Sources of Independent and Major Market and Commodity Returns around the Time of Hydraulic Fracking and Horizontal Drilling Revolution: A Differences-in-Decompositions Approach

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Abstract: Fracking and unconventional drilling have revolutionized international oil and natural gas production. Fracking increases the likelihood of well completion and decreases oil and gas equity and commodity market risk. Independent returns increased, while Major returns decreased. Independents are more likely to adapt new technologies, and their decrease in owner wealth after the fracking revolution were smaller than majors. Independent equity returns across groups were higher after the transition than Majors both across and within groups. Fracking technology increased the likelihood of successful well completion, and with lower financial market risk, equity returns decreased in the post-fracking period.

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I. Introduction

After a decade where oil and gas production were decried as in decline, hydraulic fracturing (fracking) and horizontal drilling techniques revolutionized crude and natural gas production. Hydraulic fracturing is forcing a liquid, principally water combined with other materials, into a wellbore under high pressure to create deep-rock formation fractures that more efficiently recovers oil and natural gas (EIA, Natural Gas, 2018, See Jet citation). When pressure from injected material into a well-bore is reduced, formations with injected proppants attempt to settle into pre-fracking formations (NETL, Enhanced Oil Recovery); however, fractures are kept open, which allows encased hydrocarbons to flow more freely from rock formations into the well-bore and increases well productivity (Zimmerman, 2013; EIA Fracking, ???). This hydraulic fracturing now dominates US oil and gas production and currently makes up about two thirds of natural gas and over half of US oil production (EIA, 2016 Today in Energy). Once dominated by large state-owned producers, private fracking has also transformed the international oil and gas industry. To evaluate how fracking affected oil and gas recovery, the industry is partitioned here into large integrated firms—Majors—and smaller rivals—Independents—and the fracking to evaluate how horizonal drilling revolutions have affected the industry along firm-size.

Oil and gas were traditionally extracted through vertical drilling techniques, where a well is drilled vertically from the surface into an oil formation. For many decades, it was known that horizontal drilling and unconventional methods in oil and gas recovery could increase production. The onset of modern fracking began in the 1940s, when Floyd Farris of Stanolind Oil and Gas undertook a systematic study of the relationship between oil and gas pressure and production in a well. Interest vacillated with unconventional drilling techniques in the Barnett Shale and with his effort in natural gas, George P. Mitchell created novel techniques that influenced the recovery of petroleum products (Zimmer, 2013). Harold Hamm extended unconventional techniques to crude oil in the Bakken formation into large-scale shale oil recovery, which revolutionized crude oil production. Hydraulic fracturing and horizontal drilling are now standard techniques in oil and natural gas production, adopted by firms throughout the industry.

The oil and gas industry is characterized by scale, with various periods when production is fragmented, followed by periods of mergers and consolidation.[1] In the United States, much of this industry structure developed with Standard Oil during the 19th century that led to the Majors, which are the largest integrated oil and gas producers. Although membership in the Majors varies over time, the five largest Majors with primary operations in the United States are British Petroleum, Chevron, ConocoPhillips, Exxon Mobile, and Royal Dutch Shell. The oil and gas industry is evolving, and the Independents considered here are those listed on the S&P 500 between 2008 and 2018, when the use of fracking techniques proliferated across the oil and gas industry. Independents include Apache, Anadarko, Baker Hughes, Cabot, Cimarex, Concho, Devon, EOG, Haliburton, Hemerich & Payne, HES, Holly Frontier, Kinder Morgan, Marathon

[1] Cabot and Cimarex

Oil, Marathon Petroleum, National Oilwell Varco, Newfield Exploration, Occidental, OneOK, Pioneer, Schlumberger, TechnipFMC, Valero, and Williams Companies. The Majors are large producers involved in every stage of oil and gas recovery, whereas Independents only occupy specific segments of the industry.

It is against this backdrop that three questions are considered about the oil and gas industry, market returns, and the fracking revolution. First, with the advent of new recovery techniques, how were Independent and Major firm-level equity returns related to market and commodity excess return variation? Independents are more likely to adapt new technologies, and their decrease in owner wealth after the fracking revolution were smaller than majors. Second, using a difference-in-decompositions approach, what were the sources of the change in equity return differences across and within groups? Independent equity returns across groups were higher after the transition than Majors both across and within groups.

II. Literature Review

There is a long-standing debate regarding the 1973 through 1979 oil supply shocks and their relationship with macroeconomic activity. Prior to 1972, all but one of the US post World War II recessions were preceded by a sharp increase in the price of petroleum (Hamilton, 1983, p. 228). The initial explanation between oil prices and macroeconomics was that the Organization of Petroleum Exporting Countries (OPEC) exogenously restricted the amount of oil exported to the US and Western economies (Hamilton, 1983, p. 247; Yergin, 1992). However, recent research emphasizes that oil demand shocks are combined with constrained supply, rather than only exogenous supply disruptions, and all major oil price shocks coincide with combined strong oil demand and supply constraints (Kilian, 2008, p. 903). Nonetheless, supply expectations play a role, and changes in oil supply expectations are related to oil prices and the

macroeconomy. Adverse oil announcements immediately increase oil prices, with a gradual decrease in oil production and increase in oil inventories. This has implications for the larger macroeconomy. As economic activity decreases, price and inflation expectations increase, while the dollar depreciates, indicating a strong supply chain reaction through constrained expectations (Känzig, 2021, p. 1092). Oil price variation, in turn, affects expectation uncertainties that are associated with future supply, which increases demand's precautionary motive. These expectation-based precautionary demand shocks may have immediate and large effects on US economic output (Kilian citations). Moreover, gasoline and crude prices may move in opposite directions, and it is oil price shocks that affect economic output through consumer and producer expectations and expenditures.[2]

Concern over oil's relationship with equity market performance and individual oil and gas producer returns attracts attention. Markowitz (1952) was the first to offer a mean-variance explanation for the relationship between returns and modern portfolio theory. Sharpe (1964), Litner (1965), and Mussin (1966) use mean-variance analysis to develop a single factor pricing

[2] The oil and gas fracking revolutions have also attracted attention in the economics literature. Bartik, Currie, Greenstone, and Knittel (2019) use county-level data for the largest oil and gas producing regions associated with hydraulic fracking and show geographic regions with large fracking plays leads to considerable oil and gas recovery with improvements in economic variables. County total income increased between 3.3 and 6.1 percent. County employment growth increased from 3.7 to 5.5 percent, and housing prices increased by 5.7 percent as a result of fracking in a county. Household willingness to pay for county fracking developments is about $2,500 or 4.9 percent of average income in affected counties (Bartik, Currie, Greenstone, and Knittel, 2019, p. 152). Subsequently, the relationships and macroeconomic activity and the price of energy with their relationship to oil and gas equity returns are important and long-standing debates in the economic literature.

model (Fama and French, 2004). After considerable empirical shortcomings in the original CAPM, Fama-French (1993) offer an improvement over the original single asset pricing model that includes small-minus-big and high-minus-low. Carhart (1997) adds a momentum effect to show that performance in one period are related to other period's performance. Manning (1991) was among the first to evaluate London oil producer equity returns and find that oil and equity returns are positively related, and British firm returns in exploration & production were larger than integrated oil producers. Goodwin (1993) considers US oil price variation on equity returns around the 1973 oil embargo and finds that oil price variation had positive, significant effects in refining and production. Rajgopasl (1999) demonstrates that oil and gas exposure is associated with expectations, while Faff and Brailsford (1999) illustrate the effect of oil price changes on Australian oil producer returns. Sodarsky (2001) illustrates that Canadian oil and gas producer returns were positively related to equity returns. Along with broader market measures for the S & P 500, size, value, and momentum, Mohanty and Nandha (2011) use a four factor Fama-French model to show that US oil price changes are significant for producer returns, and US oil producer returns varied considerably over time and across the industry. Carson (2020) considers Independent and Major oil and gas returns and finds that Major equity market exposure was lower than Independents. Majors were not as exposed to oil price variation, while Independent returns are positively related to size and value effects and inversely related to momentum. Subsequently, the effect of oil price variation has a long history associated with macro and industrial economics.

III. Data

Data to evaluate oil and gas returns are partitioned into Independents and Majors, and include firm daily returns between July 2008 and August 2018. Daily S&P 500 returns are the

measure for daily equity market returns. Daily oil returns are measured with West Texas Intermediate (WTI) crude. Natural gas daily returns are measured with prices at Henry Hub, which is the Louisiana Gulf coast natural gas pipeline delivery point for futures contracts on the New York Mercantile Exchange. Fama-French daily small-minus-big is the size effect, and their high-minus-low is the value effect.[3] Carhart's (1997) momentum factor augments these oil asset pricing models.

[Insert Table 1 here]

Evaluating Independent and Major returns and standard deviations indicate the value added to stockholders relative to holding underlying crude oil and natural gas. Large integrated Majors have operations in each part of the oil and gas industry, and their operations are diversified along upstream, midstream, and downstream production relative to Independents, who focus more narrowly on specialized oil and gas sectors. Between July 2008 and August 2018, Majors have lower average daily returns at -1.0^{-5}, with a standard deviation of .01803 (Table 1). Independent average daily returns over the period is 6.4^{-5}, but have a higher standard deviation at .02718, which is consistent with standard asset pricing models.

Holding individual Independent and Major equities may be riskier than holding oil and natural gas as raw commodities. Between 2008 and 2018, oil average return is 3.8^{-5}, with a standard deviation of .02496. Natural gas is an alternative to holding crude and crude equities, and daily average natural gas average returns are higher than equities and crude at .00044 but has a higher standard deviation at .045137. This risk-reward trade-off is measured by Sharpe Ratios, and between 2008 and 2018, markets priced returns in the oil and gas industry with the highest

[3] Provide Fama and Frence website for SMB and HML.

Sharpe ratios for natural gas, followed by Independents (Table 1). Crude oil has lower excess returns relative to risk; however, the lowest excess return to risk is holding Major equities. Subsequently, natural gas expected daily returns are higher than crude; nonetheless, natural gas standard deviations and risk are the highest in the oil and gas industry, and during the early 2000s, risk and returns were lower for holding Major equities.

To evaluate Independent and Major returns before and after the fracking revolution, firms are partitioned have between pre and post fracking periods. A considerable amount of the fracking revolution occurred between 2013 and 2014, and by 2015, many of the fracking gains were integrated into firm and market returns. Subsequently, the pre-fracking period is from 2008 through 2012; the fracking revolution is omits there 2013 and 2015 period, while the post-fracking period is from 2015 through 2018 (Wethe, 2019).

[Insert Table 2 here]

The pre-fracking Independent rate of return is 4.04^{-4}, with a standard deviation of .031 (Table 2. The post-fracking Independent rate of return is -4.21^{-4}, with a standard deviation of .020. Independent average excess returns decreased by over 200 percent, and average excess return's standard deviation decreased by around 33 percent. The pre-fracking Major daily rate of return is 1.50^{-4}, with a standard deviation of .024016. The post-fracking Major rate of return is -.002, with a standard deviation of .015. After the fracking revolution, negative Major returns were lower than before these technologies became prominent, and average Major standard deviation decreased by around 43 percent with the fracking revolution. Subsequently, both Major and Independent excess returns and standard deviations decreased with hydraulic fracturing and unconventional drilling techniques and the return-risk relationship decreased more for the Majors (Delitte, 2021, p. 19).

IV. Independent and Major Return Variation with Market and Commodity Risk

Evaluating individual-level Independent and Major returns related to market, commodity, size, value, and momentum effects lends insight into processes associated with the oil and gas industry before and after the fracking revolution. Pre- and post- fracking return models illustrate differences are attributable to changes in various market characteristics; however, equity and commodity market risks are greater than size, value, and momentum (Table 2).

$$\left(R_{it}-R_{ft}\right)_t^j=\theta_0^j+\theta_1^j\left(R_{mt}-R_{ft}\right)^j+\theta_2^j\left(R_{ot}-R_{ft}\right)^j+\theta_3^j\left(R_{gt}-R_{ft}\right)^j+\theta_4 SMB_t^j+\theta_5 HML_t^j+\theta_6 MOM_t^j+\varepsilon_t^j$$

(Equation 1)

R_{it} is an oil company's daily returns in the j[th] post-pre fracking period. R_{ft} is the daily risk-free return on United States three-month Treasury Bills. θ_1^j is the sensitivity for S&P 500 market (systematic) risk firm excess return variation in the j[th] period. R_{ot} is the daily return on West Texas Intermediate crude. θ_2^j is how a firm's excess rate of return varies in the j[th] period with excess returns on West Texas Intermediate crude. θ_3^j is a company's daily excess return with natural gas excess before and after fracking. SMB_t, HML_t, and MOM_t are daily Fama-French small-minus-big, high-minus-low, and momentum factors in the pre-post fracking periods. θ_4^j, θ_5^j, and θ_6^j are how oil company's excess returns vary with respect to small-minus-big, high-minus-low, and momentum factors in the pre-post fracking periods, respectively. ε_t^j is the error term. Independent and Major GARCH model coefficients and

characteristics are estimated for each time period and averaged across post and pre-fracking characteristics (Ng and Lam, 2006).[4]

[Insert Tables 3 and 4 here]

Tables 3 and 4 present Independent and Major excess return models before and after the hydraulic-fracturing revolution. An important interpretation for CAPM-based models is that firms' excess return spreads are proportional to market excess return spreads, and Independent and Major excess returns are explained by market and commodity return variations, size and value, but not momentum. Before and after the fracking revolution. The average Independent equity quantity of risk was greater than Majors (Tables 2, 3, and 4). Average Independent's equity market quantity of risk decreased with the fracking revolution, decreasing with the fracking revolution from 1.258 to 1.022, an 18.7 precent decrease. The average Major equity market quantity of risk only decreased from .888 to .835, a 5.2 percent decrease. With fracking, the average Independent's oil quantity of risk decreased by 19 percent, while the average Major oil risk premium decreased by only 5.2 percent. The Independent average oil returns risk premium increased by 17.9 percent, while the Major's average oil risk premium more than doubled. Majors—such as Exxon and Chevron—produce a considerable amount of natural gas, and their returns before and after fracking increased by 52.3 percent. On the other hand after the fracking transition, the average Independent natural gas risk premium decreased by over 41.8 percent.

Although not as large, small-minus-big, high-minus-low, and momentum return factors changed with the fracking revolution. The Independent size quantity of risk nearly doubled with

[4] GARCH models are also condemned because their standard errors are not accurately estimated (Nwogugu, 2006).

fracking and unconventional recovery, while the Major size effect decreased by 60 percent. The transition also changed Independent and Major value effects. Although they were small, the average Independent value effect decreased by nearly a factor of five, whereas the Major's value effect decreased by a factor of less than a factor of four. The average Independent returns to momentum increased by nearly a factor of eight, while the average Major return's momentum decreased by 270 percent. Subsequently, the fracking and unconventional recovery transition decreased returns to Independent equity market returns by more than the Majors equity market decrease, and both Major and Independent oil returns increased with the transition by 100.2 and 17.9 percent respectively.

V. An Independent-Major Fracking Transition Difference-in-Decompositions

A Blinder-Oaxaca decomposition is a statistical technique used to isolate differences between two dependent variables into structural and compositional effects (Blinder, 1973; Oaxaca, 1973; Schneewiess, 2011). A difference-in-difference estimator is a popular method in the quasi-experimental literature to isolate causal mechanisms using only observational data (Card and Krueger, 1993). Blinder-Oaxaca decompositions and a difference-in-difference estimator are combined here into a difference-in-decompositions to separate Independent and Major returns into structural and compositional effects before and after the hydraulic-fracturing and unconventional drilling revolution (Carson, 2018; Carson, 2019, Carson, 2020).

5.1 Model

Across and within group, Independent and Major differences-in-decompositions are constructed before and after the development of unconventional recovery techniques. Let linear Independent and Major return vectors be estimated with GARCH model coefficients in Tables 3

and 4 and expressed as returns to characteristics and average characteristics before and after fracking.

Model 1

$$R_i^{pre} = \theta_i^{pre} + \theta_i^{pre} X_i^{pre} \qquad \text{(Equation 1)}$$

Model 2

$$R_m^{pre} = \theta_m^{pre} + \theta_m^{pre} X_m^{pre} \qquad \text{(Equation 2)}$$

Model 3

$$R_i^{post} = \theta_i^{post} + \theta_i^{post} X_i^{post} \qquad \text{(Equation 3)}$$

Model 4

$$R_m^{post} = \theta_m^{post} + \theta_m^{post} X_m^{post} \qquad \text{(Equation 4)}$$

where θ_i^{pre} and θ_m^{pre} are Independent and Major pre-fracking return sensitivity parameters associated with market, oil, natural gas, size, value, and momentum effects. θ_i^{post} and θ_m^{post} are Independent and Major post-fracking autonomous return components. θ_i^{post} and θ_m^{post} are Independent and Major post-fracking sensitivity parameters associated with market, oil, natural gas, size, value, and momentum effects. Changes in these post-pre, Independent-Major return characteristics are modelled with across and within difference-in-decompositions. Unlike a difference-in-difference estimator, the difference-in-decompositions order varies between across and within decompositions. The difference-in-decompositions are first decomposed with Blinder-Oaxaca decompositions and these decompositions are then differenced, creating differences-in-decompositions that are different from difference-in-difference estimators (Wooldridge, 2010, p. 410).

5.2 Across-Group Decompositions

The across-group decomposition isolates factors associated with Independent and Major return differences into structural and compositional effects before and after the fracking revolution. Equation 5 is the across-group difference-in-decompositions for Independents observed at Major returns to average characteristics and Independent returns to characteristics.

$$\left(R_i^{post} - R_m^{post}\right) - \left(R_i^{pre} - R_m^{pre}\right) = \left(\left(\alpha_i^{post} - \alpha_m^{post}\right) - \left(\alpha_i^{pre} - \alpha_m^{pre}\right)\right) + \left(\left(\beta_i^{post} - \beta_m^{post}\right) X_m^{post} - \left(\beta_i^{pre} - \beta_m^{pre}\right) X_m^{pre}\right)$$

$$+ \left(\left(X_i^{post} - X_m^{post}\right) \beta_i^{post} - \left(X_i^{pre} - X_m^{pre}\right) \beta_i^{pre}\right) \qquad \text{(Equation 5)}$$

Equation 6 is the across-group difference-in-decompositions for Independent-Major post-pre fracking differences observed at Independent average characteristics and Major returns to characteristics.

$$\left(R_i^{post} - R_m^{post}\right) - \left(R_i^{pre} - R_m^{pre}\right) = \left(\left(\alpha_i^{post} - \alpha_m^{post}\right) - \left(\alpha_i^{pre} - \alpha_m^{pre}\right)\right) + \left(\left(\beta_i^{post} - \beta_m^{post}\right) X_i^{post} - \left(\beta_i^{pre} - \beta_m^{pre}\right) X_i^{pre}\right)$$

$$\left(\left(X_i^{post} - X_m^{post}\right) \beta_m^{post} - \left(X_i^{pre} - X_m^{pre}\right) \beta_m^{pre}\right) \qquad \text{(Equation 6)}$$

If component values are positive, post-fracking Independent returns are greater than Majors prior to the transition, whereas, if values are negative, pre-fracking Major returns were greater than Independents.

5.3 Within-Group Decompositions

Independent and Major returns are also decomposed into a within-group difference-in-decomposition estimator. Returns are first differenced between Independents and Majors. Equation 7 is the within-group difference-in-decompositions for Independent-Major, post-pre fracking differences observed at pre-fracking average characteristics and post-fracking returns to characteristics.

$$\left(R_i^{post}-R_i^{pre}\right)-\left(R_m^{post}-R_m^{pre}\right)=\left(\left(\alpha_i^{post}-\alpha_i^{pre}\right)-\left(\alpha_m^{post}-\alpha_m^{pre}\right)\right)+\left(\left(\beta_i^{post}-\beta_i^{pre}\right)X_i^{pre}-\left(\beta_m^{post}-\beta_m^{pre}\right)X_m^{pre}\right)$$

$$\left(\left(X_i^{post}-X_i^{pre}\right)\beta_i^{post}-\left(X_m^{post}-X_m^{pre}\right)\beta_m^{post}\right) \qquad \text{(Equation 7)}$$

Equation 8 is the within-group difference-in-decompositions for post-fracking average characteristics and pre-fracking returns to characteristics.

$$\left(R_i^{post}-R_i^{pre}\right)-\left(R_m^{post}-R_m^{pre}\right)=\left(\left(\alpha_i^{post}-\alpha_i^{pre}\right)-\left(\alpha_m^{post}-\alpha_m^{pre}\right)\right)+\left(\left(\beta_i^{post}-\beta_i^{pre}\right)X_i^{post}-\left(\beta_m^{post}-\beta_m^{pre}\right)X_m^{post}\right)$$

$$\left(\left(X_i^{post}-X_i^{pre}\right)\beta_i^{pre}-\left(X_m^{post}-X_m^{pre}\right)\beta_m^{pre}\right) \qquad \text{(Equation 8)}$$

If component values are positive, Independent returns relative to Majors after the transition were greater with the fracking revolution, whereas, if values are negative, Major returns were greater with the fracking revolution.

VI. **Results**

6.1 Independent and Major Across-Group Returns Difference-in-Decompositions

Table 5's Panel A is the across-group Independent-Major post-fracking returns decomposition. Panel B is the Independent-Major pre-fracking across-group returns decomposition. Panel C is the Independent-Major across-group difference-in-decompositions between Panels A and B. Panel C separates Independent-Major across-group post and pre-differences into structural and compositional effects. Elements are percent differences between Independent and Major related to with the transition.

[Insert Table 5 here]

6.2.1 Across-Group Post Fracking Returns

Table 5's Panel A indicates Independents had higher level returns relative to Majors after the fracking transition from all sources. Nevertheless, Independent-Major sources of the post-fracking, returns differences are important. Post-fracking Major returns to equity and commodity market returns were larger than Independents prior to the transition, while Independent returns to average equity values are greater than Majors, off-setting Major structural returns to characteristics. The hydraulic-fracturing and unconventional recovery techniques post-fracking transition increased the returns to natural gas; however, results are mixed between Independent and Major returns to natural gas average characteristics. The transition also affected the size and value effects between Independents and Majors, and equity market, oil, and natural gas small Independent startup returns did better than Majors after the fracking revolution. Nonetheless, the value premium and momentum effects after the transition were greater for Majors than Independents. Returns to momentum and average momentum were greater than before the transition. In sum, after the transition, large, well-capitalized Majors had a larger returns to equities, oil, high-minus-low, and momentum; however, after the fracking transition, Independents had greater returns associated with returns to average characteristics that offset Major returns to characteristics.

6.2.2 Across-Group Pre Fracking Returns

Table 5's Panel B indicates Independent's pre-fracking level returns are greater prior to the development of new drilling techniques. Prior to the fracking revolution, Majors had a larger risk premium associated with equity market and commodity risk relative to Independents than after, and Major return differences were associated with average characteristics that were approximately equal to returns associated with Independents average characteristics. Prior to fracking, the Major quantity of risk associated with crude oil was greater than Independents,

however, were greater for Independent returns to average characteristics. Nevertheless, the fracking transition affected small Independent start-ups, and Majors with embedded stable natural gas recovery processes had greater risk quantities and returns. Prior to the transition, Independent returns associated with the size effect is greater than Majors. Moreover, Independent returns associated with the value effect are small but higher than Majors prior to the fracking transition. Overall, prior to the fracking transition, Major returns to equity and commodity risks were higher prior to the fracking revolution.

6.*2.3* *Across-Group Difference-in-Decompositions*

[Insert Figure 1 here]

Table 5's Panel C and Figure is the Independent-Major returns difference-in-decompositions to the oil and gas producers, and the negative returns component indicates that Independent returns were greater relative to Majors before the adaptation of hydraulic-fracking and unconventional oil and natural gas recovery. Unidentified, pre-fracking sources were the greatest source of variation for the across group pre-fracking transition. Independent equity returns were higher than Majors after the transition, because smaller Independents adopted new technologies more readily than large Majors. Independent returns to characteristics associated with oil and natural gas were also greater than Majors after the transition. Nevertheless after the fracking transition, the returns advantage of Independents with respect to the size and value returns to characteristics were higher prior to the fracking transition, indicating that increase equity returns associated with easier access to oil and gas from technology decreased Independent's profitability from size and value effects. To the degree that momentum affected Independent and Major returns, Independent returns associated with momentum were higher prior to the fracking revolution, indicating that Independent pre-fracking returns were affected

more by returns to characteristics rather than returns to average characteristics, and the fracking revolution considerably changed returns generating processes between Independents and Majors. Figure 1 indicates the magnitude of differences in pre-fracking across-group autonomous return differences were the greatest source of return variation.

6.3 Independent and Major Within-Group Returns Difference-in-Decompositions

6.3.1 Within-Group Independent Returns

Table 6's Panel A is the within-group Independent-Major post-fracking returns decomposition. Panel B is the Independent-Major pre-fracking within-group returns decomposition. Panel C is the Independent-Major within-group difference-in-decompositions between Panels A and B. Panel C separates Independent-Major within-group post and pre differences into structural and compositional returns, and its elements are positive if Independent post-fracking returns were greater than Independent pre-fracking. Components are negative if Major returns were greater, and its elements are percent differences between Independent and Major related to with the transition.

Table 6's Panel A is the Independent within-group decomposition, and from levels, Independent returns before the fracking transition than after the transition. Independent equity returns associated with the S & P 500 were greater before the transition, however, were small and offset by returns to average returns to Independent characteristics after the transition. While small Independent returns after the transition were greater than those before, and like equity returns, Independent returns to average characteristics offset post-fracking returns to crude oil price variation. Results are small and mixed for Independent returns to natural gas; however, before the fracking revolution, Independent returns to the size effect and average characteristics

before the transition were greater than after. Independent returns to the value effect after to the transition were greater than the size effect.

6.3.2 Within-Group Major Returns

Table 6's Panel B is the Major's within-group return decomposition with the fracking transition, and like Independents, Major returns with equities were greater prior to the transition (Tables 2 and 6). Like Independent returns to equity market variation, Major equity returns to the S & P 500 were larger prior to the fracking revolutions, while returns to average S & P 500 were larger after the transition. Within-group returns to natural gas variation are mixed but offset post-fracking returns to average characteristics. The size effect for Major returns to characteristics prior to the transition were larger than after the transition. Before and after the fracking transition, Major returns were positively related to returns to and average returns to the value effect.

6.3.3 Within-Group Difference-in-Decompositions

[Insert Figure 2 here]

Table 6's Panel C and Figure 2 illustrates that the pre-transition Independent within-group returns were greater than the Major returns difference, and from level returns, the within-group pre-transition excess returns gap was larger than the Independents. Nonetheless, within-group component returns were important. Reflecting Independent technology gains with the fracking revolution, Independent producer returns were greater than Majors. Differences in how markets priced Independent returns associated with equity market returns were small but larger prior to the transition and offset by how equity markets priced returns to the average equity returns. Independents returns to oil compared to Majors were also lower after the transition,

indicating that how Majors responded to oil returns is an important reason why Majors were more positively related to the fracking transition. Changes in the market to how Independents within-group were higher with the fracking revolution are explain in a smaller degree by the size and value premiums, while the change in momentum effects are mixed. Figure 2 indicates that post-fracking autonomous return variations favored Independents, while pre-fracking small-minus-big return differences were greater for Majors.

IV. Conclusion

Hydraulic-fracking and unconventional drilling techniques have transformed the oil and gas industry, and whether Independent or Major owners benefited the most with the transition is yet to be considered. On its surface, Independents had greater returns than Majors. However, the source of return variation between Independents and Majors varied with the fracking revolution. The fracking and unconventional recovery transition decreased returns to Independent equity market returns by 29.7 percent, more than the Majors equity market decrease by only 5.2. Major and Independent oil returns increased with the transition by 101.5 and 17.9 percent respectively. From level-returns, pre-transition equity return gaps for Independents were greater than Majors. Nonetheless, decompositions indicate Independent producer returns were greater than Majors. Independent compared to Major oil returns were lower after the transition and demonstrate that Majors were positively related to the fracking revolution.

Within-group decompositions indicate unidentified sources in the intercept were the largest within-group differences. Major within-group returns to equity and commodity return differences were greater than Independents prior to the transition. However, there were sizable post Independent returns to size, value, and momentum effects within-groups with the fracking

revolution. A novel finding with oil and gas return variation is that fracking and unconventional drilling technology increased the likelihood wells are successfully brought into production. With lower risks in physical production, risk is reduced in financial markets, and across oil sectors, expected returns is reduced with fracking. Unconventional recovery techniques decreased the risk of success of well completion, which decreased financial market risk, and with it, decreased expected returns after technological innovations decreased oil field risks.

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Table 1, United States Majors and Independent Descriptive Statistics

	N	*Mean*	*S.D.*	*Sharpe Ratios*
Majors				
Exxon	2,486	-.000371	.015247	-.024
Royal Dutch Shell	2,493	.000375	.018046	.021
British Petroleum	2,469	-.000331	.019200	-.017
Chevron	2,319	-.000115	.017151	-.007
Conoco Phillips	2,493	.000382	.020502	.019
Average		-1.0^{-5}	.01803	-.002
S&P 500				
Apache	2,470	-.000031	.025234	-.001
Anadarko	2,486	.000493	.027733	.018
Baker Hughes	2,486	-.000437	.026302	-.017
Cabot	2,490	.000731	.028935	.025
Cimirex	2,376	.000720	.027404	.026
Concho	2,431	.001022	.030264	.033
Devon	2,310	.000114	.026776	.004
EOG	2,431	.000103	.024479	.004
Halliburton	2,488	-.000200	.025994	-.008
Helmerich & Payne	2,488	-.000056	.028918	-.002
HES	2,404	-.000412	.027389	-.015
Holly Frontier	2,488	.000679	.029280	.023
Kinder Morgan	1,853	-.000605	.017913	-.034
Marathon Oil	2,488	-.000209	.028174	-.007
Marathon Petroleum	1,760	.000486	.021994	.022
National OilWellVarco	2,488	-.000306	.028824	-.011
Newfield Exploration	2,487	-.000301	.031066	-.010
Occidental	2,360	-.000232	.022241	-.010
OneOK	2,488	.000397	.022279	.018
Pioneer	2,488	-.001012	.040606	-.025
Schlumberger	2,488	.000301	.028850	.010
TechnipFMC	2,485	-.000077	.026198	-.003
Valero	2,488	.000349	.025945	.014
Williams Companies	2,486	.000019	.029497	.001
Average		.000064	.027180	.002

Commodities				
Oil	2,486	.000038	.024956	.002
Natural Gas	2,486	.000443	.045137	.010

Source: Major and S & P 500 are calculated from daily adjusted close from the NYSE.

Table 2, Major and Independent Pre and Post Fracking Average Returns, Standard Deviations, and Sharpe Ratios

	Pre-Frack				*Post- Frack*				*Differences*		
Majors	N	Mean	S.D.	Sharpe	N	Mean	S.D.	Sharpe	Δ*Mean*	Δ*SD*	ΔSharpe
Exxon	856	-.000011	.021243	-.00052	1,129	-.000920	.011628	-.07912	-.00091	-.00096	-.07860
Royal Dutch Shell	861	.000549	.024485	.02242	1,131	.000324	.014675	.02208	-.00023	-.00981	-.00034
British Petroleum	851	-.000396	.026285	-.01507	1,123	-.000564	.014976	-.03766	-.00017	-.01131	-.02259
Chevron	851	-.000055	.022183	-.00248	1,122	-.000636	.013699	-.04643	-.00058	-.00848	-.04395
Conoco Phillips	853	.000362	.025881	.01399	644	.000894	.020750	.04308	.00053	-.00513	.02910
Average		-.000090	.024015	.00367		-.000180	.013745	-.01961	-.00009	-.01027	-.02328
S&P 500											
Apache	853	.000212	.030755	.00689	1,120	-.000266	.024128	-.01103	-.00048	-.00663	-.01792
Anadarko	852	.001016	.036942	.02750	1,137	.000188	.023185	.00811	-.00083	-.01376	-.01939
Baker Hughes	853	-.000367	.035442	-.01036	1,127	-.000765	.021064	-.03632	-.00040	-.01438	-.02596
Cabot	851	.001373	.038745	.03544	1,143	-.000187	.021854	-.00856	-.00156	-.01689	-.04399
Cimirex	853	.000777	.034465	.02255	1,032	.000429	.022166	.01935	-.00035	-.01230	-.00319
Concho	853	.002022	.040948	.04938	1,143	.000495	.023640	.02094	-.00153	-.01731	-.02235

Devon	805	.000853	.031481	.02710	1,049	.000125	.026339	.00475	-.00073	-.00514	-.02658
EOG	858	.000172	.032415	.00531	1,072	-.000407	.019133	-.02127	-.00058	-.01328	-..04053
Halliburton	858	.000006	.036113	.00017	1,129	-.000779	.019300	-.04036	-.00079	-.01681	-.04074
Helmerich & Payne	858	.000360	.038331	.00939	1,129	-.000741	.023635	-.03135	-.00110	-.00147	-.03138
HES	849	-.000312	.035750	-.00873	1,091	-.000915	.022813	-.04011	-.00060	-.01294	-.03652
Holly Frontier	858	.001137	.039186	.02902	1,129	-.000171	.022775	-.00751	-.00131	-.01641	-.08066
Kinder Morgan	224	.000367	.017636	.02081	1,128	-.001188	.019850	-.05985	-.00156	-.00221	-.03911
Marathon Oil	858	.000298	.032278	.00923	1,129	-.000865	.028952	-.02988	-.00116	-.00333	-.00586
Marathon Petroleum	130	-.000114	.037378	-.00305	1,129	-.000182	.020417	-.00891	-6.8^{-5}	-.01696	-.05889
National OilWellVarco	858	.000338	.041115	.00822	1,129	-.001052	.020762	-.05067	-.00139	-.02035	-.01222
Newfield Exploration	857	.000027	.038376	.00070	1,129	-.000320	.027782	-.01152	-.00035	-.01059	-.07222
Occidental	847	.000388	.031622	.01227	1,032	-.000886	.014779	-.05996	-.00127	-.01684	-.04704
OneOK	858	.000951	.024963	.03810	1,129	-.000200	.022370	-.00894	-.00115	-.00259	-.04704
Pioneer	857	.000883	.038635	.02286	1,130	.-.00066	.021807	-..03027	-.00154	-.01683	-.05312
Schlumberger	858	-.000292	.031641	-.00923	1,129	-.000973	.014840	-.04724	-.00068	-.01680	-.07621
TechnipFMC	855	.001027	.035446	.02897	1,129	-.000977	.020683	.00578	-.00200	-.01476	.01354

Valero	858	-.000278	.035844	-.00776	1,129	.000103	.017821	.00578	.00038	.00578	-.02531
Williams Companies	858	.000284	.033965	.00836	1,129	-.000524	.030917	-.01695	-.00081	-.00305	-.02531
Average		.000370	.034153	.01346		.000421	.02278	-.02197	-.00075	-.01139	-.03544
Commodities											
S&P 500	851	-.000429	.018386	-.02333	1,123	-.000536	.008019	-.06684	-.00011	-.01037	-.04351
Oil	851	-.000322	.030520	-.01055	1,123	-.000798	.023488	-.03398	-.00048	-.00703	-.02342
Natural Gas	850	-.000379	.043765	-.00866	1,123	.000942	.052415	.01797	.00132	.00865	.02663

Table 3, Independent Pre and Post Fracking Returns and Averages

	Apache		*Anadarko*		*Baker Hughes*		*Cabot*		*Cimirex*	
	Pre-Frack	Post-Frack	Pre-Frack	Post-Frack	Pre-Frack	Post-Frack	Pre-Frack	Post-Frack	Pre-Frack	Post-Frack
Intercept	-.0003	.00027	.00027	-.00005	-.00011	.00028	.00088	-.00055	.00037	.00002
S & P 500	1.18***	1.03***	1.35***	1.125***	1.342***	.90582***	1.425***	.9527***	1.283***	1.310***
Oil	.2011***	.3537	.2401***	.3310***	.243***	.29033***	.31840***	.136645***	.2337***	-.06268***
Natural Gas	.0164	.00271	-.01648*	.0112	.0217	.00776	.01114	.02297**	.01128	.02134*
SMB	.0002	.00300**	.00079	.00300	.00015	.02258*	-.00101	.00437***	.00252***	-.00134
HML	-.0016	.00658***	-.00128*	.0046***	-.00637	.00384**	-.00320	.00005	-.00172*	-.00085
MOM	.0003	-.0010	.00024	-.00684***	-.00084	-.00247**	-.00007	-.00544***	-.0007	-.00958***
N	853	1,129	852	1,137	858	1,127	851	1,143	853	1,029
Averages										
S & P 500	.00015	.00035	.00016	.00039	-.00025	-.00054	.00013	.00037	.00015	.00039
Oil	.00019	-.00004	.00019	-.00011	-.00024	-.00087	.00020	-.00009	.00019	.00004
Natural Gas	-.00050	.00035	-.00051	.00086	-.00086	.00040	-.00043	.00119	-.00050	-.00005
SMB	.00313	.01429	.01758	-.00301	-.00040	.01428	.01924	-.00440	.01917	-.00301
HML	.00084	-.00304	-.00968	-.01117	.00034	-.00279	-.01073	-.01024	-.00938	-.00981
MOM	-.05448	.02119	-.05409	.01882	-.00986	.02135	-.05085	.01467	-.05356	.00791
	Concho		*Devon*		*EOG*		*Halliburton*		*Helmerich & Payne*	
	Pre-Frack	Post-Frack	Pre-Frack	Post-Frack	Pre-Frack	Post-Frack	Pre-Frack	Post-Frack	Pre-Frack	Post-Frack
Intercept	.00090	.00018	-.00035	.00005	.00021	.00041	.00054	.00027	.00028	.00020
S & P 500	1.121***	1.046***	1.056***	1.044***	1.120***	.9432***	1.400***	1.037***	1.413***	.9822***
Oil	.36356***	.41851***	.22243***	.50007***	.2426***	.36639***	.2653***	.35365***	.29273***	.47454***

Natural Gas	.02542	.00316	-.00184	.01294	.0278*	-.0004	.01105	.0027	.01226	-.00676
SMB	.00318	-.00009	.00082	-.00041	-.00043	-.00083	.001111	.0030**	.00132	.00331
HML	-.00044	.00041	.0015	.00013	-.00159	.0061	-.00037**	.00658	-.00515***	.0094
MOM	.00023	-.00404	-.0010	-.00092	.00077	-.00147	-.00087	-.00010	-.00028***	-.0034**
N	853	1,143	805	1,049	858	1,070	858	1,129	858	1,129
Averages										
S & P 500	.00015	.00037	.00016	.00039	-.00025	-.00432	-.00025	-.00055	.00036	-.00074
Oil	.00019	-.00009	-.00021	-.00024	-.00024	-.00094	-.00024	-.00087	-.00025	-.00087
Natural Gas	-.00050	.00120	-.00035	.000389	-.00088	.00014	-.000863	.00035	-.00024	.00035
SMB	.01889	-.00368	.00485	.011087	-.0018	.01569	-.00041	.01429	-.00041	.01429
HML	-.00978	-.00848	-.00121	-.00068	-.00037	.00044	.00034	-.00304	.00034	-.00304
MOM	-.05368	.01568	-.05983	.01835	-.01268	.02198	-.00986	.02119	-.01000	.02119

Source: See Table 2.

Notes: *** is significant at .01; ** is significant at .05; * is significant at *.

Table 3, Independent Pre and Post Fracking Returns and Averages

	HES		*Holly Frontier*		*Kinder Morgan*		*Marathon Oil*		*Marathon Petroleum*	
	Pre-Frack	Post-Frack	Pre-Frack	Post-Frack	Pre-Frack	Post-Frack	Pre-Frack	Post-Frack	Pre-Frack	Post-Frack
Intercept	-.000016	.00002	.00147*	.0007	.00078	-.00047	.00010	.00048	-.00266	.00080
S & P 500	1.250***	1.065***	1.298***	1.056***	.6340	.79387***	1.131***	1.095***	1.545***	1.221***
Oil	.2603***	.43493	.20975***	.0495**	.04522	.16611***	.1961***	.49908	.0516	.06998***
Natural Gas	.01376	.00802	.00179	-.02368*	.00485	.01039***	.00435	-.00742	-.06601	-.0047
SMB	-.00012	.00161	.00535**	.00186	.00032	-.00018	-.00186*	.00174	-.00217	-.00001
HML	-.00095	.00462	.00745	.00577**	.00015	.00133	-.0030***	.08910***	-.01601	.00249
MOM	-.00065	-.00526	-.00113	-.00244	.0034	-.00100	-.00059	-.00459***	.00558	.00031
N	849	1,091	858	1,129	224	1,128	858	1,129	130	1,129
Averages										
S & P 500	-.00031	-.00092	.00114	-.00017	-.00017	-.00055	-.00030	-.00055	-.00001	-.00055
Oil	-.00019	-.00061	-.00025	-.00055	.00104	-.00087	-.00024	-.00087	.00086	-.00087
Natural Gas	-.00105	-.00051	-.00086	.00035	-.00111	.00037	-.00086	.00035	-.00245	.00035
SMB	-.00146	.00953	-.00041	.01429	-.02700	.01429	-.00041	.01429	-.03123	.01429
HML	.00062	-.00326	.00034	-.00304	-.03031	-.00302	.00034	-.00304	-.03177	-.00304
MOM	-.00914	.02180	-.00990	.02119	.04116	.02122	-.00986	.02119	.05262	.02119
	National Oilwell Varco		*Newfield Exploration*		*Occidental*		*OneOK*		*Pioneer*	
	Pre-Frack	Post-Frack	Pre-Frack	Post-Frack	Pre-Frack	Post-Frack	Pre-Frack	Post-Frack	Pre-Frack	Post-Frack
Intercept	.00036	-.00025	-.00001	.00061	.00040	-.00023	.00146***	.00060	.00157*	.00068
S & P 500	1.467***	.85367***	1.397***	1.244***	1.168***	1.022***	.8779***	.9654***	1.387***	1.005***
Oil	.29010***	.32449***	.29615***	.52975***	.17122***	.0428***	.08012***	.01128***	.33347***	.24011***

Natural Gas	.01274	.00459	.02645*	.00935	.01090	.00051	.00039	.01128	.01173	.00243
SMB	.00187	.00159	.00157	.00441**	-.00200**	.00266***	-.00042	.00288**	.00100	-.00236
HML	-.00309**	.00734***	-.00244	.00578	-.00504***	.00626***	.00179***	.00284*	-.00421***	.00313
MOM	-.00225**	-.00246**	-.00249**	.00035	-.00136**	-.00358***	.00061	-3.74^{-4}	-.00265***	-.00358*
N	858	1,129	857	1,129	847	1,032	858	1,129	857	1,130
Averages										
S & P 500	-.00025	-.00055	-.00024	-.00055	-.00021	-.00045	-.00025	-.00055	-.00024	-.00055
Oil	-.00024	.00087	-.00024	-.00087	-.00039	-.00094	-.00024	-.00087	-.00025	-.00088
Natural Gas	-.00086	.00035	-.00084	.00035	-.00070	.00045	-.00086	.00035	-.00084	.00033
SMB	-.00041	.01429	-.00100	.01429	-.00226	.01848	-.00041	.01429	-.00100	.01534
HML	.00034	-.00304	-.00018	-.00304	.00084	-.00052	.00034	-.00304	-.00018	-.00237
MOM	-.00986	.021187	-.00962	.02119	-.10909	.02413	-.00986	.02119	-.00962	.02165

Source: See Table 2.

Notes: *** is significant at .01; ** is significant at .05; * is significant at *.

Table 3, Independent Pre and Post Fracking Returns and Averages

	Schlumberger		*TechnipFMC*		*Valero*		*Williams Companies*		*Average*	
	Pre-Frack	Post-Frack	Pre-Frack	Post-Frack	Pre-Frack	Post-Frack	Pre-Frack	Post-Frack	Pre-Frack	Post-Frack
Intercept	.00014	-.00026	.0012**	-.00016	.00042	.00082*	.00064	.00068	.000356	.00021
S & P 500	1.291***	.76011***	1.294***	1.037***	1.403***	1.034***	1.356***	1.005***	1.258	1.022
Oil	.23618***	.26526***	.22422***	.27576***	.17238***	-.00758	.1576***	.24011***	.22281	.26266
Natural Gas	.01352	.00300	.03512	.03824*	.01306	-.01234	.00429	.00243	.00086	.00499
SMB	.002215**	.00022	.00015	.00353***	.00200	-.00120	.00168	-.00236	.00076	.00212
HML	-.00108	.00439***	-.00219	.00721***	-.00135	.00302	-.00063	.00313	-.00212	.00764
MOM	-.00165**	-.00132*	-.00034	-.00406***	-.00164	.00093	-.00015	-.00358*	-.00031	1.00275
N	858	1,129	855	1,129	858	1,129	858	1,129		
Averages										
S & P 500	-.00025	-.00055	-.00021	-.00054	-.00025	-.00055	-.00025	-.00055	-.00005	-.00048
Oil	-.00024	-.0008	-.00036	-.00088	-.00024	-.00087	-.00024	-.00087	-.00006	-.00058
Natural Gas	-.00086	.0003	-.00028	.000417	-.00086	.00035	-.00086	.00035	-.00079	3
SMB	-.00041	.01429	-.00171	.01444	-.00041	.01429	-.00041	.01429	.00047	.01127
HML	.00034	-.00304	.00056	-.00339	.00034	-.00304	.00034	-.00304	-.00406	-.00382
MOM	-.00986	.02119	-.00999	.02107	-.00986	.02119	-.00986	.02119	-.00031	.0201

Source: See Table 2.

Notes: *** is significant at .01; ** is significant at .05; * is significant at *.

Table 4, Majors Pre and Post Fracking Returns and Averages

	British Petroleum		*Chevron*		*Conoco Phillips*		*Exxon*		*Royal Dutch Shell*	
	Pre-Frack	Post-Frack	Pre-Frack	Post-Frack	Pre-Frack	Post-Frack	Pre-Frack	Post-Frack	Pre-Frack	Post-Frack
Intercept	.00016	.00023	-.0030**	-.00004	.0004	.0001	-.0001	-.0004*	-.0003	.0004
S & P 500	.8165***	.7586***	.8716***	.90655***	1.012***	1.001***	.8128***	.8390***	.8890***	.6691***
Oil	.11415***	.2396***	.1106***	.1737***	.1243***	.3000***	.0769***	.1481***	.1139***	.2265***
Natural Gas	-.00059	-.00715*	-.0001**	.00037	-.0044	-.0058	.0041	.0066	-.0032	-.0004
SMB	-.00437***	-.00370	.0006***	-.00018	-.0027***	.0016**	-.0012*	.0018***	-.0049***	-.0044***
HML	-.00371	.00655***	.0004	-.00007	.0003	.0072***	-.0022***	.0027***	-.0046***	.0070***
MOM	.00108**	.00023***	.0005*	-.00341***	.0006	-.0032***	.0015***	-.0006*	.0023***	-.0032***
N	851	1,123	851	1,122	853	1,142	856	1,129	861	1,130
Averages										
S & P 500	-.00043	-.00054	-.000055	-.00537	.00015	.00037	-..000199	-.00055	.00016	.00037
Oil	-.00032	-.00080	-.00043	-.00079	.00018	-.00008	-.00021	-.00087	.00018	.00003
Natural Gas	-.00039	.00094	-.00032	.00093	-.00050	.00121	-.000851	.00038	-.00033	.00123
SMB	.00810	.01601	-.0094	.01375	.01706	-.00295	-.00148	.01345	-.00057	.01353
HML	.00068	-.00336	.0049	.01517	-.01048	-.01137	-.000304	-.00394	-.00034	-.00424
MOM	-.00934	.02159	-.05277	.01300	-.04851	.01647	-.01	.02175	-.01293	.02095

	Average Pre-Frack	Post-Frack
Intercept	-.00057	5.8^{-5}
S & P 500	.88038	.83485
Oil	.10797	.21758

Natural Gas	-.00084	-.00128
SMB	-.00251	-.00098
HML	-.00192	.00468
MOM	.001196	-.00204
N		
Averages		
S & P 500	-7.48^{-5}	-.00114
Oil	-.00012	-.00050
Natural Gas	-.000478	.000938
SMB	.002742	.010758
HML	-.001109	-.00155
MOM	-.02671	.01875

Table 5, Across-groups Different in Decompositions

Post Fracking	*Structural*	*Composition*	*Structural*	*Composition*
Levels	Equation 7		Equation 9	
Sum	-.0000611	.000637	.0000505	.0005051
Total		.000576		.000576
Proportions				
Intercept	.268217		.268217	
S&P 500	-.372095	1.18202	-.1554462	.96547
Oil	-.039283	-.0363326	-.0455170	-.030092
Natural Gas	.010201	-.0004743	.0042304	.001216
SMB	.057900	.0018938	.0606633	-.000870
HML	-.007953	-.030166	-.019645	-.018474
MOM	-.023127	-.0006528	-.0248155	-.004839
Sum	-.106141	1.06141	.087687	.912313
Total		1		1
Pre-Fracking				
Levels	Equation 12		Equation 14	
Sum	.000927	.000040	.000923	.000044
Total		.000967		.000967
Proportions				
Intercept	.955748		.955748	
S&P 500	-.029207	.027389	-.020988	.019169
Oil	-.014254	.013828	-.007127	.006701
Natural Gas	-.004653	-.002750	-.007673	.000269
SMB	.009286	-.001785	.001596	.005905
HML	.000224	.006454	.000820	.004702
MOM	.041712	-.002020	.031990	.045604
Sum	.958884	.041116	.954396	.045604
Total		1		1
DID				
Levels	Equation 15		Equation 16	
Sum	-.000988	.000597	-.000872	.000481
Total		-.000391		-.000391
Proportions				
Intercept	-.954853		-.954853	
S&P 500	.029179	-.027362	.209676	-.019151
Oil	.012404	-.013815	.007120	-.006670
Natural Gas	.004649	.002475	.007665	-.000269
SMB	-.009277	.001783	-.001594	.005899
HML	-.000224	-.064478	-.000819	-.005899
MOM	-.041672	.002019	-.031959	-.007694

Table 6, Within-groups Different in Decompositions

Independents	*Structural*	*Composition*	*Structural*	*Composition*
Levels	Equation 19		Equation 21	
Sum	-.000120	-.000652	-.000126	-.000645
Total		-.000771		-.000771
Proportions				
Intercept	.186118		.186118	
S&P 500	-.016429	.562355	-.146076	.692003
Oil	.003011	.177711	.030064	.150749
Natural Gas	-.003662	-.007618	.001807	-.013087
SMB	-.000833	-.029855	-.019945	-.010644
HML	.051299	-.002294	.047257	.000636
MOM	-.064632	.14464	.063485	.016523
Sum	.154961	.845039	.163819	.836181
Total		1		1
Majors				
Levels	Equation 24		Equation 26	
Sum	.000700	-.001080	.000568	-.000949
Total		-.000380		-.000380
Proportions				
Intercept	-1.64610		-1.64610	
S&P 500	-.008955	2.34720	-.136964	2.47521
Oil	.034587	.215856	.144689	.108455
Natural Gas	-.000551	.004752	.001080	.003121
SMB	-.011089	.020573	-.043508	.052991
HML	.019238	.005400	.026858	1.002220
MOM	-.007001	.243393	.159387	-.142976
Sum	-1.83987	2.83987	-1.49458	2.49458
Total		1		1
DID				
Levels	Equation 27		Equation 28	
Sum	-.000819	.000428	-.000695	.000304
Total		-.000391		-.000391
Proportions				
Intercept	1.83222		1.83222	
S&P 500	-.007474	-1.78484	-.009113	-1.78321
Oil	-.031486	-.040846	-.114625	.042294
Natural Gas	-.003112	-.012370	.000726	-.016208
SMB	.010256	-.050328	.023563	-.066350
HML	.032061	-.007695	.021511	.002856
MOM	.162369	-.098753	-.095883	.159499

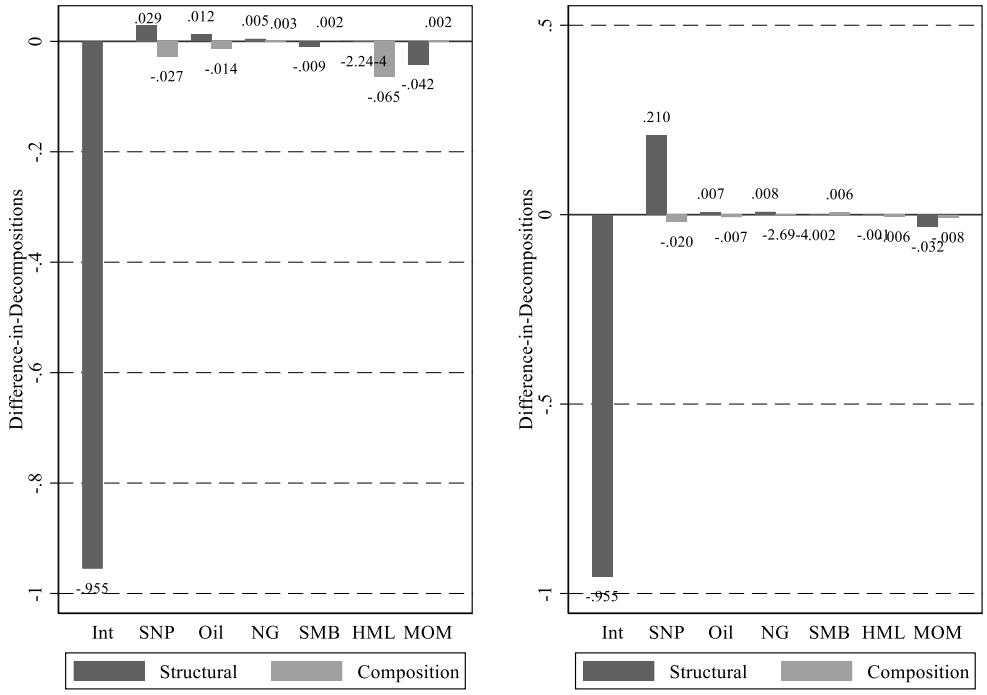

Figure 1, Across-Group Difference-in-Decompositions

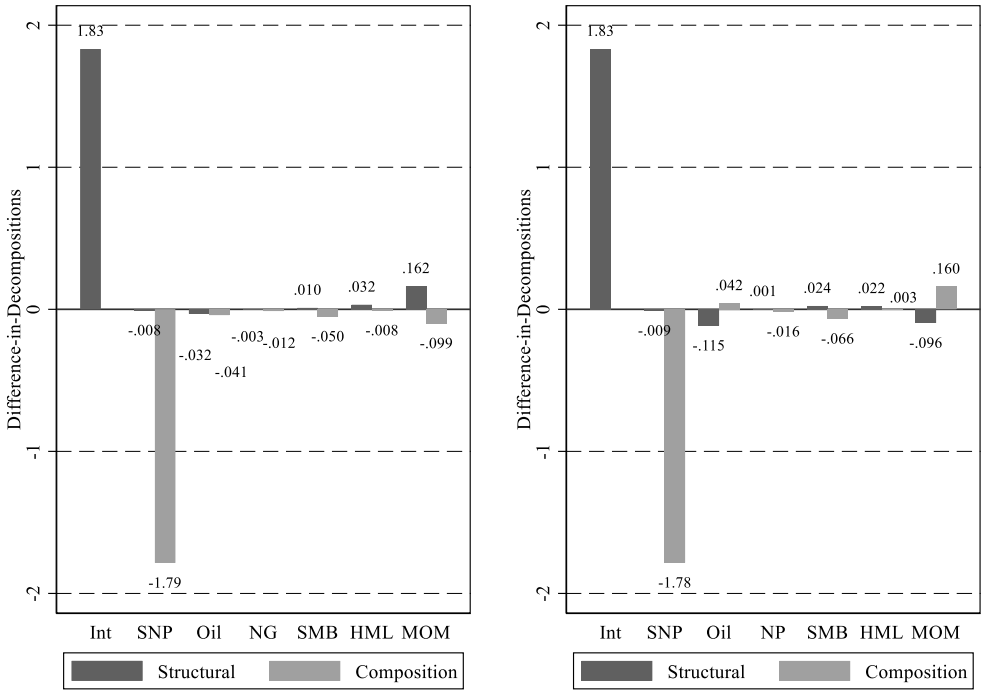

Figure 2, Within-Group Difference-in-Decompositions