Energy Investment Variability within the Macroeconomy

By David Rodziewicz

Over the past 10 years, the U.S. energy sector has exerted substantial influence on overall U.S. business fixed investment. From 2010 to 2014, a time when energy production in the United States was expanding, investment in the energy sector was a boon to aggregate investment. However, following the sharp oil price decline in 2014, the energy sector was a drag on aggregate investment. These recent examples demonstrate that the energy sector can contribute both positively and negatively to overall investment activity in the United States.

Assessing the energy sector's contribution to investment requires an understanding of the size of the energy sector relative to the overall economy, the contributions from individual segments of the energy sector, and how investment dynamics within these segments have changed over time. Energy sector technology advanced rapidly over the last decade, a period when U.S. energy activity and investment also expanded. These technological changes contributed to increased investment variability within some energy segments. Together, changing energy activity and shifting variability within segments of the energy sector can meaningfully alter both the level and variability of aggregate investment.

In this article, I estimate how individual segments of the energy sector contribute to U.S. aggregate investment activity as well as how those contributions have shifted over time. I find that levels of investment

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within segments of the energy sector differ over time, as do the year-to-year investment dynamics among those segments. Specifically, I find that the share of energy investment in the United States increased during the last decade, and that the concentration of investment shifted toward more volatile segments of the energy sector. The upstream segment in particular saw a large increase in investment variability. Over the last decade, both a higher level of energy activity and a greater concentration of investment in more volatile energy segments contributed to greater variability in aggregate U.S. investment.

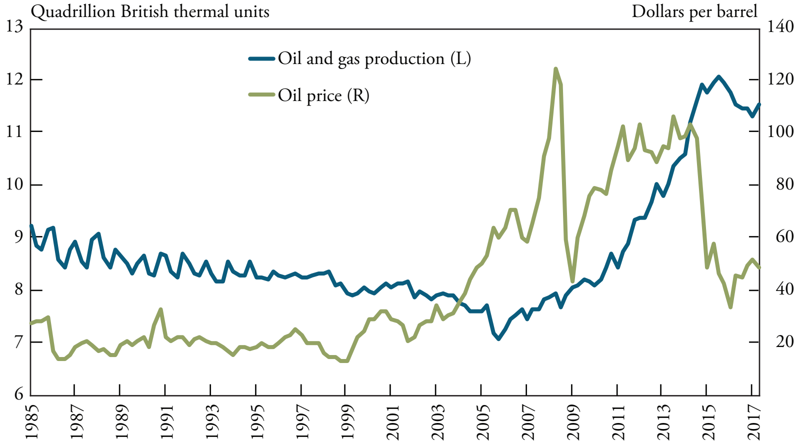
Section I describes the energy sector and energy investment landscape, the data used to capture it, and factors that can affect energy investment variability. Section II describes the measure of investment variability and the methodology used to analyze investment variability. Section III shows that energy investment is more variable than non-energy investment and that energy investment became significantly more variable over the last 10 years, driven largely by increased variability in the upstream segment and higher levels of upstream investment.

I. The Energy Investment Landscape and Data

Energy activity in the United States—specifically, oil and gas production—has varied widely over the last 30 years, making substantial contributions to economic activity during certain periods and limited contributions during others. U.S. oil production reached a high in 1970 before falling steadily through the 1980s and 1990s (EIA 2018a). In the early 2000s, oil and gas production began to increase once more in response to new drilling technologies and the shale revolution (EIA 2018b). Chart 1 shows that U.S. oil and gas production increased nearly 70 percent from 2005:Q4 to 2015:Q4, motivated by sharply rising prices. To achieve these higher production levels, the energy sector added more capital investment.

As energy production increased in the United States, the U.S. economy became increasingly sensitive to fluctuations in energy investment. Besides the overall production level, several features of the energy sector make it an important source of volatility for business fixed investment. First, energy is a capital-intensive sector that can account for a large share of aggregate investment. Second, investment decisions in the energy sector are linked to oil and gas prices, which can be inherently

Chart 1
U.S. Energy Production and West Texas Intermediate Prices



Note: The price of West Texas Intermediate crude is the benchmark for U.S-produced oil.
Sources: Energy Information Administration (Haver Analytics) and Bloomberg.

volatile (Edelstein and Kilian 2007). Third, the energy sector comprises multiple segments, each with its own capital needs. Fourth, the unique and specialized use of capital within the energy sector can amplify uncertainty about the value of investment (Pindyk 1991). Most investment in the sector is irreversible: once an oil well is drilled, for example, the majority of the capital invested in drilling that well cannot be recovered or used for other purposes. Therefore, investors must be cautious about these types of investment decisions. Lastly, the energy sector is linked to other areas of the economy through various supply chains, which can create spillovers between energy-sector investment and investment in other areas of the economy (Bergholt, Larsen, and Seneca 2017).

Investment as measured by individual firm-level data

To capture the unique features of energy sector investment, I use quarterly firm-level capital expenditures or "capex," which come from S&P Global Market Intelligence's Compustat data on U.S. publicly traded firms.[1] Capex is an individual firm's total investment expenditure on the acquisition, upgrades, and maintenance of physical assets (for example, expenditures on property, plant, and equipment) within a given quarter, measured in nominal U.S. dollars. Capex does not include the purchase or sale of other companies (that is, merger and acquisition activity).

The fundamental data in Compustat provide an ideal way to measure investment variability. Because these data are compiled from company-level quarterly and annual filings, they provide a long time series of high-frequency data. In addition, these data allow me to classify investment by sectors of the economy. As this paper is focused on oil- and gas-related companies, I define the "energy" sector as firms involved in the oil and gas supply chain. I categorize all other firms—including firms involved in other types of energy production, such as coal or uranium production—as "non-energy" firms.

Compustat's measure of capex captures a firm's total investment expenditures, allowing for a clean match between energy and non-energy investment that is not possible when using measures of business fixed investment (BFI) from the national income and product accounts (NIPA) data. For example, an energy firm involved in drilling activity might invest in drilling wells but might also purchase drilling equipment and build a new headquarters all within the same quarter. NIPA is unable to cleanly attribute all these various types of investment to a given industry or segment of the economy.[2]

Furthermore, Compustat data allow me to measure differences in investment across individual segments of the energy sector. Identifying investment within segments is critical, as each energy segment has its own unique investment patterns and dynamics. I follow prior studies such as Sengupta, Marsh, and Rodziewicz (2017) in classifying firms into upstream, midstream, downstream, and support services segments. However, I identify an additional segment, integrated firms, based the Global Industry Classification Standard (GICS) codes available in Compustat (see appendix Table A-1 for the codes used). Integrated companies are distinct from other firms in that they are diversified across multiple segments of the energy supply chain and are typically larger firms with an outsized share of investment (for sample composition and breakdown, see appendix Table A-2). Separating integrated firms from other segments allows for a more nuanced analysis of the energy sector, reflecting the actual structure of the industry.[3]

The data for energy and non-energy investment start in 1985:Q1 and end in 2017:Q2, the last quarter for which capex data are available. I start the sample in 1985 due to data quality issues prior to that date, and I remove any records without GICS codes. The resulting sample comprises 1,005,694 unique quarterly company observations including 23,289 unique companies and 1,360 unique energy companies. I then sum up the company level observations, which compresses the final dataset down to 130 quarterly investment (capex) observations for each sector (energy and non-energy) and each energy segment.

Energy sector investment

Over the last decade, investment in the energy sector has grown to a sizeable share of total U.S. investment. Chart 2 shows annual total capex for firms in the energy sector and the non-energy sector. The energy sector's share of total capex fell between the 1980s and 1990s, reaching a low of roughly 8 percent in early 2000s. The share of capex from U.S. energy firms then rebounded, reaching a peak of just over 30 percent in 2014. Although the share fell after the oil price decline in 2014, it remains well above early 2000s levels.

Chart 2 also shows that the energy sector largely drove recent investment changes within the U.S. economy, both to the upside and to the downside. From 2006 to 2014, for example, total capex for U.S. publicly traded firms rose roughly 41 percent. This increase was largely driven by energy investment, which increased by 125 percent while non-energy investment rose a modest 21 percent. After the oil price decline in 2014, total capex fell 15 percent from 2014 to 2016. This decline was also driven by energy investment, which fell over 50 percent during this period while non-energy investment rose a modest 2 percent. Overall, the chart shows that variability in energy investment has had a sizable contribution to the broader investment landscape. (See the Box for additional details on other factors affecting energy-sector investment variability). To understand this relationship in more detail, I next examine how different segments of the energy sector fit into the broader energy supply chain.

Box

Factors Affecting Energy Sector Investment Variability

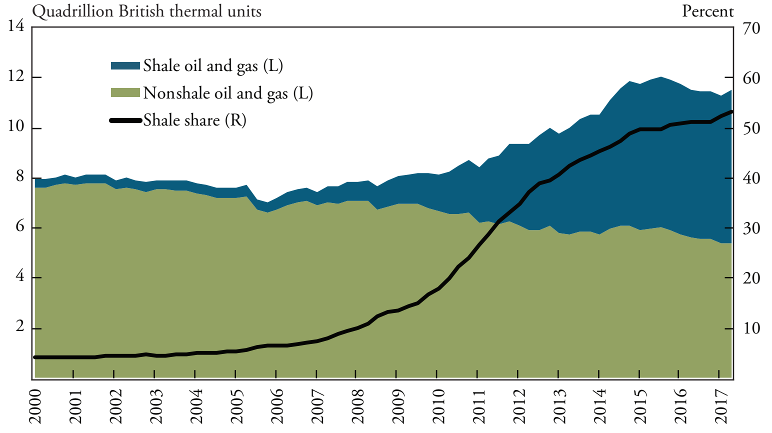
Three key factors can contribute to energy sector investment variability: commodity prices (oil and gas prices), sector composition, and technological change. Although other factors may contribute to variability, these three are particularly crucial for understanding energy investment changes.

Commodity prices broadly drive energy firm profits (Dayanandan and Donker 2011). Energy firms use profits for expansion (investment), to pay dividends, or to initiate share buybacks. Changing oil and gas prices affect investment decisions—energy firms invest more when prices are high and less when prices are low—and that can contribute to variability within the energy sector. Two substantial oil price shocks have occurred in the past decade, contributing in part to higher investment variability during that period (Baumeister and Kilian 2016).

Energy sector composition also matters when assessing energy investment variability. Firms in each segment of the energy sector have unique patterns of investment and unique investment variability characteristics. Furthermore, firms in each segment may be more or less sensitive to commodity prices, which will also affect their investment decisions (Sengupta, Marsh, and Rodziewicz 2017). Therefore, the segment mix within the energy sector will contribute to investment variability within the overall energy sector.

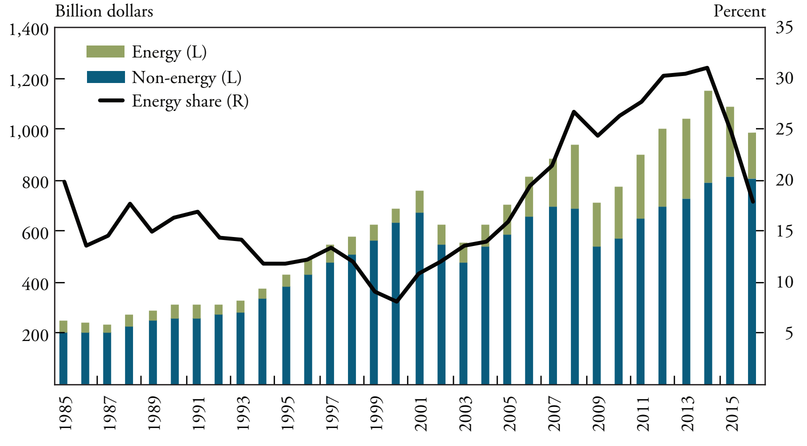
Technology can affect investment variability by altering how an industry functions. In certain cases, technology can reduce an industry's need for capital investment through greater efficiency. In other cases, technology may make an industry more responsive to price signals and may increase investment variability as a result. For example, the shale revolution structurally altered the energy industry and reversed the downward trend of U.S. oil and gas production starting in 2006 (see chart). This resurgence was driven by improved technology and an ability to drill shale oil and gas deposits in the United States (Çakır Melek 2015). The technology shift primarily affected the upstream segment, which saw an increase in overall drilling activity over the last decade, shorter investment horizons on shale projects, and an increased responsiveness to price signals (Bjørnland, Nordvik, and Rohrer 2017).

U.S. Shale Oil and Gas Production



Source: Energy Information Administration (Haver Analytics).

Chart 2
Energy and Non-energy Capital Expenditure



Source: S&P Global Market Intelligence.

Energy segments and the oil and gas supply chain

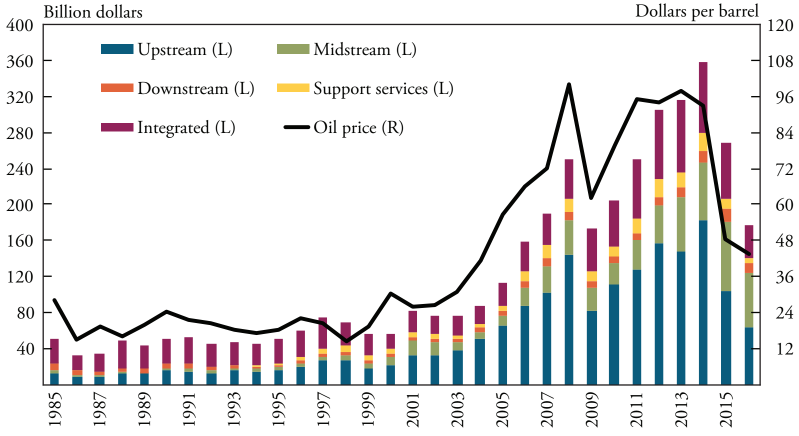
Three of the five segments of the energy sector—upstream, midstream, and downstream—define the energy supply chain. Upstream firms primarily drill for oil and gas and own the resources they are developing. These firms invest in drilling wells and developing oil and natural gas fields. Midstream firms transport the oil and gas, mostly through pipelines, to the downstream segment of the sector. They may also temporarily store these commodities in transit. Midstream firms invest in pipelines, storage tanks, and other assets associated with transporting fossil fuel resources such as terminals, trucks, rail transportation, and marine shipping. At the end of the supply chain, downstream firms mostly function as manufacturing facilities, processing oil and gas into finished products such as gasoline, diesel, and jet fuel. These firms also market and distribute finished products. Downstream firms generally invest in expanding and retrofitting refineries.

The two remaining segments of the energy sector—support services and integrated—may be involved in multiple stages of the supply chain. Support services firms provide contractual services to firms in the upstream, midstream, and downstream segments. Most of their services are directed toward the upstream segment in the form of drilling support, geotechnical services, and drilling site preparation. Support services firms primarily invest in the equipment needed to facilitate their service operations; however, the type of equipment depends on the area of the supply chain they support. For example, if a support services firm is focused on the upstream segment, that firm may invest in equipment to facilitate drilling and well completion—for example, rigs, trucks, machinery, or pumps. Finally, the integrated segment comprises firms involved in upstream activities and at least one other aspect of the supply chain (midstream or downstream). These larger firms invest in many of the same projects as the upstream segment, such as drilling wells, but may also invest in pipelines or refineries, depending on how the individual firm is integrated. Given their size and diversification, integrated firms may have markedly different investment dynamics than single-segment energy firms.

Energy segment mix

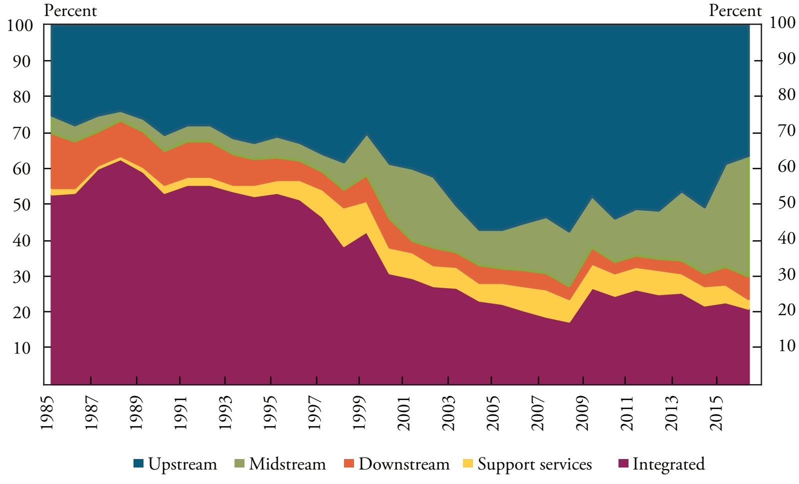
Chart 3 shows that investment grew at different rates across various segments of the energy sector from the 1980s to the 2000s. From 2006 to 2014, U.S. oil and gas production surged, and all energy segments saw a meaningful rise in investment. Subsequently, investment fell following the 2014 oil price decline. Chart 4 shows that the shares of energy investment by segment have shifted since the 1980s, with particularly large changes in the last decade. The share of energy investment in upstream firms rose from 25 percent in 1985 to roughly 50 percent in 2014. The share of energy investment in midstream firms rose from 5 percent to nearly 20 percent over the same period. The share of investment in support services firms grew slightly from about 2 percent in 1985 to roughly 6 percent in 2014 but remained a small contributor to investment over the entire sample period. In contrast, the shares of investment in both integrated and downstream firms fell. The share of investment in integrated firms fell from over 50 percent in 1985 to around 20 percent in 2014. The share in downstream firms fell from around 15 percent to roughly 4 percent over the same period. The changing composition of energy investment within the energy sector matters, as each segment has its own investment dynamics. Thus, the changing composition of the energy sector could alter the relationship between energy investment variability and aggregate investment variability.

Chart 3
Capex by Energy Segment



Sources: S&P Global Market Intelligence.

Chart 4
Capex Share by Energy Segment



Sources: S&P Global Market Intelligence.

II. Measuring Investment Variability

I measure changes in investment in the energy and non-energy sectors as well as for each segment of the energy sector using year-over-year changes in the natural log of capex that is, $ln(Capex_t)-ln(Capex_{t-4})$. I use year-over-year changes instead of quarter-over-quarter changes because the year-over-year measure removes seasonal fluctuations in investment, which can be particularly severe for publicly traded firms (Xu and Zwick 2017). Although there are many other measures of variability, such as the variance of capex, this measure differentiates between increases and decreases in investment and allows me to identify large increases (positive variability) and large decreases (negative variability) in investment. Differentiating between positive and negative variability is more difficult with other measures of variability.

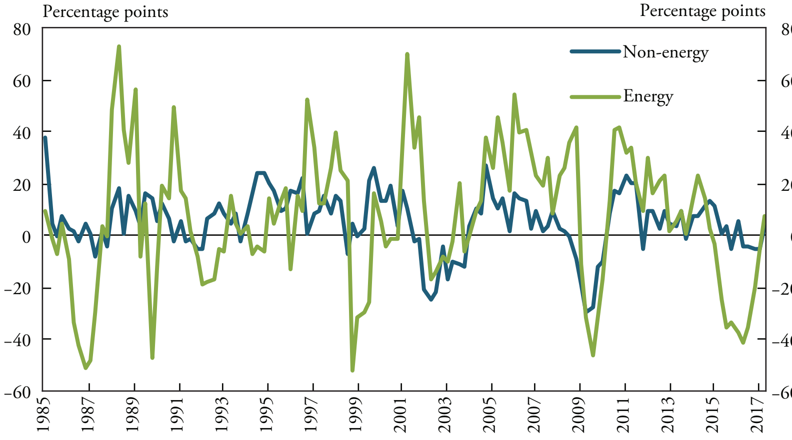
Energy and non-energy investment variability

Chart 5 shows the full time series of year-over-year capex changes in the energy and non-energy sectors from 1985 to 2017. The year-over-year changes in energy investment are noticeably more variable than the changes in the non-energy sector, with larger positive changes and larger negative changes.

Chart 6 shows a standard box-and-whisker plot that demonstrates the range of year-over-year capex changes for the energy and non-energy sectors. The horizontal line bisecting the box represents the median change, while the "x" inside the box represents the mean change. The "whiskers" extending above and below the boxes show the total range of all changes, and the box itself represents the interquartile range or central tendency of the data.

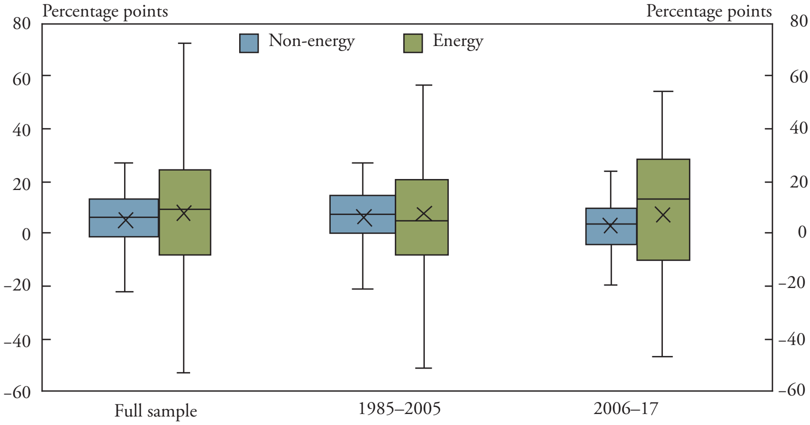
The longer whiskers outside of the green boxes show that energy firms have more extreme investment changes both on the upside and downside—larger increases and larger decreases—compared with non-energy firms. The taller green box shows that the energy sector also has a wider central tendency than non-energy firms, suggesting energy firms have greater investment variability on average. Additionally, breaking the sample into two separate periods, 1985–2005 and 2006–17, shows that investment variability increased noticeably in the energy sector

Chart 5
Year-over-Year Capex Changes for Energy and Non-energy Sectors



Note: Outliers omitted.
Source: S&P Global Market Intellegence.

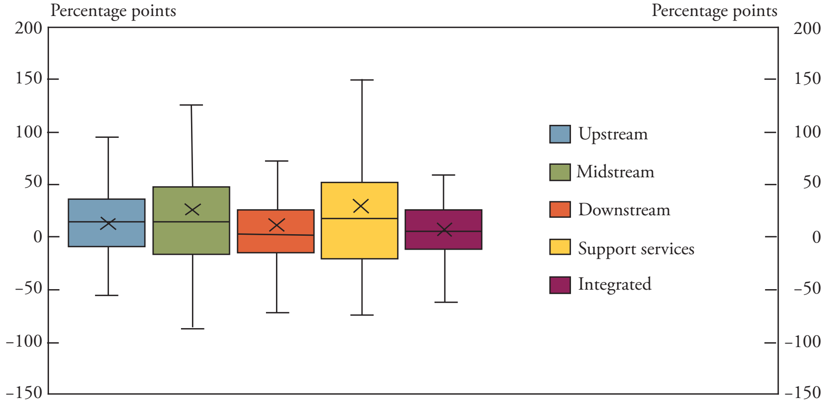
Chart 6
Distribution of Year-over-Year Capex Changes for Energy and Non-energy Sectors



Note: Outliers omitted.
Source: S&P Global Market Intellegence.

Chart 7

Distribution of Year-over-Year Capex Changes for Energy Segments



Note: Outliers omitted.
Source: S&P Global Market Intellegence.

across those two periods (represented by the taller green box for 2006–17). This break point corresponds with the start of the shale revolution and the resurgence of U.S. oil and gas production starting in 2006.

Investment variability within energy segments

Chart 7 shows a box-and-whisker plot highlighting the range of year-over-year changes in quarterly capex for the five segments of the energy sector. Much like Chart 6, Chart 7 clearly shows that certain segments have higher investment variability (taller boxes) than others—for example, midstream and support services investment is more variable than integrated or downstream investment. However, the differences between segments are less obvious than the differences between energy and non-energy sectors.

Although these summary charts can help illustrate differences in investment variability between the energy and non-energy sectors and differences in variability among the energy segments, they do not indicate whether the observed differences are statistically significant nor how much the groups differ. To differentiate more precisely between energy and non-energy investment variability and energy segment variability, I next use an analysis of variance (ANOVA) model.

Methodology

I examine differences in variability across economic sectors using a simple ANOVA process. This approach is flexible and allows me to measure the statistical difference in investment variability for both positive changes and negative changes in investment across various subgroups—first, the energy and non-energy sectors, and then the segments of the energy sector (upstream, midstream, downstream, support services, and integrated). Differences in variability for the energy and non-energy sectors are identified using the following model:

$$\Delta ln(Capex_{i,t}) = \beta_0 \, NonEnergy_{i,t}(down) + \beta_1 Energy_{i,t}(down) + \beta_2 \, NonEnergy_{i,t}\,(up) + \beta_3 \, Energy_{i,t}\,(up),$$

where $\Delta ln(Capex_{i,t})$ is equal to the four-quarter change in the natural log of capex.

I implement this model using ordinary least squares (OLS), regressing the year-over-year changes in capex on a series of indicator variables. For example, the indicator variable $NonEnergy_{i,t}(down)$ is equal to 1 for observations from the non-energy sector when the year-over-year change in energy capex is negative and 0 otherwise. Likewise, the indicator variable is equal to 1 for observations from the energy sector when the year-over-year change in energy capex is negative and 0 otherwise. The indicator variables for positive changes are defined similarly.

This model structure is able to quantify both the upside variability and downside variability of investment in the energy and non-energy sectors. The coefficients are easy to interpret: β_0 is typical negative investment change for non-energy firms, β_1 is typical negative investment change for energy firms, β_2 is typical positive investment change for non-energy firms, and β_3 is typical positive investment change for energy firms.

I use a similar model specification for the energy segment analysis but drop the non-energy firms. This specification includes a series of indicator variables for the various energy segments within the energy sector (upstream, midstream, downstream, support services, and integrated). Both models are fully saturated, representing a complete decomposition of variability (thus, the model has no error term). This approach allows me to flexibly compare average positive and negative changes in investment (positive and negative investment variability) between the energy and non-energy sectors and across segments of the energy sector. Finally, after running the full time period specifications, I break the sample into two separate periods: 1985–2005 and 2006–17, capturing the pre- and post-shale revolution.

III. Evaluating Energy Sector and Energy Segment Investment Variability

Results from the ANOVA model verify that the energy sector exhibits greater investment variability than the non-energy sector.[4] Table 1 shows that across the full sample energy investment has both larger increases and larger decreases on average than non-energy investment. The average positive change in non-energy investment is 21.3 percent, while the average positive change for energy investment is 29.3 percent, a large and statistically distinguishable difference.[5] When the change in energy investment is positive, it has an average magnitude that is 8 percentage points larger than the positive change for non-energy investment. Similarly, the average negative change in non-energy investment is 9.2 compared with an average 13.6 percent negative change for energy investment. When energy investment declines from one year to the next, the decline has an average magnitude that is 4.4 percentage points larger than the fall in non-energy investment. Thus, the energy sector has both higher upside and higher downside variability than the non-energy sector.

After generating results for the full sample, I split the sample between 1985–2005 and 2006–17 to analyze changes in investment before and after the shale revolution. I find that energy investment is more variable than non-energy investment, with larger positive changes and larger negative changes, across both sample periods (Table 1). Although investment in both the energy and non-energy sectors became more variable in the last decade, the energy sector saw a much more pronounced increase in variability between the two periods. While non-energy investment saw a modest 0.6 percentage point increase in average positive changes in the last decade, the energy sector saw a 12.7 percentage point increase. Similarly, while non-energy investment saw a 2.2 percentage point increase in downside changes, energy investment saw a 7.8 percentage point increase. Given that the energy sector had both

Table 1
Energy and Non-energy Sector Model Results

Indicator variables	Full sample (percentage points)	1985–2005 (percentage points)	2006–17 (percentage points)
Non-energy (up)	21.3	20.9	21.5
Energy (up)	29.3	26.4	39.1
Non-energy (down)	−9.2	−8.2	−10.4
Energy (down)	−13.6	−11.5	−19.3
N	260	168	92

Note: All coefficients are significant at the 1 percent level.

higher investment variability and a larger change in variability over the last decade, the natural next step is to investigate which segments of the energy sector contributed most to that variability.

The results from the energy segment specification show that investment variability differs across each of the segments—upstream, midstream, downstream, support services, and integrated (Table 2). More specifically, the full sample results indicate that midstream and support services firms have higher upside and downside investment variability than downstream and integrated firms, which have lower variability on average. Upstream firms fall somewhere in between. These results suggest that the distinct energy segments follow unique patterns of investment. More specifically, they suggest that firms in the integrated and downstream segments may make capital investments with greater regularity than others.

Results for the split sample indicate that the upstream segment drove the rise in energy investment variability from 1985–2005 to 2006–17. The upstream segment witnessed a rise in investment variability between the two periods, while all other segments witnessed a decline (Table 2). The average positive year-over-year change for upstream firms increased by 34 percentage points over the last decade. In contrast, the average positive year-over-year change for midstream, downstream, support services, and integrated firms fell by 46, 3, 55, and 12 percentage points, respectively, over that same period. In addition, upstream firms saw a 13.7 percentage point increase in negative year-over-year changes over the last decade, while midstream, downstream, and support services firms saw declines of 8, 6, and 2

Table 2
Energy Segment Model Results

Indicator variables	Full sample (percentage points)	1985–2005 (percentage points)	2006–17 (percentage points)
Upstream (up)	77.0	66.2	100.2
Midstream (up)	109.6	126.4	80.8
Downstream (up)	74.7	75.2	71.9
Support services (up)	137.7	159.1	104.2
Integrated (up)	61.9	66.9	55.0
Upstream (down)	–26.8	–21.8	–35.5
Midstream (down)	–30.2	–32.2	–24.6
Downstream (down)	–23.7	–25.8	–19.5
Support services (down)	–34.6	–35.5	–33.2
Integrated (down)	–24.0	–24.0	–24.0
N	637	407	230

Note: All coefficients are significant at the 1 percent level.

percentage points, respectively. Integrated firms saw no material shift in downside investment changes.

Improved drilling technology in the upstream segment may explain these results, as a more elastic oil supply would increase investment variability.[6] Before the shale revolution (1985–2005), approximately 28 percent of year-over-year changes in total U.S. investment were attributable to changes in energy investment. Following the shale revolution (2006–17), energy accounted for roughly 77 percent of year-over-year changes in total investment.[7] Given that energy investment is intrinsically more variable than broader aggregate investment, more energy activity alone would have contributed to higher aggregate investment variability. Compounding the effect of greater energy activity, the composition of the U.S energy sector shifted toward two highly variable energy segments (upstream and midstream), though only the upstream segment saw a rise in both upside and downside investment variability over the last decade. Therefore, as energy investment activity increased in the United States—and as more of that investment activity was concentrated in more variable segments—the energy sector's effect on aggregate investment variability strengthened. All evidence indicates that increased energy investment and more variable energy investment in the United States led to more variable aggregate investment.

IV. Conclusion

The energy sector's contribution to U.S. economic activity has changed substantially over the last few decades, falling from the 1980s to the early 2000s before rebounding significantly after the shale revolution. I examine how investment variability differs between the energy and non-energy sectors as well as how those dynamics have changed in the last decade. Unsurprisingly, the energy sector has higher investment variability than the non-energy sector (larger positive and negative changes). However, energy sector investment became even more variable over the last decade compared with the non-energy sector, driven largely by greater investment in the more variable upstream segment.

As the energy sector's contribution to overall economic activity changed, so, too, did the relative contributions of the segments that make up U.S. the energy sector. My results indicate that some segments of the energy sector have contributed more to energy investment variability than others—and that the size of those contributions has changed over time. Investment variability declined over the past decade in all of the energy segments except the upstream segment, which saw a rise in both upside and downside investment variability (that is, larger positive changes and larger negative changes). As the share of U.S. energy activity rose in the last decade, energy investment also shifted to the more variable upstream and midstream segments. The rise in aggregate investment variability in the United States over the last decade was largely driven by a combination of increased energy investment and a shift toward investment in more variable segments of the energy sector.

Accounting for the energy sector's contribution to aggregate investment variability is crucial for policymakers and economic forecasters—if the aggregate economy is more sensitive to investment fluctuations in the energy sector, then a period of unusual strength in energy investment could mask underlying weaknesses in the economy at large. Similarly, negative investment shocks to the energy sector could falsely signal weakness in an otherwise healthy economy. A better understanding of the energy sector's investment dynamics may provide useful insights into U.S. aggregate investment dynamics.

Appendix
Additional Tables

Table A-1

GICS Industry Codes, Sector, and Energy Segment

GICS industry code	GICS industry name	GICS subindustry code	GICS subindustry name	Sector	Energy segment
101010	Energy equipment and services	10101010	Oil and gas drilling	Energy	Support services
101010	Energy equipment and services	10101020	Oil and gas equipment and services	Energy	Support services
101020	Oil, gas, and consumable fuels	10102010	Integrated oil and gas	Energy	Integrated
101020	Oil, gas, and consumable fuels	10102020	Oil and gas exploration and production	Energy	Upstream
101020	Oil, gas, and consumable fuels	10102030	Oil and gas refining and marketing	Energy	Downstream
101020	Oil, gas, and consumable fuels	10102040	Oil and gas storage and transportation	Energy	Midstream
101020	Oil, gas, and consumable fuels	10102050	Coal and consumable fuels	Non-energy	n/a

Note: All GICS codes not identified in the table are classified as "non-energy."
Source: Morgan Stanley Capital Investment (MSCI).

Table A-2
Firm Counts and Capex Share

Year	Firm count			Energy segment share of energy firm count					Energy segment share of energy capex				
	Total	Non-energy	Energy	Upstream (percent)	Midstream (percent)	Downstream (percent)	Support services (percent)	Integrated (percent)	Upstream (percent)	Midstream (percent)	Downstream (percent)	Support services (percent)	Integrated (percent)
1985	7,287	6,830	457	72	4	7	15	2	25	5	15	2	53
1986	7,535	7,093	442	71	4	8	15	2	28	5	13	1	53
1987	7,658	7,248	410	70	5	9	14	3	25	5	9	1	60
1988	7,524	7,119	405	69	5	9	14	3	24	3	10	1	63
1989	7,410	6,998	412	66	5	8	17	3	26	4	10	1	59
1990	7,514	7,114	400	65	6	9	18	3	31	4	9	2	53
1991	7,667	7,280	387	63	6	9	19	3	28	5	10	2	55
1992	8,161	7,757	404	62	6	10	19	2	28	5	10	2	56
1993	8,733	8,321	412	63	6	11	18	2	32	4	9	2	54
1994	9,041	8,640	401	62	7	11	18	2	33	5	7	3	52
1995	9,683	9,258	425	60	7	10	21	2	31	6	6	4	53
1996	9,666	9,245	421	58	8	10	21	2	33	5	5	5	51
1997	9,404	9,005	399	58	9	10	21	3	36	5	5	8	46
1998	9,643	9,241	402	57	9	9	22	2	38	7	5	11	39
1999	9,570	9,159	411	56	11	9	21	3	30	12	7	9	42
2000	9,069	8,653	416	55	13	9	20	2	39	15	8	7	31
2001	8,535	8,132	403	55	14	9	20	2	40	21	3	7	30
2002	8,144	7,749	395	52	16	8	21	2	42	20	5	6	27

Table A-2 (continued)

	Firm count			Energy segment share of energy firm count					Energy segment share of energy capex				
Year	Total	Non-energy	Energy	Upstream (percent)	Midstream (percent)	Downstream (percent)	Support services (percent)	Integrated (percent)	Upstream (percent)	Midstream (percent)	Downstream (percent)	Support services (percent)	Integrated (percent)
2003	7,834	7,423	411	52	18	8	21	2	51	13	4	6	27
2004	7,543	7,119	424	50	20	8	21	2	57	10	5	5	23
2005	7,273	6,839	434	49	21	8	21	1	57	11	4	6	22
2006	6,978	6,546	432	50	20	9	20	1	55	13	5	7	20
2007	6,652	6,226	426	50	19	10	19	1	54	16	5	7	19
2008	6,358	5,938	420	51	20	10	19	1	57	15	3	6	17
2009	6,320	5,892	428	50	19	10	20	1	48	14	5	7	27
2010	6,179	5,737	442	51	19	11	19	1	54	12	3	6	25
2011	6,118	5,676	442	51	21	10	17	1	51	13	3	6	26
2012	6,290	5,819	471	50	21	10	18	1	52	14	3	7	25
2013	6,294	5,822	472	50	21	10	18	1	47	19	3	5	26
2014	6,040	5,611	429	49	21	9	19	1	51	18	4	6	22
2015	5,742	5,349	393	43	23	10	24	1	39	29	5	5	23
2016	5,286	4,931	355	42	23	10	24	1	36	34	6	3	21

Source: S&P Global Market Intellegence.

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Endnotes

[1]U.S. publicly traded firms are identified as companies incorporated in the United States. All Compustat data are copyright © 2018, S&P Global Market Intelligence. Reproduction of any information, data or material, including ratings ("Content") in any form is prohibited except with the prior written permission of the relevant party. Such party, its affiliates and suppliers ("Content Providers") do not guarantee the accuracy, adequacy, completeness, timeliness or availability of any Content and are not responsible for any errors or omissions (negligent or otherwise), regardless of the cause, or for the results obtained from the use of such Content. In no event shall Content Providers be liable for any damages, costs, expenses, legal fees, or losses (including lost income or lost profit and opportunity costs) in connection with any use of the Content.

[2]The evidence in Asker, Farre-Mensa, and Ljungqvist (2014) shows that publicly traded U.S. companies comprise roughly half of nonresidential fixed investment. Over my sample period, the year-to-year changes in total capital expenditures among publicly traded firms has an 85 percent correlation with aggregate business fixed investment recorded in NIPA. This high correlation indicates that capital expenditures among publicly traded firms provide an effective proxy for aggregate U.S. investment dynamics.

[3]The North American Industry Classification Systems (NAICS) is a commonly used industry classification system that categorizes each company under one single function (Bhojraj, Lee, and Oler). I use the GICS system as it allows for the inclusion of integrated energy firms.

[4]Although I categorize firms involved in coal or uranium production as non-energy firms, my results are robust to the inclusion or exclusion of these other types of energy firms.

[5]An f-test returns a p-value of <.001, confirming that the coefficients are statistically distinguishable from one another.

[6]Some segments had negative capex in certain quarters, which could have been due to compositional changes within companies such as bankruptcies or sales. I take a conservative approach and apply a null value to those negative quarters, resulting in 13 dropped quarterly observations. When using the changes in the natural log of capex and presenting results in percentages for the convenience of the reader, outliers can drag estimates to extreme values. The interpretation of results and comparison between groups is not affected by this outlier effect.

[7]These figures are the simple R^2 from regressing year-over-year changes in total investment on year-over-year changes in energy investment; $\Delta\ln(\mathit{Total\ Capex}_t) = \beta_1 \Delta\ln(\mathit{EnergyCapex}_t) + e_t$.

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