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Fueling Global Energy Finance: The Emergence of China in Global Energy Investment

Sucharita Gopal 1*, Joshua Pitts 2, Zhongshu Li3, Kevin P. Gallagher 4, and William N. Kring5

1   Boston University; suchi@bu.edu
2   Boston University; joshua.d.pitts@gmail.com
3   Princeton University; zhongshu@princeton.edu
4   Boston University; kpg@bu.edu
5   Boston University; wkring@bu.edu

*   Correspondence: suchi@bu.edu; Tel. +1-617-353-5744

Abstract: Global financial investments in energy production and consumption are significant since all aspects of a country's economic activity, and development require energy resources. In this paper, we assess the investment trends in the global energy sector during, before and after financial crises of 2008 using two data sources: (1) Dealogic database providing cross-border mergers and acquisitions (M&As), and (2) fDi Intelligence fDi Markets database providing greenfield (GF) foreign direct investments (FDIs). We highlight the changing role of China and compare its M&A and GF FDI activities to those of the United States, Germany, UK, Japan and others during this period. We analyze the investments along each segment of the energy supply chain of these countries to highlight the geographical origin and destination, sectoral distribution, and cross-border M&As and GF FDI activities. Our paper shows that while energy accounts for nearly 25% of all GF FDI, it only accounts for 4.82% of total M&A FDI activity in the period 1996-2016. China's outbound FDI in the energy sector started its ascent around the time of the global recession and had accelerated in the post-recession phase. In the energy sector, the development of China's outbound cross-border M&As is similar to USA or UK, located mostly in the developed countries in the west, while their outbound GF investments are spread across many countries around the world. Also, China's outbound energy M&As are concentrated in certain segments (extraction, and electricity generation) while their GF covers all segments of the energy supply chain.

Keywords: FDI, M&Q, energy, supply chain, inbound investment, outbound investment, BRI.

1. Introduction

Energy is the lifeblood of the global economy since it is a critical input to all sectors of the economy including agriculture, transportation, waste collection, information technology, and communications sources. Additionally, the energy sector creates jobs and value by extracting, transforming and distributing energy goods and services throughout the economy. The energy sector is relevant in any discussion of a country's economy in two other ways. First, the energy security is vital to the country's economic growth on both the demand side (e.g., population growth, effects of globalization, and the aspirations of less-developed countries) and the supply side (e.g., known and likely reserves of fossil fuels). Oil (31.7%) and gas (21.6%) total to 53.3% of the world's primary energy supply [1]; coal contributes to 28.1%, nuclear 4.9%, hydro 2.5%, biofuels and waste 9.7%, and others (e.g. solar, wind) 1.5%. Second, the increased consumption of fossil fuels has become an important topic in controlling climate change. Anthropogenic climate change poses a serious threat to the health, prosperity, and stability of human communities, and to the stability and existence of non-human species and ecosystems [2,3]. One method of mitigation of greenhouse gas emissions is the use of renewable sources of energy, including solar and wind [4]. As such, many countries are increasing their renewable energy reliance, as there are little to no greenhouse gas emissions.

Global energy investments have changed in the last two decades. In 2011, energy expenditures amounted to about 10% of the world gross domestic product (GDP); North America accounted for 20%, Europe for 25%, and Japan for 6%. China has become a dominant player in the energy sector since 2008. China is also the world's biggest investor in renewable energy, both at home and overseas. China's rapid integration into the world economy has established its status as a key economic player, further strengthened by its planning of the Belt and Road Initiative (BRI). The BRI framework calls for open cooperation and FDI designed to lay the infrastructure and industrial foundations to secure and solidify China's relations with 68 countries on three continents. The BRI, once complete, would reach more than 60% of the global population, account for nearly a third of world GDP and global trade, and 75% of its known energy reserves [5,6]. Under this plan, China will be linked to Europe through Central Asia and Russia; to the Middle East through Central Asia; and to Southeast Asia, South Asia, and the Indian Ocean via both land and sea routes. The BRI involves the funding and construction of a system of roads, railways, oil and natural gas pipelines, fiber-optic and communication systems, ports, and airports that have implications on global energy security in the coming decades. This infrastructure will create new forms of network connectivity across much of Central Asia and on to Europe and will lead to greater interdependence and enhanced growth for countries in this region. Central Asia is feeling the potential impact of the BRI on its energy sector. Chinese government and banks granted US$8 billion to Turkmenistan and US$13 billion to Kazakhstan to develop oil and natural gas deposits and to realize east-oriented pipelines to ship fuels to China [7].   A part of this initiative is the Khorgos–Aktau railway corridor, linking the Sino–Kazak border with the Kazakh seaport in the Caspian Sea, cross in Kazakhstan [8].   Aktau is one of the leading oil-producing areas of Kazakhstan; Chinese companies have invested here to exploit the energy sector as well as get access to the main gateway of the BRI infrastructural and energy projects [9,10]. Thus, the BRI reflects China's industrial redeployment, increased outbound investment and diversification of energy sources and trade routes.

This article examines the global investments in the energy sector from 2003-2016 of China, the US and other countries to analyze their inbound and outbound FDI flows and to characterize the trends in energy investments in the pre- and post-recession periods. It will identify China's investments in the various sectors of the energy supply chain compared with the US. FDI consists of two types, Greenfield (GF) investment and cross-border mergers and acquisitions (M&A). GF investment is a form of FDI [11] where a parent company builds a new subsidiary from the ground up at a location in a foreign country where no existing facilities are currently present. For example, Mitsubishi Heavy Industries (MHI) Dongfang Gas Turbine (Guangzhou) Co., Ltd. was established in Guandong Province in 2004, with MHI owning a 51% stake ($67.3M), and Dongfang Turbine holding the remaining 49%. MHI selected this location to leverage its access to low-price and high-quality labor resources in South China, as well as access to Guangdong domestic and Southeast Asian gas turbine markets. Similarly, in 2008, China National Petroleum (CNPC), a Chinese national oil company, invested ($494.4M) in oil extraction in Bolivar, Venezuela. Cross-border M&As, on the other hand, consists of a transfer of ownership of existing domestic firms. For example, the 2016 acquisition of the German robotics company Kuka, by Midea, a Chinese appliance company resulted in no additional production capacity in Germany. GF investment may generate additional economic activity and may lead to international technology transfers for some sectors, and potentially increase productivity growth.

Global FDI inflows rose to $2.41T in 2015 from $10.17B in 1970 [12]. Our database shows the total FDI is at $2.15T in 2015, breaking out with GF at $720.32B and M&As at $1,426.27B. The share of the value of global cross-border M&A to the value of total global FDI is about 66.4% in 2015. In 2016, total FDI in our database is at $2.16T, with GF at $730.41B and M&As at $1,371.78B. The share of the value of global cross-border M&A to the value of total global FDI is 68% in 2016. Although there is widespread recognition of the distinct nature of these investment modes, there is little research comparing GF and M&A, especially in the critical energy sector due to data constraints. Further, with China's increasing dominance and the proposed Belt and Road Initiative (BRI), research is necessary to create a baseline to differentiate the present patterns in the two modes of investment. While China

has traditionally ranked among the top countries for inbound FDI, its outbound FDI is now becoming more consequential. Chinese companies have made some big international acquisitions in many sectors; for example, Shuanghui International Holdings Ltd. purchased Smithfield Foods (world's largest pork producer) in 2013 for nearly $5 billion. The BRI policies set forth by the Chinese government will determine China's future outbound FDI investments that would result in major impacts in the global economy.

We study these investments during a critical period of global financial crises of 2008 by differentiating three distinct periods: (i) Pre-recession period 2003-2008 (ii) Peak Recession period 2008-2010 (iii) Post-recession 2010-2016.

Prior research has investigated the impacts of FDI; while many argue for the positive impacts of FDI [13], some have highlighted negative impacts [14].   FDI generates cross-sector overflows and improves the output through its upstream and downstream enterprises [15,16]. FDI can drive technological progress [17], especially in developing countries [18]. Several factors determine FDI, [19] including financial market system [20], market size [21], the level of infrastructure and stable macroeconomic policy, trade and human resources [22].   Econometric analysis helps to derive insights on how FDI promotes economic growth in host countries, including standard gravity controls in FDI regressions [23]. Other studies have investigated the effect of various driving factors on M&A and GF FDI [24-28].

China's outbound M&A and GF FDI reveal interesting trends. One study [29] identified four motives for outbound Chinese FDI including increased access to natural resources, markets, technology and managerial skills. Another [30] discuss similar determinants of FDI outflows by Chinese multinational enterprises over the period 1984 to 2001 using case studies. Later studies [31, 32] identified additional motives influencing Chinese outbound FDI: strategic assets (e.g., brands, marketing networks) and diversification. Cost minimization was not a significant motivation of Chinese outbound FDI given that China was itself a low-cost production base. "Resource diplomacy" is characterized as the Chinese effort to secure the supply of raw materials and energy for its national economy [33]. China's large deals in 2006 and 2007 [34] involve oil-producing African countries, central Asian countries, and elsewhere. China has first sought oil and then other minerals such as copper, bauxite, uranium, aluminum, and manganese. The size and composition of China's FDI outflows from 2003 to 2006 influenced by China's "go overseas" policy at this time is significant [35].

Chinese outbound investment in the energy markets in recent times reveals the growing importance of renewable energy, especially in southern Europe. The acquisitions by Chinese entities in southern Europe's renewable energy sector [36] are in Italy and Spain in solar energy while wind energy is the prime focus in Portugal and Greece. The risks associated with the growing share of Chinese FDI into Europe's energy sector particularly in southern and central Europe include challenges of fair competition and possible infringements of national security [37]. The Chinese GF investments in solar and wind in Europe, specifically in Germany, are driven by their desire to acquire technology and markets [38]. There are policy issues in Chinese cross-border M&As activity including government subsidization, transparency of the acquiring firms, and national security concerns [39]. To summarize, prior studies have examined M&A and GF FDI in separate sectors or regional contexts. Some econometric modeling has shown the significance of determinants in the origin-destination flows of investment. However, there are gaps in our understanding related to the analysis of the sectors of the energy supply chain in the context of Chinese investments into the energy sector abroad.

The paper proceeds as follows. The next section describes the data and methodology including issues in integrating the databases, Dealogic and fDi Intelligence's fDi Market, followed by a discussion on M&A and GF investments along various segments in the energy supply chain. We then provide a qualitative analysis of China and other countries inbound and outbound investments. We then discuss future research.

2. Materials and Methods

M&A and GF are the two primary forms of FDI. There are two commercial databases, Dealogic and fDi Intelligence's fDi Market that capture these two forms of FDI respectively. Appendix A shows the structure of the databases. In this paper, we utilize them to understand the landscape of FDI, with a focus on the energy sector, and by source and destination countries. We characterize the critical segments of the energy sector supply chain by integrating the two databases.

fDi Market is the dataset that includes GF FDI projects. It is developed and owned by Financial Times (www.fdimarkets.com). Although it is designed mostly for business clients, academic research now uses the dataset, especially in economic and political science [40,41]. The information consists of media reports, and for each project, the database collects information regarding both its investors (name, the source of the country) and project details (amount of capital investment, destination country, economic sector). fDi Market is a unique global database covering all economic sectors. However, because of its source of input, the database has limitations due to missing reports or zombie deals—which are deals announced but never realized. Our current database captures 171,465 GF projects from 2003 to 2016, with capital investment totaling $10.6 (See Appendix A Table B). The database classifies energy sector in two ways: first, by industrial activity; classes include mining and extraction, distribution and transmission, electricity generation, manufacture, retail and wholesale, other business services. Second, by type of fuel; types include oil & gas, coal, wind, solar, biomass, and hydroelectricity.

Dealogic is a commercial database mostly serving clients in the investment banking sector and includes significant debt, equity investment, loans and cross-border M&A cases (www.dealogic.com). We focus on the M&A segment of this database to complement the fDi Market database. Dealogic database suffers less from missing reports or zombie deals, and hence can help us deal with limitations of the fDi Market database. The M&A database includes deals from 1996 to 2016. For each M&A deal, the record includes acquiror (acquirer or buyer), divestor (seller), and target by their name, nationality and 5-digit NAICS code (Appendix A Table A). Federal statistical agencies use the North American Industry Classification System (NAICS) in classifying business establishments to collect, analyze, and publish statistical data related to the U.S. business economy. The NAICS code in the Dealogic database provides critical information about the primary economic sector of the acquirer, divestor, and target. However, since the original NAICS code is 6-digit, the sector-related information provided by Dealogic is limited to only a 5-digit code resulting in some data issues. In the energy sector, for instance, a target of an M&A deal is labeled as electricity generation on an aggregate level without specifying information on the type of electricity generation. Similarly, the semiconductor manufacture class includes a solar module manufacturer, which makes it impossible to estimate any specific research on solar module manufacture in a region. Therefore, this mismatch of NAICS codes in Dealogic results in our inability to track sector-specific flow without making specific assumptions or approximation. All M&A deals are described as such when an origin country is different from a source country unless an intermediary (divestor) is present in the transaction.

We examine the characteristics of energy supply chains related to fossil fuels and renewables globally and related to China's M&A and GF FDI. There are uncertainties in the values recorded in the two databases. First, both databases estimate the deal values and job creation numbers of companies using a specific methodology that may differ from the values that the companies publicly announce later. Second, in both databases, the announced deal value (that is publicly reported) may differ from the final, actual deal value, causing further uncertainties in the database. Dealogic database shows the following four NAICS codes in the energy sector utilized in this study: (1) exploration and extraction, (2) power generation (3) transmission, and (4) distribution. (Appendix A shows each 5-digit subcategory of each code). Each includes detailed sub-types, such as oil and gas extraction, coal mining, natural gas extraction, and crude petroleum extraction. Figure 1 shows the NAICS codes along the various segments of the energy supply chain in the upstream, midstream and downstream industries. The upstream oil and gas industries include exploration, extraction, and production. The midstream industries involve the transportation (by pipeline, rail, barge, oil tanker or truck), storage, and wholesale marketing of crude oil or other petroleum products. The

downstream industries incorporate petroleum crude oil refining and the processing and purification of the raw natural gas, as well as the marketing and distribution of products (retail) derived from these sources. We have also included manufacturing of equipment necessary for the energy sector in our estimation of energy investments, but we have excluded the sub-type called manufacturing of petrochemicals.

Unlike Dealogic, FDi Market GF database is not categorized by the NAICS codes, instead of by industrial activity and industry sector. We developed a schema crosswalk table that shows similar elements (or "fields") in more than one database schema. We map the elements in fDi Market schema to the equivalent elements in the Dealogic schema. We have selected "Electricity" and "Extraction" for denoting energy-related industry activity. Our primary industry sectors are "Alternative/Renewable energy," "Coal, Oil, and Natural Gas" in energy GF FDI. Each has a sub-sector. This categorization is related to the Dealogic database. This schema crosswalk between two databases requires some definitions and rules.   For our analysis, we identify the following categories based on the industry activity called Electricity that contains the following three sectors and sub-sectors: (1) Alternative/Renewable energy, (2) Coal, Oil, and Natural Gas and (3) Industrial Machinery, Equipment & Tools. Alternative/Renewable energy contains the following sub-sectors: biomass power, solar electric power, geothermal electric power, hydroelectric power, marine electric power, and other electric power. (See Appendix A – Table C for detailed listing of energy sectors and subsectors). The subsectors refer to upstream, midstream and downstream segments of the supply chain.
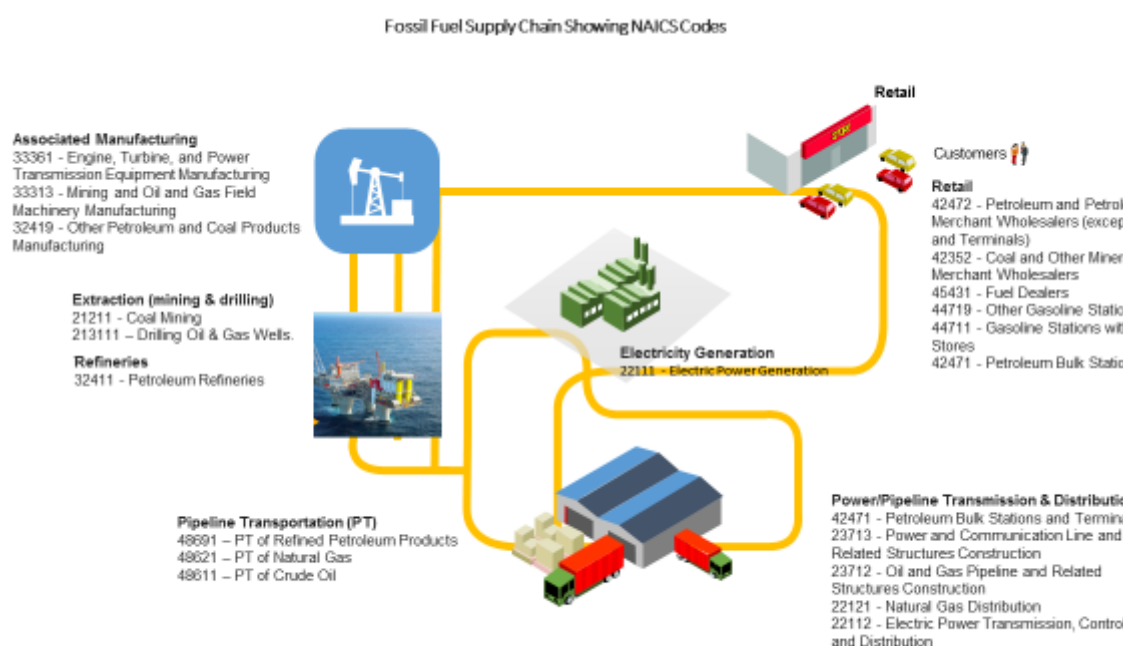

Figure 1. Supply chain of the energy sector (fossil fuel) shows the NAICS codes along the various segments of the energy supply chain in upstream, midstream and downstream industries. The upstream oil and gas industries include exploration, extraction, and production. The midstream industries involve the transportation and storage. The downstream industries incorporate petroleum crude oil refining, as well as the marketing.

The industry activity called Coal, Oil, and Natural Gas Includes subsectors such as fossil fuel electric power, and other electric power generation (Coal, Oil and Natural Gas). Similarly, fossil fuel electric power and oil & gas extraction are selected out of many sub-sectors in their group. Since NAICS Codes are not present in fDi Market, but fDi Market does have a much more detailed classification system, we need to identify which Activities, Sectors, & Sub-Sectors

to include in the analysis. This step is critical in aggregating activities in order to map the supply chain. We need to have a consistent agreement to crosswalk between the two databases, to allow comparison between fDi Market's classifications and Dealogic's NAICS codes. Furthermore, fDi Market provides crucial detail to smaller steps in the energy supply chain.

The final step in our methodology is data analysis and visualization. Developing effective data integration and visualizations are critical for understanding and analyzing the merged investment data in a variety of contexts. We used Tableau Desktop software [42, 43], an easy-to-use tool for creating customized, real-time exploration of our complex databases. We created longitudinal graphical displays of our databases, defined new groups of variables (using NAICS codes), clustered BRI countries, as well as defined phases such as pre- and post-recession and recession. We juxtaposed graphics and maps on digital "dashboards" with shared timescales and drillable details, such as M&As along the various segments of the supply chain such as extraction, electric power generation, retail) to facilitate a visual synthesis of multiple types of potentially relevant information.

3. Results

In this paper, we want to investigate the following. What is the level of GF and M&A investments by and to countries and continents in the period 2003-2016? What was the impact of the global financial crises on GF and M&A investments? What are the patterns of investment in energy before and after the crises? In the energy sector, what are clear distinctions in patterns of GF and M&A investments in China versus other countries? Do such sector-level FDI patterns vary according to different pairs of origin and destination countries? Does this hold true for both M&A and GF investment?

We explore the differences between M&A and GF FDI in the energy sector of various countries to compare and contrast to China's strategies. Since the energy sector includes mining and drilling, as well as electricity generation, it is useful to examine patterns of GF and M&A along the supply chain. What are consistent patterns in inbound and outbound investments? Overall, does China invest consistently more in the energy sector of some countries? The presentation of the analysis is as follows:

1. Global Trends in M&A and GF FDI Activities: Total FDI, GF (1996-2016) and M&A (2003-2016) trends and energy GF and M&A with a focus on tracking the impacts of the financial crises in 2008 across the various regions.
2. Energy Sector Supply Chains: Characteristics of energy supply chains related to fossil fuels and renewables globally and related to China's GF and M&A investments.
3. Origin and Destination of Energy FDI: We discuss the energy outbound investment originating in countries such as China, UK, Germany, and the US to their destinations such as China, Cambodia, Vietnam, and India.

3.1. Global Trends – GF and M&A Activities

We classify the period of this study 2003-2016 into 3 phases: (1) Pre-recession period 2003-2008 (2) Peak Recession period 2008-2010 (3) Post-recession 2010-2016. Figure 2 shows the total global GF and M&As investments from 2003-2016. The overall pattern indicates that there are similar highs and lows in both investments over time. There was an increase in GF and M&A investments until 2007. During the period of recession, both activities fell. While M&As dropped after 2007, GF peaked before the economic recession, fell during the recession, and then gradually recovered in the post-recession period. In 2007, the total amount of GF reached around \$751.76B while M&A was around \$1,771.16B. While both have exhibited an upward trend from 2013 with a peak around 2015, they never reached the pre-recession levels of investment. The number of jobs (not shown) resulting from the

investment   is   closely   related   to   the   amount   of   inbound   investment   [44].
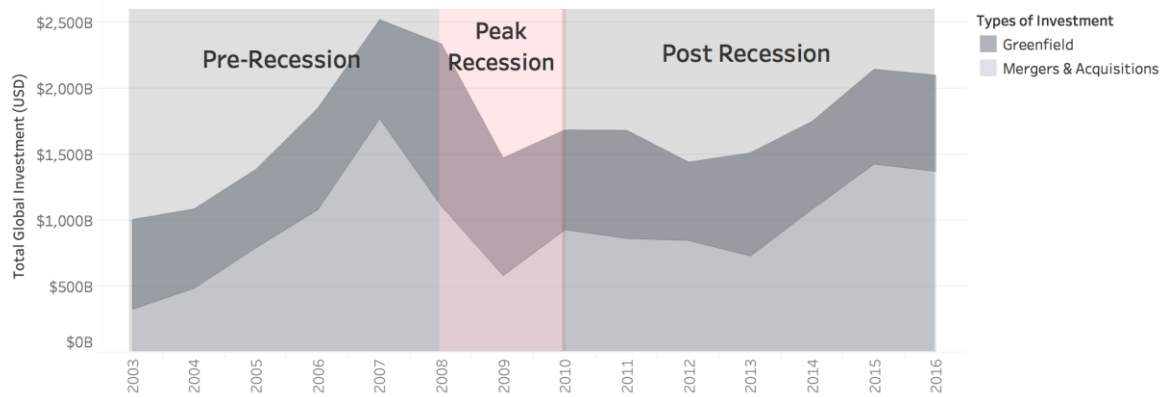

Figure 2. Total FDI and M&A deal value across all sectors into 3 phases: (1) Pre-recession period 2003-2008 (2) Peak Recession period 2008-2010 (3) Post-recession 2010-2016.

Inbound FDI is the value of a direct investment made by non-resident investors into the reporting economy. Outbound FDI is the value of a direct investment made by the residents of the reporting economy to external economies. Thus, the outbound and inbound investments represent the origins and destinations of money flows.   Figure 3 shows inbound and outbound GF FDI in which terms of broad regions; Appendix B shows the countries of each region. Asia (China, Japan, and India) exhibit both investments, while Europe and North America exhibit primarily outbound investment. Figure 4 shows the outbound GF FDI from the top 20 countries in the period 1996-2016. The value of China's outbound GF FDI experienced a 2-fold increase from pre- to mid-recession and a 4-fold increase from mid- to post-recession. In contrast, the US experienced less than the 2-fold increase from recession to post-recession. Notably, in 2008, the beginning of the Great Recession, there is a peak in Chinese investment. Maybe this reflects the completion of deals signed before the Great Recession or that China was relatively well insulated from the crisis due to its pre-emptive stimulus package that prevented the initial negative shock from turning into a major recession [45]. Australia survived the global economic crisis well-reflecting sound macroeconomic policies and strong demand for raw materials from China. [46]. Of the seven largest economies in the world by GDP, only China grew by 9% in the third quarter of 2008 [47, 48].
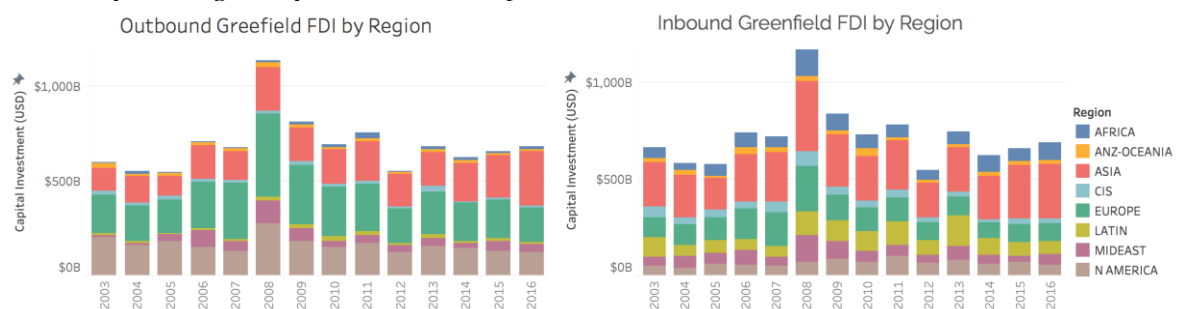

Figure 3. Inbound and outbound GF FDI (2003-2016). Asian FID patterns are compared with Europe and North America.
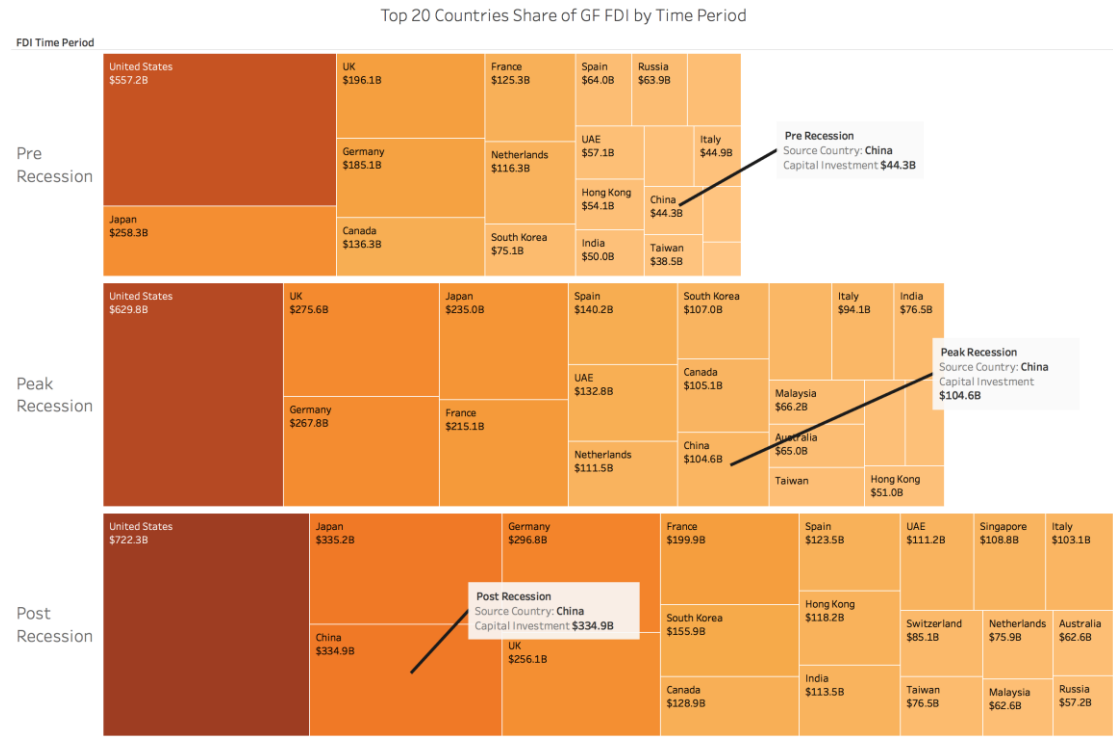
Figure 4. Top 20 countries share of GF FDI sources (1996-2016). China's ascent is notable in the recession and post-recession phases.

Figure 5 displays the breakout of top countries by Inbound GF FDI investments (2003-2016) where China is the dominant player followed by the US, India, UK, Brazil, Russia, and Vietnam by substantially smaller FDI amounts.   While in 2003, China received 30% of the top 20 Countries (by FDI) inbound investment, by 2016 it was receiving only 12.3%. The US retained the second spot in terms of its inbound investment in the period 2008-2015. In 2016, India gained the second rank, receiving around 12% of Inbound FDI investment.
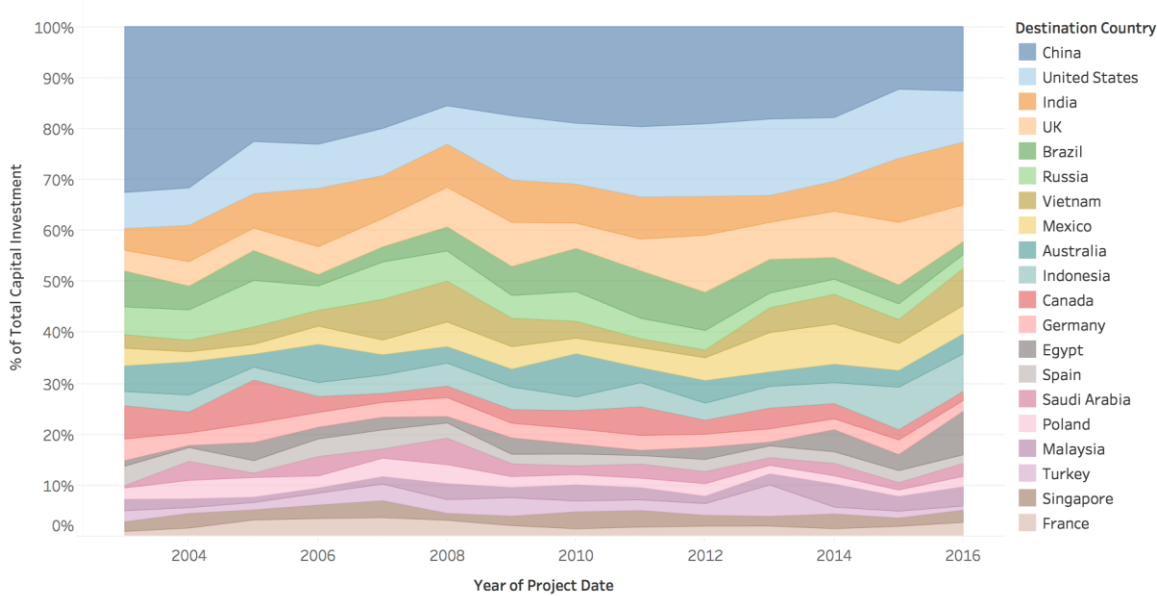

Figure 5. Top Percent share of GF FDI into top 20 countries (2003-2016). China and India occupy ranks 1 and 3.

Figure 6 breaks out the inbound GF FDI investment by the top 20 industrial sectors in the same set of countries. Real estate, financial, chemical and automotive exceeds energy GF FDI in China during this period [49]. Inbound energy GF FDI investments dominate in the US as fracking attracted massive foreign investments including Canada, South Africa, Egypt, Saudi Arabia and Taiwan.   Investment is directed towards the construction facilities to chemically convert natural gas into diesel fuel, as well as to produce petrochemical and plastic-related products.
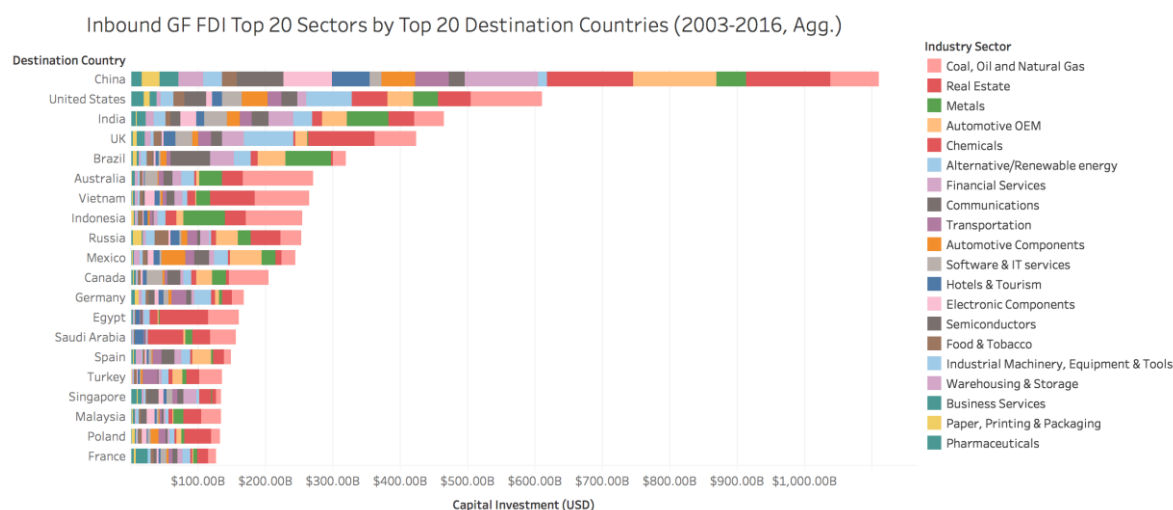

Figure 6. Sectors of GF FDI investments in top 20 countries across 2003-2016. Real estate is a dominant investment followed by energy.

Figure 7 shows inbound and outbound M&A (similar to Figure 3 with GF FDI) in which Europe and North America (Appendix B) exhibit both outbound and inbound investments suggesting a dominant north-north M&A pattern. While GF FDI shows the inclusion of China and India, M&A are dominated by Western Europe and North America.

Table 1 shows the top 10 outbound countries for M&A in the database over the same time by the value and the number of outbound investments. The US has nearly the double number of M&As compared with the second highest country, UK during this period. China ranks 13 (not shown in the table) with 3988 M&As as compared with that of US at 23,830 during this period. Thus, the US is nearly six times larger than China in terms of the volume of outbound M&As during this period.
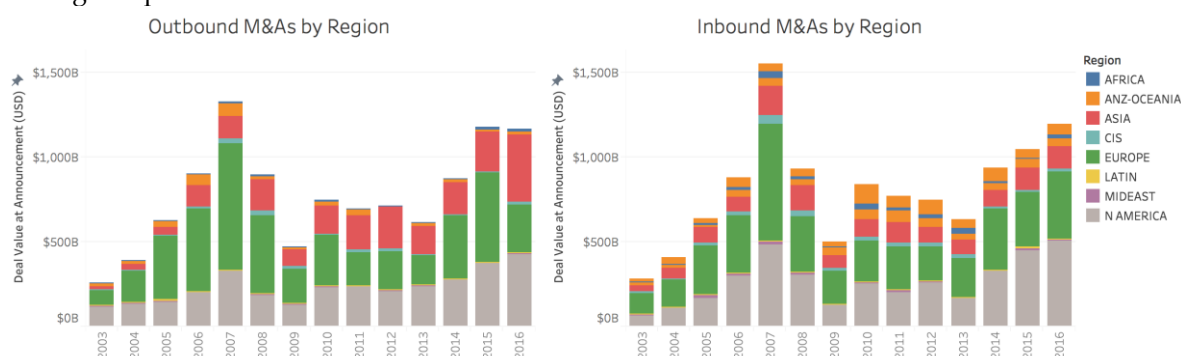
Figure 7. Outbound and Inbound M&A (2003-2016). Europe and North America show both outbound (left) inbound investments (right).

Inbound and outbound investments of countries offer more insights. Table 1 also shows the top 10 outbound and inbound investment countries by number and value in the Dealogic M&A database; USA and UK are the top two countries in terms of the value and the number of outbound deals (four columns on the left). China occupies the seventh rank in the outbound investment with $657B. Western Europe along with Japan and Hong Kong are in this top ten list. USA and UK are the top two countries in terms of the number of inbound deals (last column on right) followed by

China and Germany in this period. China ranks ninth in the value of inbound M&A funding. The US is nearly seven times larger than China in terms of the number of inbound M&As during this period. US, Western Europe, Canada and Australia are in the top seven rankings indicting they attract larger M&A deals.

Table 1. Summary of top 10 nations inbound and outbound M&As (2003-2016)

Top 10 Outbound Countries				Top 10 Inbound Countries			
Value of Investment (USD)		Number of Investments		Value of Investment (USD)		Number of Investments	
United States	$2,239B	United States	23,830	United States	$2,809B	United States	17,913
United Kingdom	$1,257B	United Kingdom	11,604	United Kingdom	$1,754B	United Kingdom	9,604
France	$871B	Canada	8,983	Canada	$621B	China	9,159
Canada	$823B	Japan	6,788	Germany	$609B	Germany	7,027
Germany	$718B	Germany	6,484	Australia	$492B	Canada	6,096
Japan	$695B	France	6,345	Netherlands	$492B	Australia	5,340
China	$657B	Hong Kong	5,214	France	$489B	France	4,410
Netherlands	$512B	Australia	4,519	Spain	$453B	India	3,707
Switzerland	$472B	Sweden	3,652	China	$421B	Spain	3,033
Spain	$417B	Netherlands	3,500	Italy	$359B	Italy	2,802

China ranks third in the number of M&A inbound investments, it ranks ninth in the total value of inbound investments during the same period suggesting a smaller value of the deals. Figure 8 shows China's inbound and outbound M&A during the observation period. While China's outbound M&A has shown an increasing trend from 2005, its inbound M&A displays a decreasing trend from 2008. Figure 8 shows a reversal in China's position in M&A. To summarize, China's GF FDI was insignificant during the pre-recession period. Its outbound investment grew from US $44.38B to $104.68B to $334.98B—close to Japan in the post-recession years. China has changed its status from having more outbound than inbound investments. China ranks eighth in this period in terms of outbound investment.   However, China ranks third in the number of M&A inbound investment; it ranks ninth in the total value of investment during the same period. Both investment types show the rise of China in the global economy in the period following the recession.
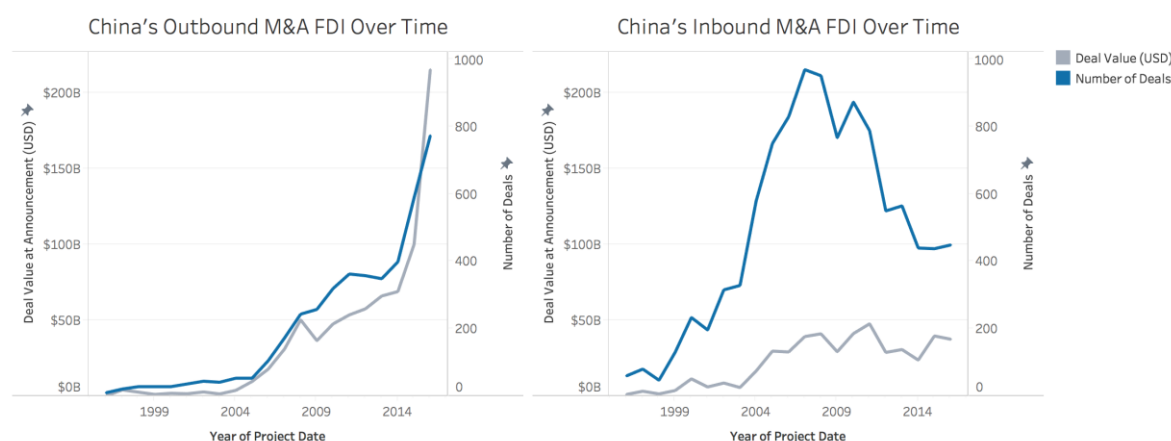
Figure 8. China's Outbound and Inbound M&A investments. China's reversal in M&A positioning is shown in terms of the number and amount of investment.

3.2. M&As and GF FDI in the Energy Sector

While energy accounts for nearly 25% of all FDI, it only accounts for 4.82% of total M&A activity during 2003-2016. The share of energy M&As as a share of total global M&As in the three phases of recession is around 5% while the share of energy as a share of total global GF FDI is around 25-26% during pre-recession and recession. However, the share of energy in GF FDI has

decreased to 21% in the post-recession phase. Thus, the proportion of global M&A and GF FDI in the energy sector is around 5:1.

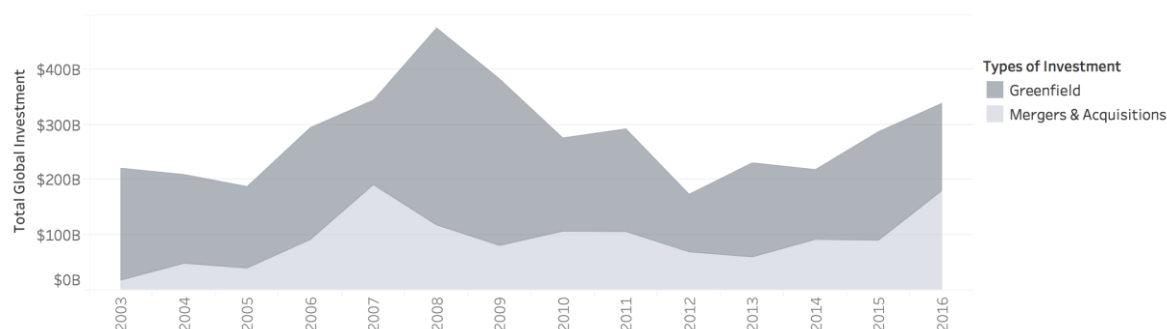**Figure 9.** Total Energy FDI, split by M&A and GF FDI. GF and M&A dropped following the global recession and have recovered since 2015. Highest GF was around 2008.

Error! Reference source not found. exhibits an overall trend in energy investments similar to that shown in Figure 2, with a peak in 2007-2008. Greenfield FDI is the dominant form of energy FDI, which peaked around 2008 while M&A peaked in 2007 before the recession hit and both investments fell sharply. Energy GF patterns experienced a second downturn in 2012, swung upwards in 2013, a slight downturn in 2014 and a generally upward trajectory since 2014. On the other hand, M&A shows an upward trend from 2013. To summarize, GF and M&A investment in energy reflect the period of recession in the global economy around 2008-2009.

Table 2. M&A and GF FDI by region for energy investments

Energy M&A and GF FDI by Region (2011-2016)

Greenfield		Mergers & Acquisitions	
Outflows	Inflows	Outflows	Inflows
Region	Region	Region	Region
AFRICA $25.95B	AFRICA $139.36B	AFRICA $1.80B	AFRICA $6.83B
ANZ-OCEANIA $10.04B	ANZ-OCEANIA $31.43B	ANZ-OCEANIA $16.71B	ANZ-OCEANIA $61.18B
ASIA $235.69B	ASIA $190.87B	ASIA $109.99B	ASIA $64.02B
CIS $38.18B	CIS $29.07B	CIS $18.64B	CIS $4.33B
EUROPE $293.74B	EUROPE $84.56B	EUROPE $111.96B	EUROPE $166.41B
LATIN $16.21B	LATIN $114.99B	LATIN $0.06B	LATIN $0.02B
MIDEAST $39.97B	MIDEAST $84.42B	MIDEAST $0.08B	MIDEAST $3.15B
N AMERICA $126.71B	N AMERICA $81.73B	N AMERICA $250.41B	N AMERICA $182.72B

As a first step, we analyze general inbound and outbound global energy FDI for both M&A and GF investment types. We present the energy investments in Table 2 (similar to Figures 3 and 7). Note that Asia (China, Japan, and India) and to a smaller degree Latin America represent the destination for inbound investment while Europe and North America are mostly sources of outbound investment. In the last decade, India has eased its policy and now permits 100% FDI in the power sector for the generation, transmission, distribution of electricity and power trading, (except atomic energy). As a result, India could receive more GF FDI from China as would other BRI countries. Table 2 indicates that many North-North deals are consisting of intra-Europe and intra-N American M&A deals.

We next examine leading outbound investment countries in the FDI energy sector in the post-recession period. The US is the leading outbound source in FDI energy sector investment. Overall, the US has an investment of $852B while Japan and Germany have $387B and $362B each. China holds the fourth rank with $355B. Germany, France, UK, and Canada are other sources. We primarily focus our analysis on post-recession years (2010-2016) to understand the emerging FDI patterns in the most recent years.

Table 3 shows the GF FDI of the top ten countries in the various segments of the energy supply chain, revealing patterns of specialization. China leads in GF investment in power/pipeline transmission followed by Canada. Besides, China leads in GF FDI in electricity generation followed by Japan and Spain. China invests in Europe, India, and Turkey. China has seen 50% and more increases in the investment of power/pipeline transmission from pre-recession ($1B) to post-recession ($7B). China's GF FDI in electricity generation is remarkable given its meteoric rise from $5B to $7B in the pre-to-peak recession period to over $53B in post-recession. China's focus on electricity generation can be as an effective way of securing energy supply similar to the world's leading energy-consuming countries. The US and South Africa lead in GF FDI in manufacturing followed by UK and China as shown in 3. France and the US lead in extraction followed by Norway, India, Netherlands, UAE, and Japan with around $6-7B. China and Canada have investments of $5B each.

Figure 10 shows China's GF FDI outbound investment in the energy sector in 2003-2016 as a box-whisker plot. Each year's investments are shown as a quartile distribution with whiskers from the first to third quartile along with outliers (shown as dots in 2007, 2014-16). The median value of the investment is around $1B with variations in the distributions. The most substantial investments are the outliers in 2014-2016; in 2015, China invested in $10B in an energy project while in 2014 and 2016 in projects over $5B. We can expect China's investments to grow in this sector given the BRI, covering 75% of known global energy reserves (Zhang et al. 2018).

Table 3. GF FDI across energy supply chain sectors; top 10 countries, post-recession.

GF FDI Top 10 Inbound and Outbound Investments by USD ($), Post Recession (2010-2016)

| Power / Pipeline Transmission				Electricity Generation			
Outbound Investment		Inbound Investments		Outbound Investment		Inbound Investments	
Malaysia	$17.08B	Australia	$17.57B	China	$54.24B	United States	$45.11B
China	$7.16B	Turkey	$10.01B	Spain	$50.97B	UK	$43.14B
Canada	$4.98B	Mexico	$5.13B	United States	$45.69B	India	$33.81B
Netherlands	$4.62B	China	$3.71B	Japan	$45.10B	Chile	$29.39B
Russia	$4.05B	United States	$2.43B	France	$36.53B	Pakistan	$28.10B
Singapore	$3.13B	Indonesia	$1.54B	Italy	$36.29B	Myanmar	$23.07B
United States	$2.90B	India	$1.49B	Germany	$32.96B	Mexico	$20.97B
UK	$1.92B	Spain	$1.22B	South Korea	$29.93B	Vietnam	$18.79B
Norway	$1.44B	UAE	$1.04B	India	$26.12B	Indonesia	$18.56B
India	$1.43B	UK	$0.83B	Canada	$25.41B	South Africa	$15.95B
Manufacturing				**Resource Extraction**			
Outbound Investment		Inbound Investments		Outbound Investment		Inbound Investments	
United States	$34.13B	United States	$26.97B	United States	$27.13B	UK	$15.42B
South Africa	$21.78B	Egypt	$18.10B	France	$23.76B	Australia	$13.35B
UK	$17.95B	Turkey	$13.23B	UK	$16.97B	Egypt	$11.80B
Russia	$12.08B	Vietnam	$12.27B	Italy	$10.38B	Canada	$11.28B
France	$11.99B	Australia	$10.65B	Canada	$9.20B	Nigeria	$9.01B
China	$11.80B	Indonesia	$8.99B	Netherlands	$8.27B	Indonesia	$5.12B
Japan	$9.76B	China	$8.75B	India	$6.39B	Iran	$3.54B
Germany	$9.45B	Brazil	$8.29B	Japan	$5.79B	Russia	$3.20B
Netherlands	$8.46B	Saudi Arabia	$5.98B	UAE	$4.88B	Malaysia	$2.94B
UAE	$7.99B	India	$4.59B	South Korea	$3.63B	United States	$2.79B
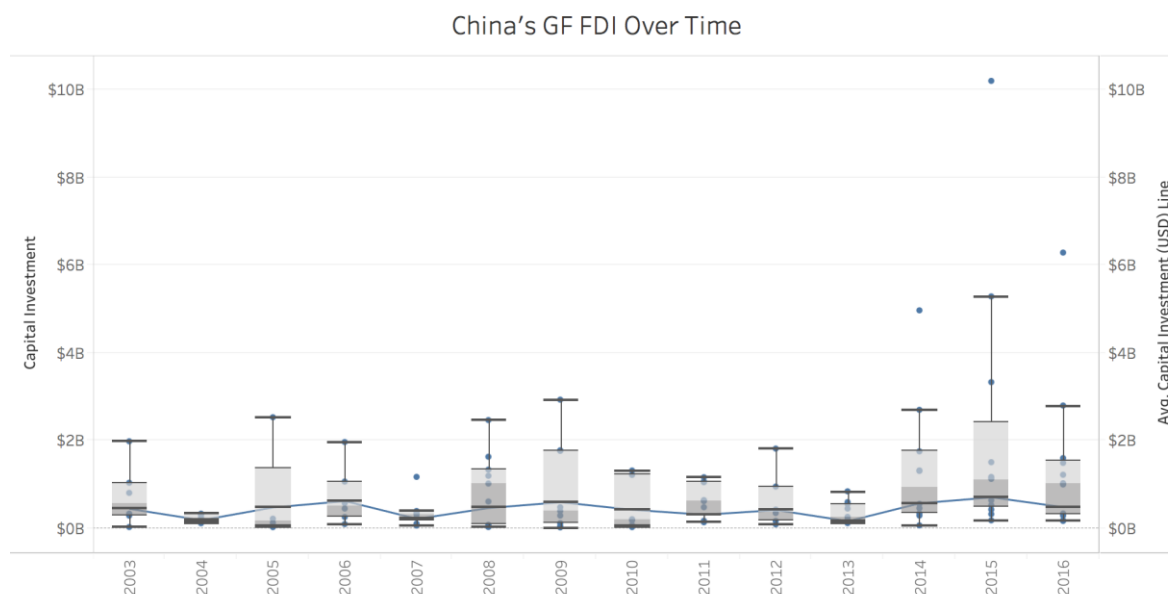
Figure 10. Box and whisker plot China's GF FDI in Energy Sectors. The left axis shows the capital investment for each year.   The average investment (right axis) is shown as a blue line in the box plot. The median value of the investment is around $1B with variations in the distributions; widest distribution in 2015.

Table 4 shows M&A activity in energy supply chain for the period 2003-2016 concerning the announced deal. China leads in extraction, Italy in electricity generation, Canada in power/pipeline transmission, and distribution. China ascended to this position in extraction following the economic recession.

Table 4. Mergers & Acquisitions by energy supply chain segment.

Outbound M&A FDI, Top 10 Countries, (2003-2016 agg.)

	Extraction	Electricity Generation	Power/Pipeline Transmission & Distribution	Refineries	Manufacturing	Retail & Wholesalers	Grand Total
China	$156.37B	$24.48B	$22.51B	$2.63B	$4.04B	$1.55B	**$211.59B**
United States	$78.06B	$32.73B	$42.71B	$4.78B	$29.31B	$2.76B	**$190.34B**
Canada	$45.63B	$40.53B	$83.32B	$2.62B	$0.59B	$5.98B	**$178.68B**
United Kingdom	$77.88B	$29.49B	$47.38B	$2.49B	$6.40B	$0.81B	**$164.44B**
Italy	$21.84B	$95.42B	$7.65B	$0.71B	$0.55B	$7.50B	**$133.67B**
France	$33.16B	$74.88B	$19.48B	$0.49B	$2.21B	$0.19B	**$130.41B**
Netherlands	$103.45B	$2.26B	$4.07B	$0.88B	$0.22B	$2.61B	**$113.49B**
Germany	$10.63B	$52.55B	$14.76B	$0.47B	$11.52B	$1.58B	**$91.51B**
Spain	$23.54B	$34.81B	$21.90B	$0.02B	$0.40B	$0.04B	**$80.70B**
Japan	$45.05B	$26.93B	$6.41B	$0.33B	$1.35B	$0.47B	**$80.53B**
Rest of World	$313.28B	$126.17B	$96.91B	$47.31B	$20.05B	$13.17B	**$616.90B**

3.3. Origin and Destination of Energy FDI

We discuss the energy flows from origin countries such as China, UK, Germany, and the USA in the post-recession period regarding segments of the energy supply chain as well as destinations of the investments. In the context of M&As, China has around 65% in the extraction segment, 33% in electricity generation, and around 20% in pipeline transmission & distribution in the post-recession period shown in Figure 11. In contrast, the US invests around 31% in the extraction segment and 17% in electricity generation. Other significant M&A investments for the US are 27% in pipeline transmission & distribution and 21% in manufacturing. Thus, the US has a more even spread of M&As in all segments of the energy supply chain compared with China's concentration in the upstream segment of the oil and gas sector. Figure 11 concerns M&A, China is still focused on

extraction experiencing over 100% growth in M&A in this segment during this period. While the US has experienced over 200% growth in M&A in pipeline transmission & distribution, manufacturing, and electricity generation. To summarize, China's focus is mostly on the upstream segment of the supply chain whereas the US focus is on all segments except refineries and retail/wholesale. China's strategy in the future seems to be one of diversification.
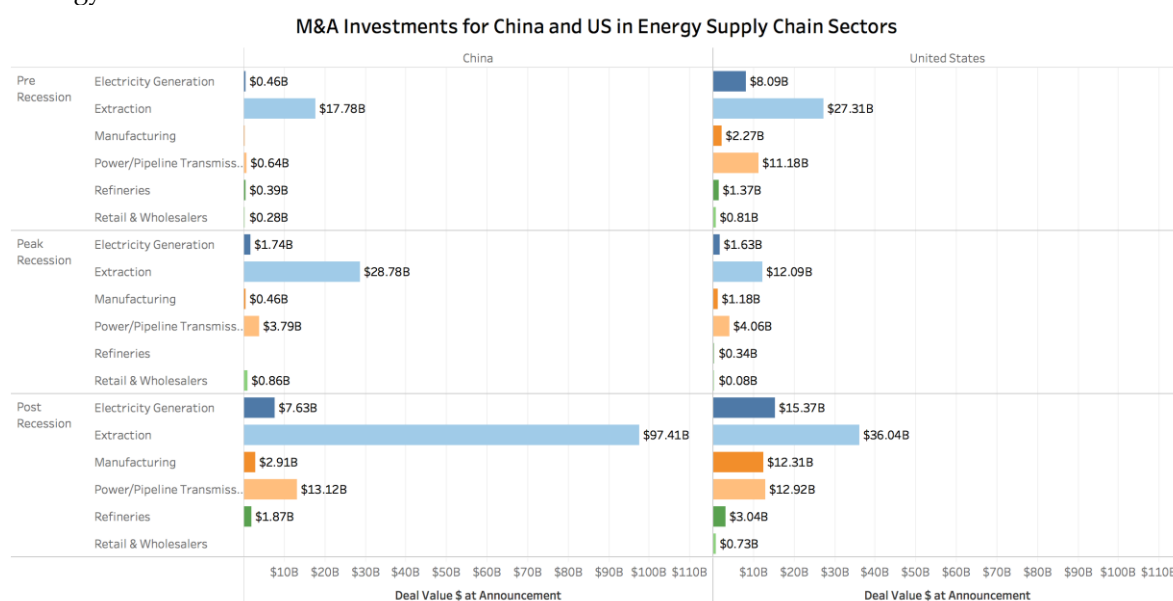

Figure 11. China & US – M&As in energy sector supply chain segments

Table 5. Outbound FDI of China, USA, Japan, and France in the energy sector.

Select Countries' Outflows for Energy FDI, Top 10 Destinations (2011-2016)

Mergers and Acquisitions				Greenfield			
China		**United States**		**China**		**United States**	
Australia	$15.88B	France	$25.15B	Pakistan	$10.35B	Canada	$12.46B
Brazil	$15.14B	Canada	$14.21B	India	$10.34B	Turkey	$11.25B
Portugal	$4.51B	United Kingdom	$8.26B	Mozambique	$4.00B	Brazil	$7.16B
France	$4.32B	Italy	$8.25B	United States	$3.81B	Nigeria	$4.64B
Malaysia	$4.22B	Spain	$6.66B	Indonesia	$3.62B	Chile	$4.29B
Canada	$3.60B	Australia	$6.49B	Malaysia	$3.15B	India	$4.09B
Italy	$3.38B	China	$2.92B	UK	$2.81B	Australia	$3.86B
Pakistan	$2.35B	Denmark	$2.68B	UAE	$2.10B	Argentina	$2.94B
United States	$1.73B	Mexico	$2.14B	Morocco	$2.00B	Myanmar	$2.91B
Indonesia	$1.71B	India	$1.96B	South Africa	$2.00B	UK	$2.41B
Japan		**France**		**Japan**		**France**	
United States	$8.25B	United Kingdom	$11.48B	Myanmar	$9.85B	UK	$5.94B
Australia	$3.59B	Italy	$7.86B	Vietnam	$5.19B	Romania	$4.02B
Canada	$2.73B	Germany	$2.20B	Indonesia	$5.02B	United States	$3.44B
United Kingdom	$2.33B	United States	$1.44B	Malaysia	$3.72B	Iran	$2.76B
France	$1.22B	India	$0.73B	UAE	$3.12B	Chile	$1.85B
Brazil	$1.15B	Poland	$0.46B	Australia	$2.61B	Brazil	$1.83B
Germany	$0.91B	Belgium	$0.38B	Thailand	$2.43B	Canada	$1.78B
Portugal	$0.66B	Spain	$0.35B	United States	$2.02B	Russia	$1.46B
South Korea	$0.57B	Canada	$0.15B	Chile	$1.59B	South Africa	$1.19B
Denmark	$0.41B	Egypt	$0.10B	Philippines	$1.38B	Germany	$1.14B

The origin-destination in Table 5 show outbound M&A and GF FDI of China, USA, Japan, and France. China's largest recipient in GF is Pakistan and India while Australia and Brazil are the most significant destinations of its M&A. USA's greatest GF outflow is into Canada with some investments elsewhere in Latin America, Asia, Africa and Australia. China's greatest GF outflow is into countries in Latin America (Brazil) and Asia (India); China's most significant M&A is to France, Canada, UK, Italy, Spain, and Australia. Japan's most substantial GF outflows are to Australia while its M&As are

to the US, Australia, Canada, UK, France, Germany, Spain, and China. To summarize, China's pattern of GF investment flows into the countries in Latin America and Asia. While the US, UK, and Japan choose Western Europe, Canada, and Australia as destinations in their M&A, their GF is more inclusive of the rest of the world. China, on the other hand, seems to be moving away from this North-North model as it invests in other regions of the world especially in the energy sector. We next describe specific cases of Chinese outbound FDI in the energy sector to provide representative examples detailing Chinese investment in all energy sub-sectors across different regions around the world.

3.3.1. Greenfield Projects

Resource extraction is a very important sub-sector for Chinese energy investment, particularly in Africa. As early as 2003, China Petroleum and Chemical (Sinopec) invested $1.8B for oil & gas fields representing the most significant example of Chinese investment in the African energy sector. In the electricity generation sector, Zonergy invested $1.5B in Pakistan for 1000 MW solar projects in 2015, which is now the most massive greenfield project China has ever invested in an overseas market; 300 MW of the project has come online in 2017, and the rest is expected to be online in late 2018. For transmission and distribution, China National Petroleum recently initiated a $4.0B investment in Mozambique to collectively build a gas pipeline with local oil & gas companies. The total length of the pipeline will be 1,600 miles and construction is expected to start in 2018. In Southeast Asia, many Chinese solar manufacturers started to offshore their production capacity. For instance, Comtec Solar System invested $372M in Malaysia. The manufacturing plant started operation in 2014 with an annual capacity of 300MW.

3.3.2. M&A Projects

Chinese M&A FDI is more substantial in the amount invested but fewer in number. In the resource extraction sector, the China National Offshore Oil Corporation (CNOOC) acquired Canadian Nexen at the cost of $18.2B. The deal completed in 2012 represents the single most considerable Chinese overseas investment in the energy sector. In the transmission and distribution sector, the State Grid Corporation of China acquired 35% share of a gas distribution network asset in Italy at the cost of $2.8B in 2014. For electricity generation, China Three Gorges Corporation acquired two hydroelectric plants, totaling 4.8 GW of generating capacity, in Brazil at the cost of $3.7B in 2015. Chinese investors now collectively own around 10% of the total power-generating asset in Brazil. In the wind manufacturing space, consolidation is a very recent trend, but Chinese turbine manufacturers are relatively less involved. The most substantial M&A deal Chinese firms have ever made is the acquisition of 70% of Vensys Energy in 2008 by Xinjiang Goldwind. The deal cost Goldwind $60 million and facilitates the export of Goldwind's turbines to the European market.

4. Discussion

In this paper, we investigated M&A and GF FDI in the energy sector using two databases. We divided the time of observation into pre-, peak-, and post-recession periods. We examined the level of M&A and GF investments by countries and continents in the period 2003-2016 and highlighted investment patterns in the 3 phases of recession. The share of energy M&As as a share of total global M&As in the three phases of recession is around 5% while the share of energy GF as a share of total GF is around 25-26% during pre-recession and recession. While energy accounts for nearly 25% of all FDI, it only accounts for 4.82% of total M&A activity in the period 1996-2016. Thus, global GF exceeds M&A activity in the energy sector at almost 5:1. Both investment types have recovered in the post-recession phase.

We highlighted the inbound and outbound investments in the energy sector, explicitly comparing and contrasting China with the US. China has invested heavily in the extraction and electricity generation sectors, while the US invests in many segments of the supply chain including pipeline, transmission & distribution, and manufacturing as well as extraction and electricity generation. Outbound M&A and GF FDI in the energy sector are changing. The Northern economies

are the traditional hotspots attracting investment.   Northern countries dominate outbound M&As; Northern and Southern countries receive inbound GF. A small number of countries account for a significant share of overall activity in all segments of the energy supply chain. The most consistent outbound investments in M&A are North-North countries. However, with the entry of China into the energy space in the recession and post-recession period, North-South outbound investments are emerging. China invests consistently more in the energy sector of European countries regarding M&A but has a more widespread distribution concerning GF.

Our paper provides a qualitative analysis of energy investments using two databases. Our fundamental contribution is segmenting the energy supply chain to discuss origin-destinations flows integrating two databases related to M&A and GF FDI. We specifically characterized China's investment and differentiated the pattern from that of the US investments. The next step in our research is to use spatial panel models of the data to quantitatively model energy flows and provide the rationale for such investments. Our long-term goal is to set up a framework to study China's BRI initiative especially related to energy sector. We want to characterize the flows of investment, as well as social, environmental, and economic impacts in the destination countries.

Supplementary Materials:

Appendix A: Database Details & Definitions

This appendix describes the definitions used for analyzing the energy supply chain steps in both databases.

Table A. Definitions for M&A Database, Dealogic

Definitions: M&A

Supply Chain Step	Target Primary NAICS	Number of Deals in DB
Electricity Generation	22111 - Electric Power Generation	3,272
Extraction	21111 - Oil and Gas Extraction	5,126
	21211 - Coal Mining	841
	42381 - Construction and Mining (except Oil Well) Machinery and Equipment Merchant W..	103
Manufacturing	32419 - Other Petroleum and Coal Products Manufacturing	143
	33313 - Mining and Oil and Gas Field Machinery Manufacturing	284
	33361 - Engine, Turbine, and Power Transmission Equipment Manufacturing	507
Power/Pipeline Transmission & Distribution	22112 - Electric Power Transmission, Control, and Distribution	674
	22121 - Natural Gas Distribution	643
	23712 - Oil and Gas Pipeline and Related Structures Construction	231
	23713 - Power and Communication Line and Related Structures Construction	223
	42471 - Petroleum Bulk Stations and Terminals	153
	48611 - Pipeline Transportation of Crude Oil	96
	48621 - Pipeline Transportation of Natural Gas	153
	48691 - Pipeline Transportation of Refined Petroleum Products	27
Refineries	32411 - Petroleum Refineries	342
Retail & Wholesalers	42352 - Coal and Other Mineral and Ore Merchant Wholesalers	88
	42472 - Petroleum and Petroleum Products Merchant Wholesalers (except Bulk Stations ..	177
	44711 - Gasoline Stations with Convenience Stores	91
	44719 - Other Gasoline Stations	63
	45431 - Fuel Dealers	123

Table B. Definitions for FDI Database: FDI Markets; Electricity Generation, Extraction, Manufacturing

Supply Chain Step	Industry Sector	Cluster	Sub-Sector	Industry Activity	# of Deals
Electricity Generation	Alternative/Renewable energy	Environmental Technology	Biomass power	Electricity	270
			Geothermal electric power	Electricity	71
			Hydroelectric power	Electricity	155
			Marine electric power	Electricity	23
			Other electric power gene..	Electricity	71
			Solar electric power	Electricity	824
			Wind electric power	Electricity	822
	Coal, Oil and Natural Gas	Energy	Fossil fuel electric power	Electricity	362
			Natural, liquefied and co..	Electricity	7
			Nuclear electric power ge..	Electricity	17
			Other electric power gene..	Electricity	226
			Other petroleum & coal pr..	Electricity	12
		Environmental Technology	Fossil fuel electric power	Electricity	1
Extraction	Coal, Oil and Natural Gas	Energy	Coal mining	Extraction	79
			Fossil fuel electric power	Extraction	1
			Natural, liquefied and co..	Extraction	35
			Oil & gas extraction	Electricity	1
				Extraction	940
			Other electric power gene..	Extraction	1
			Other petroleum & coal pr..	Extraction	123
		Environmental Technology	Oil & gas extraction	Extraction	1
		Industrial	Coal mining	Extraction	1
		Physical Sciences	Coal mining	Extraction	2
Manufacturing	Alternative/Renewable energy	Environmental Technology	Biomass power	Manufacturing	369
			Geothermal electric power	Manufacturing	1
			Hydroelectric power	Manufacturing	1
			Other electric power gene..	Manufacturing	5
			Wind electric power	Manufacturing	2
	Automotive Components	Transport Equipment	Power transmission equip..	Manufacturing	3
	Coal, Oil and Natural Gas	Construction	Other petroleum & coal pr..	Manufacturing	2
		Energy	Coal mining	Manufacturing	2
			Fossil fuel electric power	Manufacturing	4
			Natural, liquefied and co..	Manufacturing	158
			Nuclear electric power ge..	Manufacturing	14
			Other petroleum & coal pr..	Manufacturing	183
			Petroleum refineries	Manufacturing	166
		Industrial	Other petroleum & coal pr..	Manufacturing	15
			Petroleum refineries	Manufacturing	1
		Physical Sciences	Other petroleum & coal pr..	Manufacturing	6
		Transport Equipment	Other petroleum & coal pr..	Manufacturing	5
	Engines & Turbines	Energy	Engines & Turbines	Manufacturing	34
		Environmental Technology	Engines & Turbines	Manufacturing	222
	Industrial Machinery, Equipment & Tools	Energy	Power transmission equip..	Manufacturing	42
		Environmental Technology	Power transmission equip..	Manufacturing	19
		ICT & Electronics	Power transmission equip..	Manufacturing	13
		Industrial	Power transmission equip..	Manufacturing	320
		Transport Equipment	Power transmission equip..	Manufacturing	12
	Transportation	Energy	Other pipeline transporta..	Manufacturing	2
	Warehousing & Storage	Energy	Petroleum bulk stations &..	Manufacturing	31

Table C. Definitions for FDI Database: FDI Markets; Power/Pipeline Transmission & Distribution, Retail & Wholesale

Supply Chain Step	Industry Sector	Cluster	Sub-Sector	Industry Activity	# of Deals
Power/Pipeline Transmission & Distribution	Alternative/Renewable energy	Environmental Technology	Biomass power	Logistics, Distribution & Transport..	2
			Hydroelectric power	Logistics, Distribution & Transport..	2
			Other electric power gene..	Logistics, Distribution & Transport..	4
	Coal, Oil and Natural Gas	Construction	Other petroleum & coal pr..	Logistics, Distribution & Transport..	1
		Energy	Coal mining	Logistics, Distribution & Transport..	2
			Fossil fuel electric power	Logistics, Distribution & Transport..	1
			Natural, liquefied and co..	Logistics, Distribution & Transport..	103
			Nuclear electric power ge..	Logistics, Distribution & Transport..	1
			Oil & gas extraction	Logistics, Distribution & Transport..	11
			Other electric power gene..	Logistics, Distribution & Transport..	4
			Other petroleum & coal pr..	Logistics, Distribution & Transport..	94
		Industrial	Other petroleum & coal pr..	Logistics, Distribution & Transport..	3
		Transport Equipment	Other petroleum & coal pr..	Logistics, Distribution & Transport..	3
		Transportation, Warehou..	Other petroleum & coal pr..	Logistics, Distribution & Transport..	1
	Industrial Machinery, Equipment & Tools	ICT & Electronics	Power transmission equipment	Electricity	1
				Logistics, Distribution & Transport..	1
		Industrial	Power transmission equip..	Logistics, Distribution & Transport..	15
	Transportation	Energy	Other pipeline transporta..	Logistics, Distribution & Transport..	4
			Pipeline transportation of..	Logistics, Distribution & Transport..	51
			Pipeline transportation of..	Logistics, Distribution & Transport..	128
		Environmental Technology	Other pipeline transporta..	Logistics, Distribution & Transport..	3
		Transportation, Warehousing & Storage	Pipeline transportation of..	Logistics, Distribution & Transport..	1
			Pipeline transportation of..	Logistics, Distribution & Transport..	1
	Warehousing & Storage	Energy	Petroleum bulk stations &..	Logistics, Distribution & Transport..	121
		Environmental Technology	Petroleum bulk stations &..	Logistics, Distribution & Transport..	2
		Industrial	Petroleum bulk stations &..	Logistics, Distribution & Transport..	1
		Transportation, Warehou..	Petroleum bulk stations &..	Logistics, Distribution & Transport..	36
Retail & Wholesalers	Coal, Oil and Natural Gas	Energy	Gasoline stations	Shared Services Centre	3

While there is no accepted standard for region definitions, we selected regions as defined by the PLATTS database, which the team's researchers have been suing for other research projects.

Appendix B: Definitions for Regions

Region	
AFRICA	Algeria Angola Benin Botswana Burkina Faso Burundi Cameroon Cape Verde Central African Republic Chad Comoros Congo Congo, Democratic Republic of Cote D'Ivoire (Ivory Coast) Djibouti Egypt Equatorial Guinea Eritrea Ethiopia Gabon Gambia Ghana Guinea Guinea-Bissau Kenya Lesotho Liberia Libya Madagascar Malawi Mali Mauritania Mauritius Morocco Mozambique Namibia Niger Nigeria Reunion Rwanda Sao Tome and Principe Senegal Seychelles Sierra Leone Somalia South Africa South Sudan Sudan Swaziland Tanzania Togo Tunisia Uganda Western Sahara Zambia Zimbabwe
ANZ-OCEANIA	American Samoa Australia Cook Islands Fiji French Polynesia Guam Kiribati Marshall Islands New Caledonia New Zealand Niue Northern Mariana Islands Palau Samoa Solomon Islands Tokelau Tonga Tuvalu Vanuatu
ASIA	Bangladesh Bhutan Brunei Darussalam Cambodia China India Indonesia Japan Laos Malaysia Maldives Mongolia Myanmar Nepal North Korea Pakistan Papua New Guinea Philippines Singapore South Korea Sri Lanka Taiwan Thailand Timor-Leste Vietnam
CIS	Armenia Azerbaijan Belarus Georgia Kazakhstan Kyrgyzstan Moldova Russian Federation Tajikistan Turkmenistan Ukraine Uzbekistan
EUROPE	Albania Andorra Austria Belgium Bosnia and Herzegovina Bulgaria Croatia Cyprus Czech Republic Denmark Estonia Faroe Islands Finland France Germany Gibraltar Greece Greenland Hungary Iceland Ireland Isle of Man Italy Latvia Liechtenstein Lithuania Luxembourg Macedonia Malta Monaco Montenegro Netherlands Norway Poland Portugal Romania Serbia Slovak Republic Slovenia Spain Sweden Switzerland
LATIN	Bermuda St Lucia Suriname Trinidad & Tobago Turks and Caicos Islands Uruguay Venezuela
MIDEAST	Syria Turkey UAE Yemen
N AMERICA	Canada St. Pierre and Miquelon United States
NULL	Guernsey Hong Kong Jersey Macao San Marino Serbia and Montenegro UK United Kingdom Vatican City State (Holy See)

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