNBDI(-5)	-0.0011	-0.299	0.0450	(0.0097)
	(0.0008)	(0.056)	(0.028)	(0.0098)		(0.0008)	(0.056)	(0.0286)	(0.0059)

	[-1.648]	[-5.580]	[1.197]	[0.1166]		[-1.405]	[-5.326]	[1.573	[-1.682]
	0.0996	*0.0000*	*0.2300*	*0.9072*		*0.1600*	*0.0000*	*0.1160*	*0.0927*
LNBDI(-6)	0.0012	0.0614	-0.0354	-0.0065	LNBDI(-6)	0.0011	0.0514	-0.0333	0.0057
	(0.0008)	(0.058)	(0.029)	(0.0101)		(0.0008)	(0.058)	(0.029)	(0.006)
	[1.525]	[1.0514]	[-1.213]	[-0.6439]		[1.4369]	[0.881]	[-1.114]	[0.954]
	0.1275	*0.2932*	*0.225*	*0.5197*		*0.1509*	*0.378*	*0.2654*	*0.3401*
LNBDI(-7)	0.0009	-0.0085	0.0673	0.0025	LNBDI(-7)	0.0008	-0.0212	0.0450	(0.0012)
	(0.0007)	(0.050)	(0.0252)	(0.0087)		(0.0007)	(0.049)	(0.0255)	(0.0052)
	[1.265]	[-0.169]	[2.671]	[0.2884]		[1.187]	[-0.426]	[1.958]	[-0.2336]
	0.2060	*0.8657*	*0.0076*	*0.7730*		*0.2354*	*0.6707*	*0.0504*	*0.8154*
LNBRENT(-1)	0.00134	0.0848	0.0633	-0.0105	LNBRENT(-1)	0.00082	0.1242	0.1195	(0.0019)
	(0.0013)	(0.098)	(0.0494)	(0.017)		(0.0013)	(0.095)	(0.0485)	(0.0098)
	[0.9748]	[0.8593]	[1.281]	[-0.6125]		[0.6390]	[1.309]	[2.464]	[-0.1899]
	0.3298	*0.3903*	*0.2004*	*0.5403*		*0.5229*	*0.1908*	*0.0138*	*0.8494*
LNBRENT(-2)	0.001540	0.0352	0.0591	0.00143	LNBRENT(-2)	0.0016	0.0724	0.0827	(0.0061)
	(0.0013)	(0.099)	(0.0494)	(0.0172)		(0.0013)	(0.096)	(0.0480)	(0.0099)
	[1.106]	[0.356]	[1.1947]	[0.0836]		[1.269]	[0.756]	[1.689]	[-0.6162]
	0.2687	*0.786*	*0.2324*	*0.9334*		*0.2045*	*0.4499*	*0.0913*	*0.5379*
LNBRENT(-3)	0.00128	0.2235	0.0382	-0.0566	LNBRENT(-3)	0.0011	0.2521	0.0564	(0.0332)
	(0.0013)	(0.098)	(0.0491)	(0.0171)		(0.0013)	(0.097)	(0.0492)	(0.0099)
	[0.966]	[2.276]	[0.777]	[-3.3134]		[0.871]	[2.621]	[1.147]	[-3.338]
	0.3342	*0.0230*	*0.4377*	*0.0009*		*0.3839*	*0.0089*	*0.2517*	*0.0009*
LNBRENT(-4)	-0.0000122	0.0636	-0.107	0.05377	LNBRENT(-4)	-0.0007	0.1074	-0.0832	0.00896
	(0.0013)	(0.099)	(0.0496)	(0.0172)		(0.0013)	(0.098)	(0.0450)	(0.010)
	[-0.009]	[0.641]	[-2.158]	[3.1208]		[-0.526]	[1.098]	[-1.664]	[0.887]
	0.993	*0.5214*	*0.0311*	*0.0018*		*0.599*	*0.2726*	*0.0963*	*0.3752*
LNBRENT(-5)	-0.0011	-0.0272	0.0272	0.01692	LNBRENT(-5)	-0.0005	-0.0042	0.0512	0.0123
	(0.0014)	(0.100)	(0.051)	(0.01745)		(0.0013)	(0.098)	(0.050)	(0.010)
	[-0.797]	[-0.271]	[0.541]	[0.9694]		[-0.404]	[-0.043]	[1.026]	[1.221]
	0.426	*0.7862*	*0.588*	*0.3325*		*0.6866*	*0.9654*	*0.305*	*0.2224*
LNBRENT(-6)	0.0023	-0.0153	0.0519	0.0024	LNBRENT(-6)	0.0028	0.0403	0.0447	0.0073
	(0.0014)	(0.099)	(0.050)	(0.0174)		(0.0013)	(0.097)	(0.0499)	(0.010)
	[2.149]	[-0.1528]	[1.037]	[0.1389]		[2.1073]	[0.4125]	[0.895]	[0.7268]
	0.0318	*0.8786*	*0.3001*	*0.8895*		*0.0352*	*0.6800*	*0.3707*	*0.4654*
LNBRENT(-7)	-0.0027	0.07862	0.0247	-0.022	LNBRENT(-7)	-0.0028	0.0151	0.0132	(0.0242)
	(0.0013)	(0.097)	(0.049)	(0.0169)		(0.0013)	(0.097)	(0.0492)	(0.0099)
	[-1.949]	[0.8066]	[0.506]	[-1.254]		[-2.120]	[0.1563]	[0.268]	[-2.433]
	0.0514	*0.4200*	*0.6136*	*0.2097*		*0.0341*	*0.8769*	*0.7886*	*0.0151*
LNEMBI_EXPORT(-1)	0.0048	0.4328	0.3809	0.282	LNEMBI_IMPORT(-1)	-0.0054	1.3665	0.2322	0.3867
	(0.0039)	(0.286)	(0.143)	(0.0497)		(0.006)	(0.468)	(0.2388)	(0.0482)
	[1.233]	[1.514]	[2.663]	[5.669]		[-0.860]	[2.924]	[0.972]	[8.015]
	0.2180	*0.1301*	*0.0078*	*0.0000*		*0.3897*	*0.0035*	*0.3311*	-
LNEMBI_EXPORT(-2)	-0.0084	0.3315	0.1449	-0.1186	LNEMBI_IMPORT(-2)	0.0005	-0.2753	0.1143	(0.1010)
	(0.004)	(0.300)	(0.151)	(0.0523)		(0.0067)	(0.498)	(0.2544)	(0.0514)
	[-2.064]	[1.1045]	[0.965]	[-2.27]		[0.0747]	[-0.553]	[0.4489]	[-1.964]
	0.039	*0.2696*	*0.3348*	*0.0231*		*0.9404*	*0.5804*	*0.6536*	*0.0496*
LNEMBI_EXPORT(-3)	0.0036	-0.8625	-0.0623	0.1550	LNEMBI_IMPORT(-3)	0.0010	-0.5142	-0.4461	0.09595
	(0.004)	(0.305)	(0.1526)	(0.053)		(0.0067)	(0.496)	(0.253)	(0.051)
	[0.861]	[-2.827]	[-0.4078]	[2.924]		[0.145]	[-1.037]	[-1.759]	[1.873]
	0.3895	*0.0047*	*0.6835*	*0.0035*		*0.8845*	*0.3002*	*0.0787*	*0.0612*
LNEMBI_EXPORT(-4)	-0.0072	0.7964	0.2871	0.0113	LNEMBI_IMPORT(-4)	-0.01916	0.0191	0.5352	0.03307
	(0.0042)	(0.309)	(0.1546)	(0.0537)		(0.0067)	(0.493)	(0.252)	(0.051)
	[-1.728]	[2.578]	[1.856]	[0.2110]		[-2.876]	[0.0388]	[2.1236]	[0.6496]

	0.0842	*0.0100*	*0.0636*	*0.8329*		*0.00400*	*0.96910*	*0.03400*	*0.5160*
LNEMBI_EXPORT(-5)	-0.0011	-0.5715	0.5967	0.0741	LNEMBI_IMPORT(-5)	0.0057	-0.2686	-0.0340	(0.0705)
	(0.0042)	(0.308)	(0.1544)	(0.0536)		(0.0066)	(0.488)	(0.249)	(0.051)
	[-0.265]	[-1.853]	[3.8657]	[1.382]		[0.867]	[-0.551]	[-0.136]	[-1.401]
	0.7909	*0.0641*	*0.0001*	*0.1671*		*0.3860*	*0.5820*	*0.8915*	*0.1617*
LNEMBI_EXPORT(-6)	-0.0025	0.9471	-0.1944	-0.04035	LNEMBI_IMPORT(-6)	-0.0036	1.3436	-0.419	0.0398
	(0.004)	(0.307)	(0.154)	(0.05331)		(0.006)	(0.484)	(0.247)	(0.0499)
	[-0.614	[3.087]	[-1.266]	[-0.757]		[-0.5439]	[2.775]	[-1.694]	[0.7984]
	0.539	*0.002*	*0.2058*	*0.4493*		*0.587*	*0.0056*	*0.0905*	*0.4248*
LNEMBI_EXPORT(-7)	0.0067	0.236	0.2727	-0.0943	LNEMBI_IMPORT(-7)	0.0080	0.2282	0.7213	(0.1351)
	(0.004)	(0.297)	(0.148)	(0.0515)		(0.0062)	(0.462)	(0.236)	(0.0476)
	[1.660]	[0.7968]	[1.838]	[-1.829]		[1.283]	[0.494]	[3.056]	[-2.832]
	0.097	*0.426*	*0.0663*	*0.068*		*0.199*	*0.6214*	*0.0023*	*0.0047*
C	0.00015	-0.0041	-0.0015	0.0004	C	0.00016	-0.0049	-0.0011	0.0006
	(5.0E-05)	(0.004)	(0.0019)	(0.0006)		(5.0E-05)	(0.004)	(0.0019)	(0.0004)
	[3.0429]	[-1.098]	[-0.811]	[0.6252]		[3.1029]	[-1.324]	[-0.593]	[1.664]
	0.0024	*0.272*	*0.4175*	*0.5319*		*0.0019*	*0.1857*	*0.5523*	*0.0964*
R-squared	0.6403	0.4303	0.1935	0.2174	R-squared	0.6436	0.4189	0.1493	0.2727
Adj. R-squared	0.6155	0.3911	0.1378	0.1634	Adj. R-squared	0.6195	0.3796	0.0917	0.2235
Sum sq. resids	0.0004	2.0322	0.5091	0.0614	Sum sq. resids	0.0004	2.0769	0.5422	0.0222
S.E. equation	0.0010	0.0708	0.0354	0.0123	S.E. equation	0.0009	0.0709	0.0363	0.0073
F-statistic	25.812	10.954	3.478	4.0268	F-statistic	26.701	10.659	2.5932	5.5436
Log likelihood	2422.6	549.92	851.06	1311.11	Log likelihood	2466.2	559.249	856.73	1565.2
Akaike AIC	-11.004	-2.395	-3.7796	-5.8947	Akaike AIC	-11.003	-2.394	-3.737	(6.9355)
Schwarz SC	-10.733	-2.123	-3.5079	-5.6231	Schwarz SC	-10.736	-2.126	-3.469	(6.6675)
Mean dependent	0.00033	-0.0066	-0.0014	0.0007	Mean dependent	0.0003	-0.0061	-0.0014	0.00098
S.D. dependent	0.0015	0.0907	0.0381	0.0134	S.D. dependent	0.0016	0.0899	0.0379	0.0083

Appendix E: Granger-Causality – Individual Countries

VARIABLE		*SHOCKS TO COUNTRY TOTAL RETURNS:* LNGLOBAL	LNBDI	LNBRENT	LNWTI	BOILMAX	BOILMIN
LNBRL	*chi-square*	23.638***	12.7700	19.7352**	21.4581**	29.369***	14.1292
	p-value	0.0026	11.9800	0.0114	0.0181	0.0020	0.2259
LNCLP	*chi-square*	17.7789**	13.8905	11.4496	11.2755	16.9145	23.4689**
	p-value	0.0229	0.0847	0.1725	0.1866	0.1104	0.0152
LNCNY	*chi-square*	30.81***	30.219***	33.490***	27.995***	33.169***	29.099***
	p-value	0.0006	0.0008	0.0002	0.0055	0.0005	0.0022
LNCOP	*chi-square*	27.103***	16.5602	13.5396	21.1800	23.8099**	7.0475
	p-value	0.0025	0.0847	0.1950	0.0694	0.0136	0.7952
LNKZT	*chi-square*	44.753***	25.802***	15.7058**	15.6761	22.526***	21.6755**
	p-value	0.0000	0.0005	0.0279	0.1093	0.0021	0.0270
LNMXN	*chi-square*	25.086***	14.6069	16.5132**	17.1167	29.358***	13.6050
	p-value	0.0015	0.0673	0.0356	0.0718	0.0002	0.2556
LNPHP	*chi-square*	39.217***	22.7769**	24.876***	23.9424**	48.498***	19.007
	p-value	0.0000	0.0116	0.0056	0.0207	0.0000	0.0883
LNRUB	*chi-square*	24.750***	35.531***	23.646***	18.725	18.409	21.8972**
	p-value	0.0058	0.0001	0.0086	0.0439	0.0485	0.0156
LNPLN	*chi-square*	16.595**	20.082***	17.8379**	10.772	24.875***	26.039***
	p-value	0.0346	0.0100	0.0225	0.2149	0.0095	0.0064
LNTRY	*chi-square*	31.208***	22.3377**	20.6724**	16.237	27.834***	19.106
	p-value	0.001	0.014	0.024	0.181	0.003	0.059
LNVEF	*chi-square*	14.367	16.2262**	16.2347**	23.038***	17.329***	12.638
	p-value	0.073	0.039	0.039	0.011	0.099	0.318
LNZAR	*chi-square*	18.9893**	27.124***	14.809	14.378	28.243***	21.226**
	p-value	0.015	0.001	0.063	0.156	0.003	0.031
LNUSA	*chi-square*	22.5582**	15.210	10.766	18.1195	11.3488	6.5041
	p-value	0.0125	0.1246	0.3761	0.1121	0.4145	0.8700

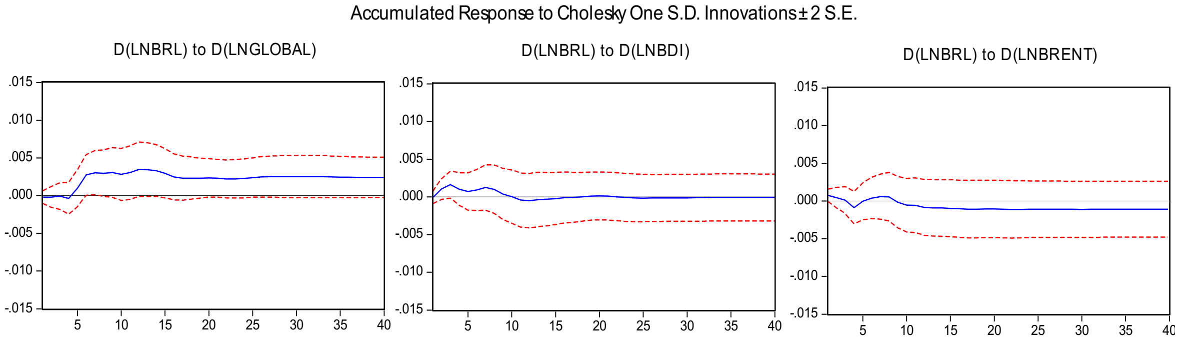
The values above represent Wald chi-square statistics and related p-values.
** Significance at 5% level, ***Significance at 1% level

Appendix F: Variance Decomposition – Individual Countries

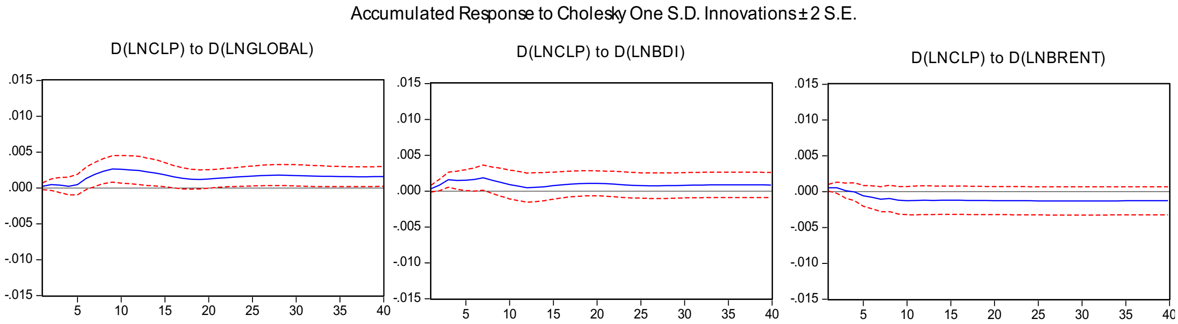
Variance Decomposition Time Period 4, 8, 12	LNGLOBAL			LNBDI			LNBRENT		
Dependent Variable:	4	8	12	4	8	12	4	8	12
LNBRL	0.1236	4.0337	4.2690	1.6183	1.7929	2.3206	1.5001	2.1636	2.6877
LNCLP	0.3181	3.3575	3.5159	2.3169	2.6691	3.2529	1.1749	2.1001	2.2004
LNCNY	0.6545	3.3777	4.1992	4.5040	5.4240	5.5340	1.9223	3.5647	5.7591
LNCOP	0.1957	3.4430	3.8912	2.7915	2.7808	3.0736	0.7230	1.4508	2.1645
LNKZT	2.1505	9.6754	10.1337	3.4964	3.7923	3.8991	2.3540	4.4788	4.5092
LNMXN	2.2086	3.9163	4.0621	2.6546	2.9198	3.4048	1.7607	2.2297	2.4077
LNPHP	0.8330	5.1932	5.9799	3.1133	3.1193	3.9817	2.7361	3.6087	3.7356
LNRUB	0.2314	3.1625	3.4269	3.7423	4.6107	4.5676	1.5722	3.5404	3.5811
LNPLN	0.5604	2.6152	2.9646	2.9943	4.7524	4.7076	0.8645	2.1913	2.9989
LNTRY	0.3040	4.2843	4.6608	3.2886	3.1872	3.1511	1.5128	2.4961	2.7459
LNVEF	3.6183	3.9792	4.0959	1.7090	2.0400	2.1798	1.1332	2.2034	2.4175
LNZAR	0.2241	2.5394	3.0942	5.6202	5.3961	5.4333	1.5232	2.4947	2.4267

Appendix G: Impulse Response Functions Individual Countries

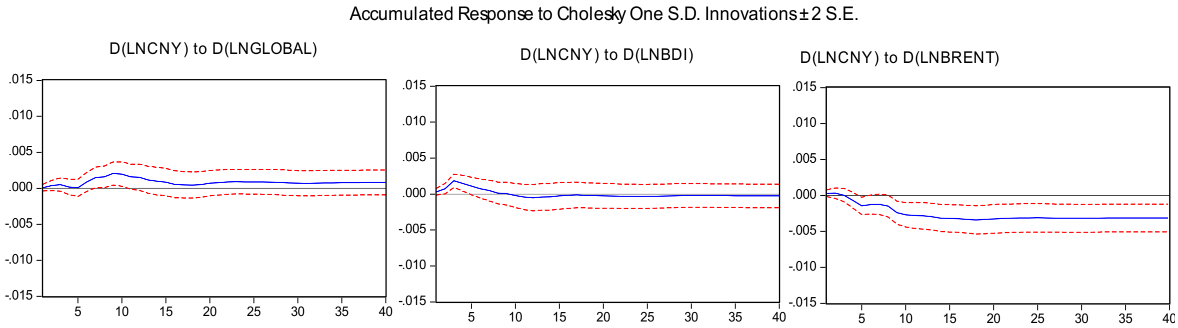
BRAZIL



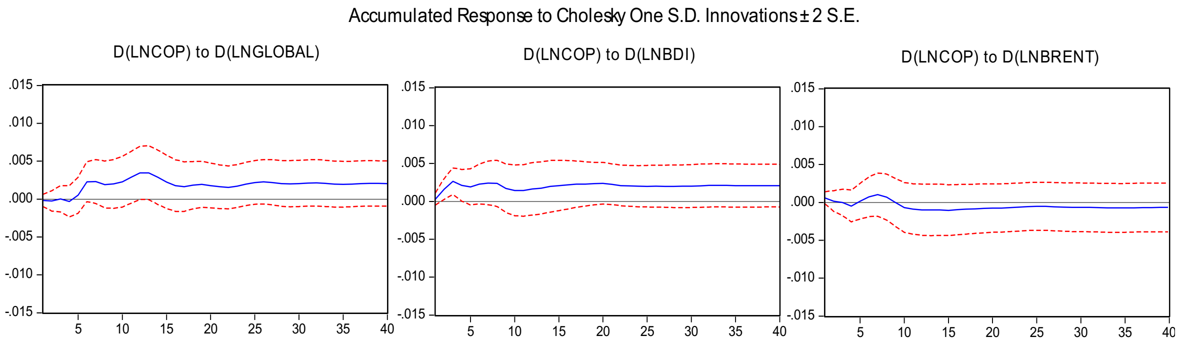
CHILE



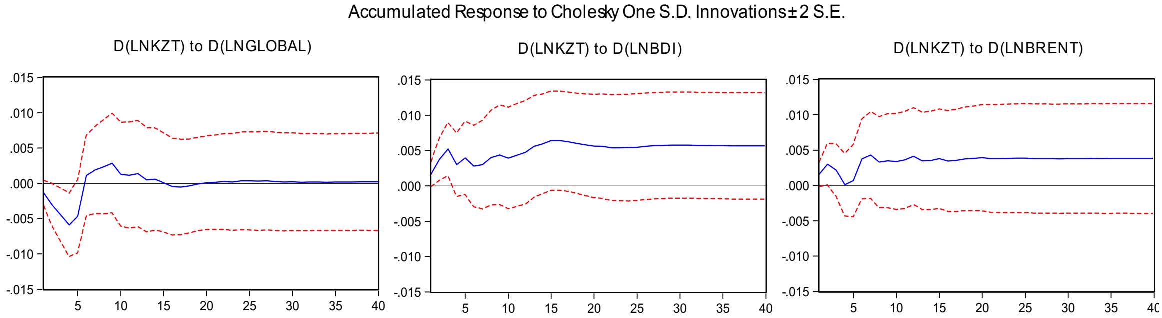
CHINA



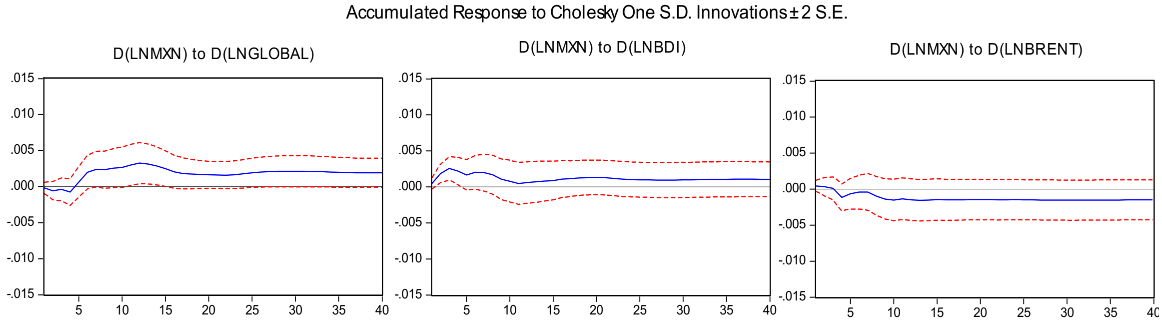
COLOMBIA



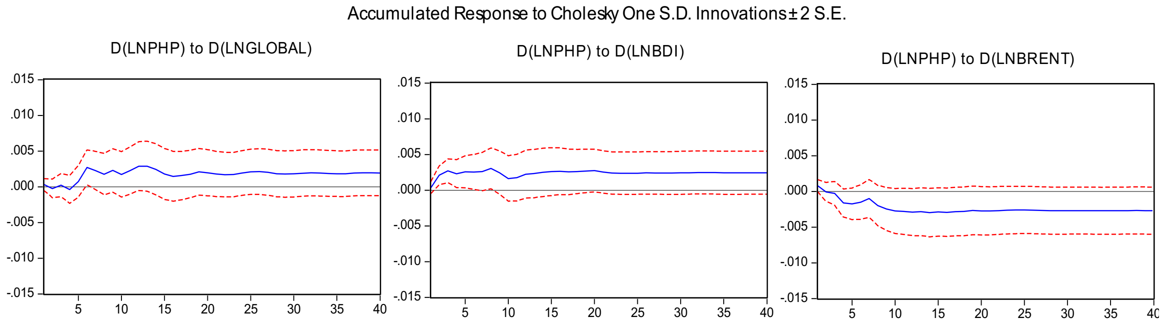
KAZAKHSTAN



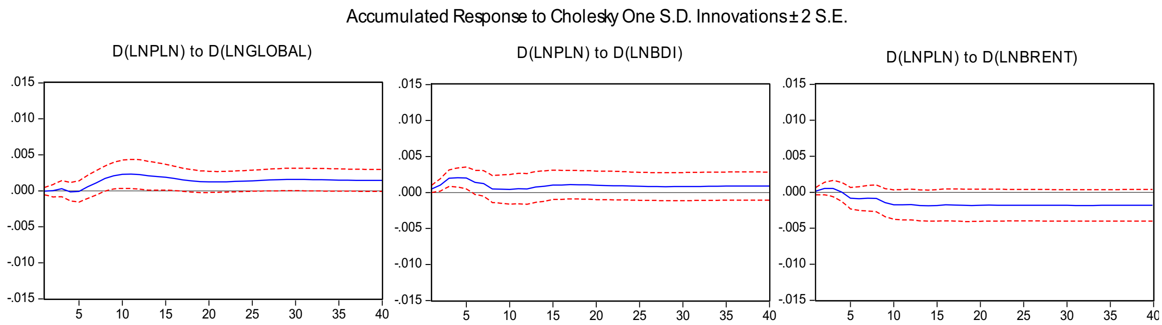
MEXICO



PHILIPPINES

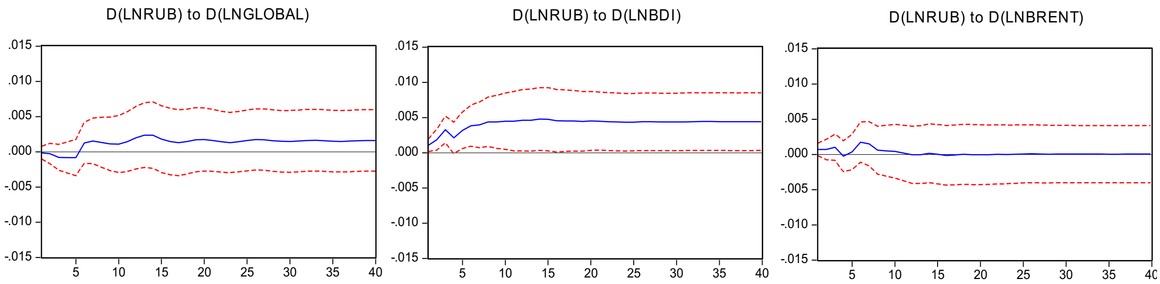


POLAND



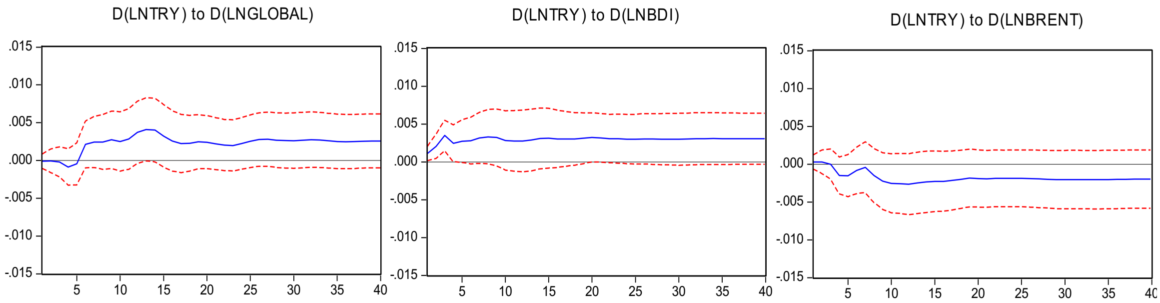
RUSSIA

Accumulated Response to Cholesky One S.D. Innovations ± 2 S.E.



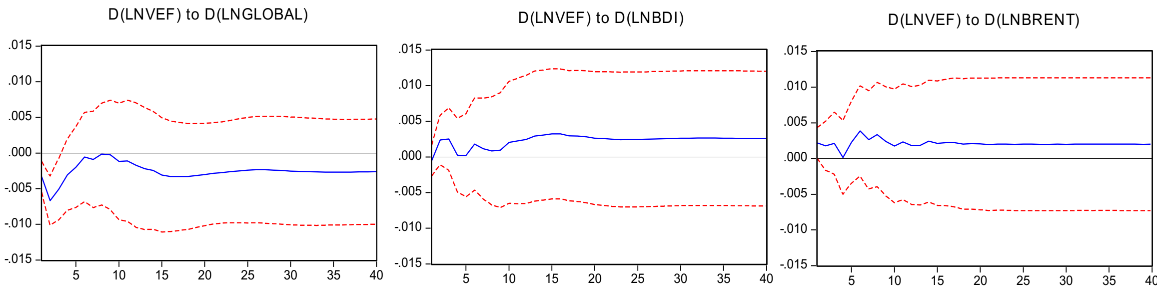
TURKEY

Accumulated Response to Cholesky One S.D. Innovations ± 2 S.E.



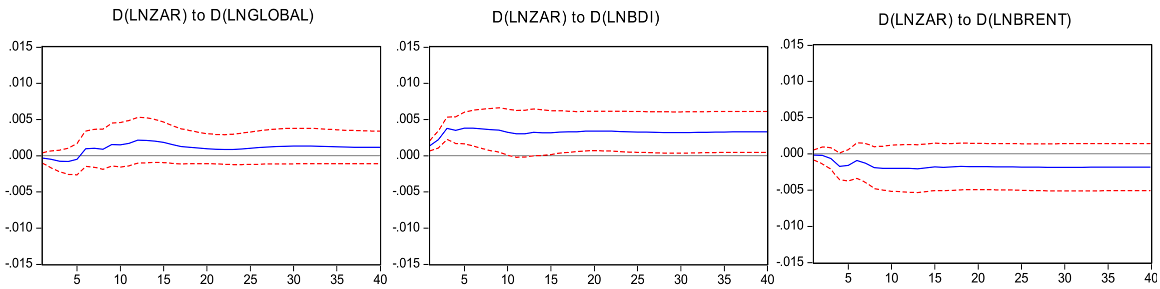
VENEZUELA

Accumulated Response to Cholesky One S.D. Innovations ± 2 S.E.



SOUTH AFRICA

Accumulated Response to Cholesky One S.D. Innovations ± 2 S.E.

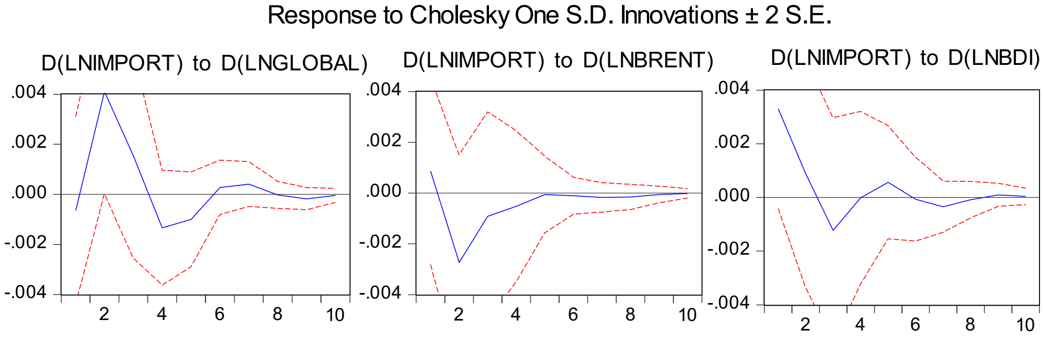


Appendix H: Monthly SVAR Results

Included observations: 92 2007-2014
Standard errors in ( ) & t-statistics in [ ]

	D(LNGLOBAL)	D(LNBDI)	D(LNBRENT)	D(LNIMPORT)
D(LNGLOBAL(-1))	-0.194086	0.917286	0.829570	0.726232
	(0.10416)	(4.05734)	(1.25461)	(0.30661)
	[-1.86336]	[0.22608]	[0.66122]	[2.36859]
D(LNGLOBAL(-2))	-0.074485	-0.646218	-0.606182	0.108821
	(0.10458)	(4.07370)	(1.25967)	(0.30785)
	[-0.71224]	[-0.15863]	[-0.48122]	[0.35349]
D(LNBDI(-1))	0.004078	0.144286	0.003149	0.001791
	(0.00293)	(0.11412)	(0.03529)	(0.00862)
	[1.39211]	[1.26438]	[0.08925]	[0.20774]
D(LNBDI(-2))	0.005962	-0.204592	-0.019988	-0.004512
	(0.00292)	(0.11389)	(0.03522)	(0.00861)
	[2.03903]	[-1.79639]	[-0.56755]	[-0.52421]
D(LNBRENT(-1))	0.007236	0.793950	0.358350	-0.043407
	(0.00951)	(0.37043)	(0.11454)	(0.02799)
	[0.76096]	[2.14332]	[3.12849]	[-1.55064]
D(LNBRENT(-2))	-0.012766	0.258164	0.264869	0.016415
	(0.00980)	(0.38193)	(0.11810)	(0.02886)
	[-1.30205]	[0.67595]	[2.24275]	[0.56873]
D(LNIMPORT(-1))	-0.077743	3.194804	1.222335	0.397091
	(0.03579)	(1.39419)	(0.43111)	(0.10536)
	[-2.17214]	[2.29151]	[2.83531]	[3.76898]
D(LNIMPORT(-2))	0.073040	0.710078	0.184234	-0.317698
	(0.03671)	(1.43015)	(0.44223)	(0.10807)
	[1.98942]	[0.49651]	[0.41660]	[-2.93961]
C	0.001675	-0.039766	-0.010049	0.002950
	(0.00070)	(0.02743)	(0.00848)	(0.00207)
	[2.37874]	[-1.44965]	[-1.18467]	[1.42304]
R-squared	0.231105	0.221334	0.329847	0.272832
Adj. R-squared	0.156994	0.146282	0.265254	0.202743
Sum sq. resids	0.003091	4.690156	0.448458	0.026784
S.E. equation	0.006103	0.237714	0.073506	0.017964
F-statistic	3.118384	2.949066	5.106547	3.892675
Log likelihood	343.3063	6.368501	114.3492	243.9776
Akaike AIC	-7.267528	0.057207	-2.290199	-5.108209
Schwarz SC	-7.020831	0.303903	-2.043502	-4.861513
Mean dependent	0.001155	-0.020090	-0.002359	0.004336
S.D. dependent	0.006647	0.257275	0.085754	0.020119

Determinant resid covariance (dof adj.)	3.26E-12
Determinant resid covariance	2.16E-12
Log likelihood	713.4633
Akaike information criterion	-14.72746
Schwarz criterion	-13.74068

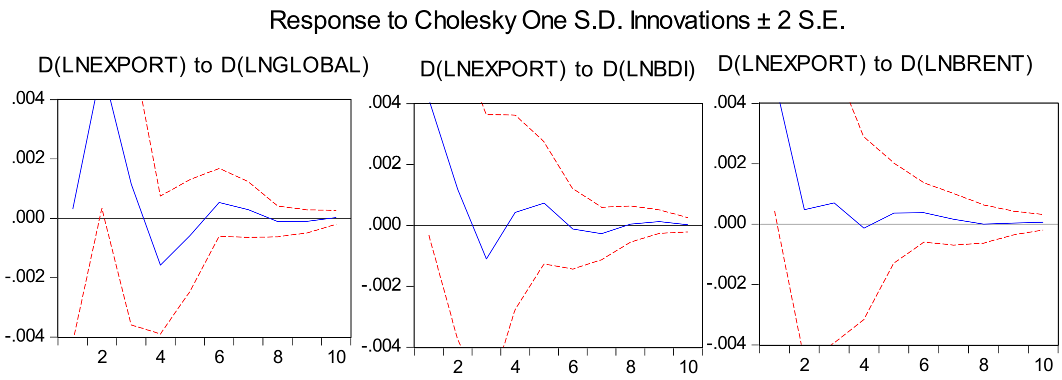


Included observations: 92 2007-2014
Standard errors in ( ) & t-statistics in [ ]

	D(LNGLOBAL)	D(LNBDI)	D(LNBRENT)	D(LNEXPORT)
D(LNGLOBAL(-1))	-0.180580	0.318248	0.601597	0.811738
	(0.10474)	(3.88931)	(1.19428)	(0.36412)
	[-1.72413]	[0.08183]	[0.50373]	[2.22932]
D(LNGLOBAL(-2))	-0.108122	-1.596926	-0.879150	0.063176
	(0.10415)	(3.86765)	(1.18763)	(0.36209)
	[-1.03811]	[-0.41289]	[-0.74025]	[0.17447]
D(LNBDI(-1))	0.003541	0.123090	-0.003847	8.34E-05
	(0.00302)	(0.11206)	(0.03441)	(0.01049)
	[1.17330]	[1.09846]	[-0.11181]	[0.00795]
D(LNBDI(-2))	0.006125	-0.185996	-0.013769	-0.005670
	(0.00297)	(0.11026)	(0.03386)	(0.01032)
	[2.06280]	[-1.68693]	[-0.40668]	[-0.54926]
D(LNBRENT(-1))	0.008486	0.560575	0.274424	-0.016804
	(0.01001)	(0.37165)	(0.11412)	(0.03479)
	[0.84787]	[1.50835]	[2.40466]	[-0.48295]
D(LNBRENT(-2))	-0.012187	0.230300	0.252080	0.027731
	(0.00982)	(0.36457)	(0.11195)	(0.03413)
	[-1.24130]	[0.63170]	[2.25174]	[0.81248]
D(LNEXPORT(-1))	-0.049716	3.756941	1.359424	0.342885
	(0.03162)	(1.17413)	(0.36054)	(0.10992)
	[-1.57237]	[3.19976]	[3.77053]	[3.11932]
D(LNEXPORT(-2))	0.051629	1.077351	0.357079	-0.258136
	(0.03404)	(1.26394)	(0.38812)	(0.11833)
	[1.51683]	[0.85237]	[0.92003]	[-2.18147]
C	0.001651	-0.039677	-0.009970	0.001986
	(0.00070)	(0.02604)	(0.00800)	(0.00244)
	[2.35450]	[-1.52377]	[-1.24689]	[0.81465]
R-squared	0.205557	0.268857	0.379471	0.191724
Adj. R-squared	0.128984	0.198385	0.319661	0.113817
Sum sq. resids	0.003194	4.403912	0.415251	0.038600
S.E. equation	0.006203	0.230346	0.070732	0.021565
F-statistic	2.684461	3.815101	6.344606	2.460955
Log likelihood	341.8027	9.265245	117.8881	227.1676
Akaike AIC	-7.234841	-0.005766	-2.367132	-4.742774
Schwarz SC	-6.988145	0.240931	-2.120435	-4.496077

Mean dependent	0.001155	-0.020090	-0.002359	0.003450
S.D. dependent	0.006647	0.257275	0.085754	0.022908

Determinant resid covariance (dof adj.)	4.11E-12
Determinant resid covariance	2.72E-12
Log likelihood	702.7628
Akaike information criterion	-14.49484
Schwarz criterion	-13.50806



Appendix I: Independent Oil Producer Firms - Panel Model

Symbol	Company Name	Market Cap (Million USD)	Management Ownership	Permian Basin Activity	Bankruptcy Year or Acquisition Events
AXAS	Abraxas Petroleum Corporation	313.3	8.92	1	
AREX	Approach Resources Inc.	285.5	9.10	1	
BBG	Bill Barrett Corporation	455.9	2.44		
BCEI	Bonanza Creek Energy, Inc.	995.5	2.70		
BBEP	BreitBurn Energy Partners, L.P.	1,118.0	1.35		2016
CPE	Callon Petroleum Company	515.8	1.84	1	
CRZO	Carrizo Oil & Gas, Inc.	2,551.5	6.03		
XEC	Cimarex Energy Co	10,855.7	1.60	1	
CWEI	Clayton Williams Energy, Inc.	664.1	51.14		
CRK	Comstock Resources, Inc.	166.1	20.33		
CXO	Concho Resources Inc.	11,824.0	1.16	1	
CLR	Continental Resources Inc.	10,810.0	76.99		2016
DNR	Denbury Resources Inc.	2,505.7	2.04		
EROC	Eagle Rock Energy Partners, L.P.	397.8			Acquired by Vanguard
ESTE	Earthstone Energy, Inc.	287.8	7.23	1	
EOX	Emerald Oil, Inc.	39.6	2.35		2016
EGN	Energen Corporation	4,974.3	0.62	1	
EXXI	Energy XXI Ltd.	314.5	3.03		2016
EPM	Evolution Petroleum	250.4	10.73		
GDP	Goodrich Petroleum Corporation	154.9	15.70		2016
HK	Halcon Resources Corporation	684.8	2.53		2016
LPI	Laredo Petroleum, Inc.	2,964.4	1.22	1	
LGCY	Legacy Reserves LP	673.4	7.23		
LINE	Linn Energy, LLC	3,537.3	0.85	1	2016
LRE	LRR Energy, L.P.	217.3		1	Acquired by Vanguard
MCEP	Mid-Con Energy Partners, LP	169.0	7.10	1	
MUR	Murphy Oil Corporation	7,560.1	5.65		
NFX	Newfield Exploration Company	5,885.3	0.88		
NOG	Northern Oil and Gas, Inc.	431.3	8.77		
OAS	Oasis Petroleum Inc.	2,273.1	3.24	1	
PE	Parsley Energy, Inc.	2,492.7	16.40	1	
PVA	Penn Virginia Corporation	322.3	1.31	1	2016
PNRG	PrimeEnergy Corporation	138.4	47.23	1	
QEP	QEP Resources, Inc.	3,305.3	0.78		
REN	Resolute Energy Corporation	81.3	14.91	1	
SD	Sandridge Energy Inc.	566.3	0.94	1	2016
SM	SM Energy Company	3,322.6	1.70	1	
SGY	Stone Energy Corporation	768.1	3.59		2016
SFY	Swift Energy Company	97.0	4.61		2016
SYRG	Synergy Resources Corporation	1,195.7	9.72		
TPLM	Triangle Petroleum Corporation	382.2	2.50		2016
VNR	Vanguard Natural Resources LLC	1,267.0	1.03	1	
WRES	Warren Resources, Inc.	60.9	6.45		2016
WLL	Whiting Petroleum Corporation	6,591.2	0.03	1	

Appendix J: Firms used in OPEC Event Study Analysis

Portfolio	Symbol	Company Name
SME Independents	CLRX	Continental Resources Inc.
	DNR	Denbury Resources Inc.
	EGN	Energen Corporation
	HK	Halcon Resources Corp.
	LPI	Laredo Petroleum, Inc.
	MUR	Murphy Oil Corporation
Oil Majors	APA	Apache Corporation
	BP	British Petroleum, p.l.c.
	CABOT	Cabot Oil & Gas Corporation
	CVX	Chevron Corporation
	DVN	Devon Energy Corporation
	EQT	EQT Corporation
	MRO	Marathon Oil Corporation
	OXY	Occidental Petroleum Corporation
	RDS	Royal Dutch Shell plc
	XOM	Exxon Mobil Corporation

Appendix K: Robustness Testing for Event Study Windows

MEAN Approach Shorter Event Test Window					Portfolio Matching Approach Shorter Event T				
N	OIL MAJORS	SME IND+	EM IMPORTER	EM EXPORTER		OIL MAJORS	SME IND+	EM IMPORTER	EM EXPORTEI
CAR-5	-0.09%	-0.11%	-0.10%	0.15%	CAR-5	-0.17%	0.00%	-0.19%	0.05%
CAR-4	-0.03%	-0.05%	-0.42%	0.52%	CAR-4	-0.29%	-0.01%	-0.80%	0.14%
CAR-3	0.02%	0.34%	-0.88%	0.75%	CAR-3	-0.32%	0.25%	-1.32%	0.31%
CAR-2	0.07%	0.26%	-0.47%	0.59%	CAR-2	-0.54%	0.21%	-0.92%	0.14%
CAR-1	0.09%	0.37%	-0.30%	0.71%	CAR-1	-0.69%	0.32%	-0.83%	0.18%
CAR 0	**-0.12%**	**-2.67%*****	**-0.44%**	**-0.59%*****	**CAR 0**	**-0.80%**	**-2.26%*****	**-0.40%**	-0.54%***
CAR1	-0.15%	-2.87%***	-0.76%	-0.96%**	CAR1	-0.55%	-2.40%***	-0.62%	-0.82%***
CAR2	-0.13%	-2.75%***	-1.15%	-1.54%**	CAR2	-0.59%	-2.21%***	-1.00%	-1.39%***
CAR3	-0.05%	-2.66%***	-1.00%	-1.32%**	CAR3	-0.63%	-1.98%***	-1.08%	-1.40%***
CAR4	-0.05%	-2.56%***	-0.99%	-1.56%**	CAR4	-0.70%	-2.03%***	-1.01%	-1.59%***
CAR5	0.10%	-2.94%***	-1.22%	-2.14%**	CAR5	-0.83%	-2.28%***	-0.78%	-1.70%***
CAR6	0.17%	-3.91%***	-1.02%	-2.76%**	CAR6	-0.79%	-2.64%***	-0.02%***	-1.75%***
CAR7	0.11%	-4.70%***	-0.83%	-3.38%**	CAR7	-0.91%	-2.93%***	1.09%***	-1.46%***
CAR8	0.17%	-5.15%***	-0.35%	-3.63%**	CAR8	-0.87%	-3.29%***	1.74%***	-1.54%***
CAR9	0.14%	-5.87%***	-0.74%	-5.53%***	CAR9	-1.08%	-3.39%***	2.68%***	-2.11%***
CAR10	0.15%	-6.39%***	-0.70%	-7.22%***	CAR10	-1.11%	-3.66%***	3.76%***	-2.76%***

+SME Independents

Significance: * at 10% level, ** at 5% level, *** at 1% level.

MEAN Approach Longer Event Test Window						Portfolio Matching Approach Longer Event Test Window			
N	OIL MAJORS	SME IND [+]	EM IMPORTER	EM EXPORTER		OIL MAJORS	SME IND [+]	M IMPORTER	M EXPORTER
CAR-20	0.09%	-0.05%	0.11%	0.17%	CAR-20	0.06%	-0.19%	-0.19%	-0.13%
CAR-19	0.08%	0.08%	-0.20%	0.15%	CAR-19	0.00%	-0.03%	-0.48%	-0.13%
CAR-18	0.08%	0.12%	0.04%	0.39%	CAR-18	0.11%	-0.10%	-0.35%	0.01%
CAR-17	0.14%	-0.01%	0.01%	0.21%	CAR-17	0.17%	-0.35%	-0.35%	-0.16%
CAR-16	-0.03%	-0.44%	-0.49%	-0.29%	CAR-16	0.06%	-0.59%	-0.58%	-0.38%
CAR-15	-0.04%	-0.32%	-0.66%	-0.32%	CAR-15	0.06%	-0.55%	-0.69%	-0.35%
CAR-14	-0.06%	-0.40%	-1.29%	-0.55%	CAR-14	0.16%	-0.69%	-1.20%	-0.47%
CAR-13	0.11%	-0.49%	-1.17%	-0.86%	CAR-13	0.15%	-0.64%	-0.92%	-0.61%
CAR-12	0.03%	-0.36%	-0.78%	-0.43%	CAR-12	0.24%	-0.62%	-0.67%	-0.32%
CAR-11	-0.02%	-0.62%	-1.64%	-0.56%	CAR-11	0.20%	-0.86%	-1.47%	-0.38%
CAR-10	0.02%	-0.99%	-2.26%	-0.70%	CAR-10	0.29%	-1.11%	-2.02%	-0.45%
CAR-9	0.06%	-1.02%	-2.11%	-1.13%	CAR-9	0.24%	-0.94%	-1.78%	-0.80%
CAR-8	0.04%	-0.97%	-1.60%	-1.34%	CAR-8	0.37%	-0.79%	-1.17%	-0.91%
CAR-7	0.04%	-1.82%	-1.40%	-1.41%	CAR-7	0.39%	-1.47%	-0.98%	-0.99%
CAR-6	-0.05%	-2.05%	-0.83%	-1.45%	CAR-6	0.46%	-1.51%	-0.55%	-1.16%
CAR-5	-0.13%	-2.17%	-0.93%	-1.30%	CAR-5	0.29%	-1.50%	-0.74%	-1.11%
CAR-4	-0.08%	-2.10%	-1.25%	-0.93%	CAR-4	0.17%	-1.52%	-1.35%	-1.03%
CAR-3	-0.03%	-1.71%	-1.71%	-0.70%	CAR-3	0.14%	-1.26%	-1.87%	-0.86%
CAR-2	0.02%	-1.80%	-1.30%	-0.86%	CAR-2	-0.08%	-1.30%	-1.47%	-1.03%
CAR-1	0.04%	-1.69%	-1.13%	-0.74%	CAR-1	-0.23%	-1.18%	-1.38%	-0.98%
CAR 0	**-0.16%**	**-4.72%*** **	**-1.27%**	**-2.04%*** **	**CAR 0**	-0.33%	-3.76%***	-0.95%	-1.71%***
CAR1	-0.20%	-4.92%***	-1.59%	-2.41%**	CAR1	-0.09%	-3.91%	-1.17%	-1.99%***
CAR2	-0.17%	-4.81%***	-1.98%	-2.99%**	CAR2	-0.13%	-3.72%	-1.55%	-2.56%***
CAR3	-0.10%	-4.71%***	-1.83%	-2.77%**	CAR3	-0.17%	-3.49%	-1.63%	-2.57%
CAR4	-0.10%	-4.61%***	-1.82%	-3.01%**	CAR4	-0.24%	-3.54%	-1.56%	-2.75%
CAR5	0.05%	-4.99%***	-2.05%	-3.59%**	CAR5	-0.37%	-3.78%	-1.33%	-2.86%
CAR6	0.12%	-5.96%***	-1.86%	-4.21%**	CAR6	-0.33%	-4.15%***	-0.56%**	-2.92%
CAR7	0.07%	-6.75%***	-1.67%	-4.83%**	CAR7	-0.44%	-4.44%***	0.55%**	-2.62%
CAR8	0.13%	-7.20%***	-1.19%	-5.08%**	CAR8	-0.40%	-4.80%***	1.19%**	-2.70%
CAR9	0.09%	-7.92%***	-1.58%	-6.98%***	CAR9	-0.62%	-4.90%***	2.13%**	-3.28%***
CAR10	0.10%	-8.45%***	-1.53%	-8.67%***	CAR10	-0.65%	-5.17%***	3.21%**	-3.93%***
CAR11	0.17%	-8.47%***	-1.57%	-9.92%***	CAR11	-0.58%	-4.45%***	4.10%**	-4.25%***
CAR12	0.12%	-8.21%***	-1.12%	-7.47%***	CAR12	-0.42%	-4.79%***	2.92%**	-3.43%***
CAR13	-0.22%	-7.49%***	-1.19%	-6.24%***	CAR13	-0.62%	-4.85%***	1.57%**	-3.48%
CAR14	-0.10%	-8.17%***	-1.48%	-5.08%***	CAR14	-0.75%	-5.85%***	0.60%**	-2.99%
CAR15	-0.01%	-8.04%***	-1.57%	-4.41%***	CAR15	-0.87%	-5.93%***	0.24%**	-2.60%
CAR16	-0.22%	-7.21%***	-1.62%	-4.34%	CAR16	-0.66%	-5.37%	0.00%	-2.72%
CAR17	-0.16%	-7.00%	-1.53%	-4.44%	CAR17	-0.72%	-5.21%	0.11%	-2.80%
CAR18	-0.16%	-7.01%	-1.58%	-4.51%	CAR18	-0.82%	-5.24%	0.07%	-2.86%
CAR19	-0.08%	-7.20%	-1.81%	-4.58%	CAR19	-0.90%	-5.37%	-0.10%	-2.87%
CAR20	-0.08%	-7.41%	-2.36%	-5.08%	CAR20	-0.98%	-5.55%	-0.50%	-3.22%
CAR21	-0.06%	-7.40%	-2.39%	-5.14%	CAR21	-0.99%	-5.50%	-0.51%	-3.27%
CAR22	0.11%	-7.37%	-2.41%	-5.57%	CAR22	-1.11%	-5.44%	-0.47%	-3.63%
CAR23	0.28%	-8.49%	-2.54%	-6.61%	CAR23	-1.37%	-6.30%	0.10%	-3.97%
CAR24	0.35%	-8.77%	-2.46%	-7.63%	CAR24	-1.52%	-6.15%	0.81%	-4.36%
CAR25	0.34%	-8.99%	-1.99%	-7.25%	CAR25	-1.58%	-6.43%	0.88%	-4.38%
CAR26	0.22%	-8.09%	-1.77%	-6.69%	CAR26	-1.29%	-5.75%	0.58%	-4.34%
CAR27	0.42%	-8.03%	-2.35%	-7.39%	CAR27	-1.27%	-5.70%	0.30%	-4.74%
CAR28	0.41%	-8.40%	-2.67%	-8.01%	CAR28	-1.54%	-5.93%	0.33%	-5.01%
CAR29	0.42%	-8.66%	-2.13%	-8.08%	CAR29	-1.50%	-6.03%	0.84%	-5.12%
CAR30	0.42%	-8.66%	-2.13%	-8.08%	CAR30	-1.63%	-5.97%	0.73%	-4.52%

[+] SME Independents

Significance: * at 10% level, ** at 5% level, *** at 1% level.

Appendix L: Chapter 6 Regression Diagnostics

OLS Regression for Hedge Ratio Production and BV Reserve/MV Equity

regress STOCK_RETURN SP500_QRETURN WTI_RETURN HEDGE_PROD_ROIL BVRES_MVE_ROIL HH_RETURN

Source	SS	df	MS		
Model	24.0323091	5	4.80646182	Number of obs =	721
Residual	248.581308	715	0.347666165	F(5, 715) =	13.82
				Prob > F =	0.0000
				R-squared =	0.0882
Total	272.613617	720	0.378630024	Adj R-squared =	0.0818
				Root MSE =	0.58963

STOCK_RETURN	Coef.	Std. Err.	t	P>|t|	[95% conf interval]	
SP500_QRETURN	0.0122808	0.0039005	3.15	0.002	0.0046229	0.199386
WTI_RETURN	0.4534573	0.2264974	2.00	0.046	0.0087777	0.8981368
HEDGE_PROD_ROIL	-0.2266811	0.2242235	-1.01	0.312	-0.6668962	0.213534
BVRES_MVE_ROIL	0.0568303	0.0219784	2.59	0.010	0.0136804	0.0999802
HH_RETURN	0.1357631	0.1594698	0.85	0.395	-0.1773218	0.4488481
_cons	-0.0151477	0.0258772	-0.59	0.558	-0.0659522	0.0356568

REGRESSION Diagnostics

Leverage Variable influence results (collinearity test)

Variable	VIF	1/VIF
WTI_RETURN	2.57	0.389175
HEDGE_PROD_ROIL	2.05	0.488228
BVRES_MVE_ROIL	1.27	0.787843
SP500_QRETURN	1.26	0.792195
HH_RETURN	1.06	0.946139
Mean VIF 1.64		

Residual test for Normality: LARGE skew and kurtosis present

	Percentiles	Smallest		
1%	-0.6597875	-1.01159		
5%	-0.3392935	-0.966517		
10%	-0.2794241	-0.9401304	Obs	721
25%	-0.1516931	-0.8793603	Sum of Wgt.	721
50%	-0.0383423		Mean	-3.72E-10
		Largest	Std Dev.	0.58758
75%	0.0670467	2.844502		
90%	0.2179588	5.757221	Variance	0.34525
95%	0.3387231	6.838637	Skewness	13.15501
99%	0.8186193	11.15399	Kurtosis	219.8507

Shapiro-Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
r	721	0.222	364.405	14.408	0.0000

FIXED EFFECT PANEL Diagnostics

Hausman Test - confirm fixed effect

	Coefficients			
	Fixed	Random	Diff	SE
LOG_TA	-0.3717935	0.3579938	-0.7297872	0.2724513
ROA	0.0447609	0.0579525	-0.0131916	
HEDGE_PROD	0.8930857	0.7775739	0.1155118	0.0686852
CAPEX_TA	0.4843478	0.0096425	0.4747052	0.2039591
OPSEXP_SHARE	-0.0762954	-0.0585519	-0.0177435	0.0037254
D/E	-0.0140155	-0.0152836	0.0012681	0.000332

Reject null hypothesis - - confirmation fixed effect approach

Prob>chi2 = 0.0001

Appendix M: Hedge Ratio: Oil hedges to Oil Production conditional on Permian Basin