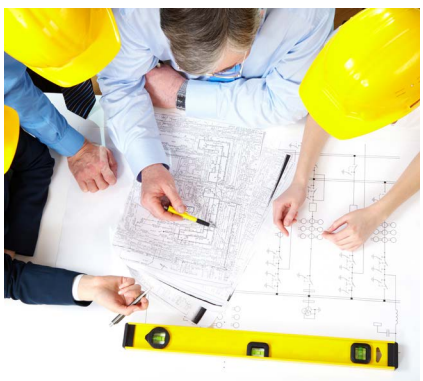
An IHS Energy / IHS Economics report

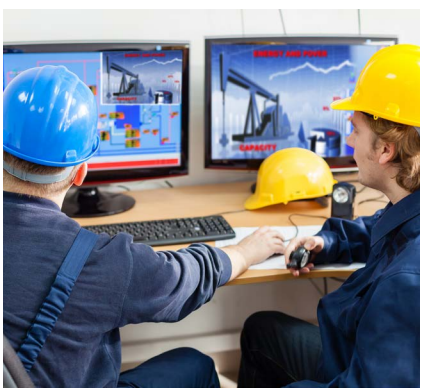
Unleashing the Supply Chain

Assessing the economic impact of a US crude oil free trade policy

March 2015





Appendix B: Supply chain modeling methodology

About IHS (ihs.com)

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Additional resources

Appendices are available at www.ihs.com/crudeoilsupplychain. Additionally, the results included in this study are available on an interactive website that provides access to detailed data for the supply chain and congressional districts which can also be accessed through this website.

Study purpose

Building on prior work assessing the industry and macroeconomic impact of changing US policy to allow exports of US crude oil, this study examines the impact on an intricate and interdependent supply chain that supports the oil industry and has made the scale-up of tight oil production possible. The analysis considers 60 separate supply chain industries and provides granular impact analysis at the congressional district level to fully understand the economic and job growth impact across the nation.

This report draws on the multidisciplinary expertise of IHS, including upstream, downstream and macroeconomic teams across IHS Energy and IHS Economics. The study has been supported by a group of sponsors in numerous industries. The analysis and conclusions contained in this report are entirely those of IHS Inc., which is solely responsible for the contents herein.

Related reports

The "Great Revival" in US natural gas and crude oil production has caused significant market and economic shifts. IHS has provided continuing analysis of these developments, their impact on global oil markets, and their influence on the US economy and US competitiveness. Some of the current studies include:

$30 or $130? Scenarios for the Global Oil Market to 2020

These are momentous times for the oil market. We are in a world without OPEC—at least as we knew it. Companies and investors face a heightened degree of uncertainty about the future of oil supply, price, and demand. IHS addresses the uncertainty through a new study, *$30 or $130? Scenarios for the Global Oil Market to 2020*. IHS Scenarios provide a coherent, dynamic framework to discuss several potential futures for the oil market and to test decisions. Through interactive workshops, study participants participate in the scenario development and helping identify key supply, demand, and geopolitical drivers that will shape the oil market to 2020. Decision making is more robust when analysis takes into account more than one view of the future.

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Oil: The Great Deflation

Through this framework series, IHS is providing insights and decision support to clients as they assess the impact and implications of the low oil price. IHS's unique breadth and depth of expertise spans the energy value chain and into adjacent industries and overall economies providing a fully integrated and objective perspective. The series provide a framework for more detailed discussions and consulting on a wide range of topics including: the tight oil and global production response, capital programs, cost deflation, storage and financial market influences, company strategies, demand response and asset transactions. The series is delivered through IHS Connect and a webinar series.

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America's New Energy Future

America's New Energy Future: The Unconventional Oil and Gas Revolution and the US Economy is a three-volume series based on IHS analyses of each shale gas and tight oil play. It calculates the investment of capital, labor and other inputs required to produce these hydrocarbons. The economic contributions of these investments are then calculated using the proprietary IHS economic contribution assessment and macroeconomic models to generate the contributions to employment, GDP growth, labor income and tax revenues that will result from the higher level of unconventional oil and natural gas development. Volume 3 in the study includes state-by-state analysis of the economic impacts and projections of additional investment in manufacturing as a result of these supplies.

See more at http://press.ihs.com/press-release/economics/us-unconventional-oil-and-gasrevolution-increase-disposable-income-more-270#.

Unleashing the Supply Chain study sponsors

The following organizations provided support for this study. The analysis and conclusions in this study are those of IHS, and IHS is solely responsible for the report and its content.

Baker Hughes, Chaparral Energy, Chesapeake Energy, Chevron, Concho Resources, ConcocoPhillips, Continental Resources , Devon Energy, Energy Equipment and Infrastructure Alliance, EOG Resources, Exxon Mobil, General Electric, Halliburton, Helmerich & Payne , Hess, Marathon Oil, Newfield Exploration, Oasis Petroleum, Occidental Petroleum, Pioneer Natural Resources, QEP Resources, Rosetta Resources, and WPX Energy

Appendix B: Supply chain modeling methodology

Methodology and approach

This appendix presents the data requirements and the assumptions we used to model the supply chain economic impact assessment of removing the ban on crude oil exports. The approach was the same for both the Base and Potential Production Cases.

Data requirements and assumptions

IHS compiled the data required to undertake the supply chain economic impact assessment of removing the crude oil export ban. The upstream activity data was segmented to distinguish the economic activity by industry groupings. These activities were segmented in the direct contributions in terms of production and capital expenditures. These metrics were used as inputs to the IHS US Macroeconomic Model (US Macro Model) to assess the national macroeconomic impact and again in the IMPLAN model to assess the supply chain sector impact on state and congressional level basis. The models require average annual estimates for production and capital spending. The following sector activities were determined to be the major, direct contributors:

- Oil and natural gas extraction
- Oil and natural gas drilling
- Support activities for oil and natural gas
- Construction of facilities, related materials and machinery for hydraulic fracturing and completions, and construction of oil and natural gas pipeline

The IMPLAN model required production and capital expenditure values in nominal dollar terms. The production levels were transformed into value of output using the IHS oil price outlook used in the previous study, *US Crude Oil Export Decision*. Capital expenditures and support services for drilling, completion, facilities, gathering and processing were provided in nominal dollars for the baseline outlook period.

Upstream assumptions

This section discusses the production profiles and associated capital expenditures in the upstream sector for removing the crude oil export ban. Conventional and unconventional oil and natural gas differ only in terms of well construction; all other aspects from exploration to marketing are identical. Wells for unconventional oil and natural gas require long horizontal wellbores and multi-stage hydraulic fracture completions to produce low-permeability reservoirs. This study assumes exploration and production from both conventional and unconventional oil plays.

Capital expenditure at the upstream phase of oil is undertaken for well construction, drilling, well completion, facilities, and gathering. Capital expenditures, on cumulative basis, are expected to be $746 billion between 20162 and 2030 in the Base Production Case and $974 billion in the Potential Production case. Cumulative value of oil production over the same period is assumed to be $751 and $995 billion in the two production cases.

Well construction starts with detailed planning of a well's location, both at the surface and for the trajectory and target below ground. IHS Energy estimated that an unconventional oil well in a shale or tight sand play can cost between $3 million and $12 million to drill and prepare for production. The cost of a well depends on the well type, the vertical depth of the well bore, its lateral length, reservoir pressure, rock characteristics, and the number of fracture stages for wells that are hydraulically fractured.

After drilling is completed, the well is prepared to begin production. This phase is called well completion and it concentrates more than 50% of total upstream capital expenditures for unconventional oil. The costs of drilling and constructing a well and putting it into operation represent the lion's share of the upstream capital expenditures. These two phases also represent the central components of the total economic contributions of the upstream oil activity. In addition to preparing the wells for production, a large component of the capital expenditure is spent for gathering lines and facilities; these include construction contractors and equipment manufacturers and dealers. The tables below present the types of capital expenditures for upstream and the corresponding IMPLAN categories.

Capital expenditure inputs to the IMPLAN model: US crude oil export supply chain

IMPLAN sector	Description	% of category expenditure
Drilling		
28	Drilling oil and gas wells	7.1%
29	Support activities for oil and gas operations	22.3%
36	Construction of other new nonresidential structures	21.4%
160	Cement manufacturing	0.9%
171	Steel product manufacturing from purchased steel	21.4%
220	Cutting tool and machine tool accessory manufacturing	21.4%
357	Insurance carriers	3.7%
369	Architectural, engineering, and related services	1.8%
Completions		
26	Sand, gravel, clay, and ceramic, and refractory minerals mining and quarrying	14.4%
28	Drilling oil and gas wells	13.0%
29	Support activities for oil and gas operations	14.0%
33	Water, sewage and other systems	7.2%
36	Construction of other new nonresidential structures	5.3%
121	Industrial gas manufacturing	7.2%
125	All other basic inorganic chemical manufacturing	7.2%
201	Fabricated pipe and pipe fitting manufacturing	1.1%
206	Mining and oil and gas field machinery manufacturing	14.3%
226	Pump and pumping equipment manufacturing	7.3%
227	Air and gas compressor manufacturing	6.1%
335	Truck transportation	2.9%
Facilities		
36	Construction of other new nonresidential structures	15.3%
188	Power boiler and heat exchanger manufacturing	1.6%
189	Metal tank (heavy gauge) manufacturing	24.5%
201	Fabricated pipe and pipe fitting manufacturing	17.5%
206	Mining and oil and gas field machinery manufacturing	8.3%
222	Turbine and turbine generator set units manufacturing	1.6%
226	Pump and pumping equipment manufacturing	3.6%
227	Air and gas compressor manufacturing	1.6%
247	Other electronic component manufacturing	10.5%
251	Industrial process variable instruments manufacturing	7.0%
256	Other measuring and controlling device manufacturing	3.5%
369	Architectural, engineering, and related services	5.0%
Gathering		
201	Fabricated pipe and pipe fitting manufacturing	10.8%
206	Mining and oil and gas field machinery manufacturing	23.6%
227	Air and gas compressor manufacturing	65.6%

Source: IHS Energy Insight and IHS Economics

National assessment

Here we present the methodology for measuring the economic contribution of the supply chain impacts under the restricted trade and free trade scenarios. The results are presented in terms of the difference in levels of economic contribution between free trade and restricted trade for each case: the Base Production Case and the Potential Production Case.

Using data and analyses from proprietary databases and the IMPLAN model, IHS evaluated the impacts to the supply chain by applying a customized industrial structure of the US economy. The data categories in the model were tailored to the specific mix of equipment, materials, and services that characterize the US crude oil supply chain. IHS linked the IMPLAN model to its dynamic US and state macroeconomic models in order to augment the supply chain determination of employment, value added, and labor income impacts with a comprehensive dynamic modeling methodology employed in the US Crude Oil Export Decision. IHS' baseline macroeconomic forecasts for the US and state economies were re-specified to assess the contribution on the 60 supply chain sectors if the export ban on US crude oil were eliminated. All models were run using the initial set of input assumptions and were calibrated. The resulting economic impact is measured in terms of jobs created or sustained, value added contribution to GDP, and employee wages and compensation. The calibration process compared the sum of the direct, indirect, and induced impacts (for all metrics) from the supply chain (IMPLAN) model and scaled it to the total impact from the state macroeconomic models. While all the supply chain sectors were selected from the direct and indirect effects (defined below), the induced effect was left out as it relates to the income effect.

Direct Impacts: This is the effect of the core industry's output, employment, and income. For example, removing the US crude oil export ban will have implications for the energy value chain – its upstream (production), midstream (transportation and logistics), and downstream (processing and marketing) elements – in terms of capital expenditures and operating expenditures. These activities directly contribute to exploration (capital expenditures) and production activity (operating expenditures). Others directly involved in US crude oil export activities are midstream processing and pipeline transportation companies, downstream local distribution companies, and onsite construction service providers.

Indirect Impacts: Purchasing patterns of crude oil development indirectly contribute to all of the supplier industries. Changes in demand from the directly impacted industries lead to corresponding changes in output, employment, and labor income throughout each industry's own supply chains via inter-industry linkages. The affected supplier activities span the majority of US industries. For this crude oil export supply chain analysis, IHS has focused on the 60 major supply chain sectors.

State assessment

While the previous study, *US Crude Oil Export Decision*, used macroeconomic state models to assess the total economic impact of lifting the US crude oil export ban under two projection trajectories, this study utilizes Input/Output models to trace and assess the impacts at the sector- and supplier-industry levels. IHS has integrated and calibrated the two modeling approaches by embedding and linking the sectoral model within the IHS macroeconomic modeling system.

The model framework utilized in this analysis was established as a system of linked state economies to capture the flow of trade across state borders. As a result, the sourcing of supplies requisite for crude oil development activity impacts states that do not have an oil play within their borders. For example, oil development in North Dakota relies on companies that provide banking, financial, and insurance services in Chicago and New York City as well as professional services firms that might be located in Dallas, San Francisco and Boston. Capturing these connections highlights the indirect economic contribution even in non-producing states.

By focusing on the interaction of economic activity among the states, IHS provides a more careful analysis of state-level impacts resulting from a change in crude oil export policy. In addition, while the economic value created by oil production is attributed solely to states with plays, the allocation of capital

expenditures across the 50 states is interconnected. Capital spending may be incurred at an oil production site, but the machinery and equipment, architectural and engineering services, materials, and other expenditures may occur in other locations far from production. To ensure that these effects are fully captured in the analysis, insights from the IHS Economics and IHS Energy teams, web-based primary research, and IHS proprietary databases were employed to appropriately allocate capital expenditures to the individual states.

IHS integrated information from a number of different proprietary and public sources to determine interstate trade flows. The analysis was supported by multiple industry sources, the IHS TRANSEARCH© Business Market Insight databases, and IHS expert judgment. For example, unconventional oil extraction employing hydraulic fracturing techniques requires sand with unique properties produced primarily in Wisconsin, Minnesota, Ohio, and Arkansas. Since not all states with unconventional oil or gas plays produce these distinctive sands, they must procure them from suppliers elsewhere (and are assumed to do so in the sectoral model). The IHS TRANSEARCH© trade-flow database was one of several sources used to determine the origin and destination of the various materials and equipment on a state level. This process was undertaken for all of the detailed capital expenditure categories (defined as various products and services). The set of products and services, and — in a producing state — the value of production, were input into the corresponding state model to assess the impact of the supply chain in each individual state's economy as determined by the multi-regional analysis capability and related coefficients of the IMPLAN model. The net result is an assessment of the supply chain across all state economies.

Congressional district assessment

State-level results were linked to congressional districts using two internal IHS sources. First, the IHS Energy team provided assumptions at the district-level for drilling, production, and other exploration activities. Second, the IHS Economics team provided detailed sector-level economic activity, by congressional district, found in the proprietary IHS Business Market Insights dataset. As described below, types of impacts from the supply chain model – direct, indirect, and induced economic impacts – were linked and integrated from states to congressional districts separately.

Direct impacts at the congressional district level are a function of both the economic activity's location, as provided by IHS Energy, and the baseline economic activity in IHS Business Market Insights data. This process assigns the share of the impact to the district where the direct activity occurred, while crediting the residual shares to other districts within the state as a function of the location of the baseline activity. This logic allows for intrastate sourcing of direct activity but assumes a higher probability that supply chain activity (if available) will occur at the location of the direct activity.

Indirect and induced impacts are distributed to congressional districts as a function of baseline economic activity for each congressional district from IHS Business Market Insights. This logic allows for intrastate sourcing of indirect and induced activity based on the statewide distribution of supplier industries and income induced.

Finally, once all direct, indirect, and induced economic impacts were distributed to congressional districts, a final validation process was applied to ensure that economic activity in a given sector is not assigned to a district where that sector does not exist in the baseline. This logic was implemented to ensure that constraints in the location of skilled labor and capital were enforced.

NAICS definitions

The categories listed represent the NAICS-based BLS industrial employment categories used in the analysis of the unconventional energy supply chain. The source of this information is the US Census' Bureau's official NAICS website: http://www.census.gov/eos/www/naics/index.html.

The categories are presented below in the order of the key industry segments of the unconventional supply chain.

Construction and well services

23 Construction of New Nonresidential Manufacturing Structures and Other New Nonresidential Structures

In non-producing states, the construction activities will be concentrated in rail, pipelines, and storage facilities. In the producing states, the construction activities will incorporate marine structures, facilities to export LNG, and manufacturing structures.

213111 Drilling Oil and Gas Wells

This US industry comprises establishments primarily engaged in drilling oil and gas wells for others on a contract or fee basis. This industry includes contractors that specialize in spudding in, drilling in, redrilling, and directional drilling.

213112 Support Activities for Oil and Gas Operations

This US industry comprises establishments primarily engaged in performing support activities on a contract or fee basis for oil and gas operations (except site preparation and related construction activities). Services included are exploration (except geophysical surveying and mapping); excavating slush pits and cellars, well surveying; running, cutting, and pulling casings, tubes, and rods; cementing wells, shooting wells; perforating well casings; acidizing and chemically treating wells; and cleaning out, bailing, and swabbing wells.

Industrial equipment and machinery

3331 Agriculture, Construction, and Mining Machinery Manufacturing

This industry comprises establishments primarily engaged in:

- Manufacturing oil and gas field machinery and equipment, such as oil and gas field drilling machinery and equipment; oil and gas field production machinery and equipment; and oil and gas field derricks and (2) manufacturing water well drilling machinery.
- Manufacturing underground mining machinery and equipment, such as coal breakers, mining cars, core drills, coal cutters, rock drills and manufacturing mineral beneficiating machinery and equipment used in surface or underground mines.
- Manufacturing farm machinery and equipment, powered mowing equipment and other powered home lawn and garden equipment.
- Manufacturing agricultural and farm machinery and equipment, and other turf and grounds care equipment, including planting, harvesting, and grass mowing equipment (except lawn and garden-type).
- Manufacturing powered lawnmowers, lawn and garden tractors, and other home lawn and garden equipment, such as tillers, shredders, yard vacuums, and leaf blowers.
- Manufacturing construction machinery, surface mining machinery, and logging equipment.

4231 Motor Vehicle and Motor Vehicle Parts and Supplies Merchant Wholesalers

This industry group comprises establishments primarily engaged in the merchant wholesale distribution of automobiles and other motor vehicles, motor vehicle supplies, tires, and new and used parts.

4238 Machinery, Equipment, and Supplies Merchant Wholesalers

This industry group comprises establishments primarily engaged in the merchant wholesale distribution of construction, mining, farm, garden, industrial, service establishment, and transportation machinery, equipment and supplies.

332410 Power Boiler and Heat Exchanger Manufacturing

This industry comprises establishments primarily engaged in manufacturing power boilers and heat exchangers. Establishments in this industry may perform installation in addition to manufacturing power boilers and heat exchangers.

332420 Metal Tank (Heavy Gauge) Manufacturing

This industry comprises establishments primarily engaged in cutting, forming, and joining heavy gauge metal to manufacture tanks, vessels, and other containers.

333112 Lawn and Garden Tractor and Home Lawn and Garden Equipment Manufacturing

This US industry comprises establishments primarily engaged in manufacturing powered lawnmowers, lawn and garden tractors, and other home lawn and garden equipment, such as tillers, shredders, yard vacuums, and leaf blowers.

333515 Cutting Tool and Machine Tool Accessory Manufacturing

This US industry comprises establishments primarily engaged in manufacturing accessories and attachments for metal cutting and metal forming machine tools.

333611 Turbine and Turbine Generator Set Units Manufacturing

This US industry comprises establishments primarily engaged in manufacturing turbines (except aircraft); and complete turbine generator set units, such as steam, hydraulic, gas, and wind.

333612 Speed Changer, Industrial High-Speed Drive, and Gear Manufacturing

This US industry comprises establishments primarily engaged in manufacturing gears, speed changers, and industrial high-speed drives (except hydrostatic).

333613 Mechanical Power Transmission Equipment Manufacturing

This US industry comprises establishments primarily engaged in manufacturing mechanical power transmission equipment (except motor vehicle and aircraft), such as plain bearings, clutches (except motor vehicle and electromagnetic industrial control), couplings, joints, and drive chains.

333618 Other Engine Equipment Manufacturing

This US industry comprises establishments primarily engaged in manufacturing internal combustion engines (except automotive gasoline and aircraft).

333911 Pump and Pumping Equipment Manufacturing

This US industry comprises establishments primarily engaged in manufacturing general purpose pumps and pumping equipment (except fluid power pumps and motors), such as reciprocating pumps, turbine pumps, centrifugal pumps, rotary pumps, diaphragm pumps, domestic water system pumps, oil well and oil field pumps and sump pumps.

333912 Air and Gas Compressor Manufacturing

This US industry comprises establishments primarily engaged in manufacturing general purpose air and gas compressors, such as reciprocating compressors, centrifugal compressors, vacuum pumps (except laboratory), and nonagricultural spraying and dusting compressors and spray gun units.

333922 Conveyor and Conveying Equipment Manufacturing

This US industry comprises establishments primarily engaged in manufacturing conveyors and conveying equipment, such as gravity conveyors, trolley conveyors, tow conveyors, pneumatic tube conveyors, carousel conveyors, farm conveyors, and belt conveyors.

333991 Power-Driven Handtool Manufacturing

This US industry comprises establishments primarily engaged in manufacturing power-driven (e.g., battery, corded, pneumatic) handtools, such as drills, screwguns, circular saws, chain saws, staplers, and nailers.

334419 Other Electronic Component Manufacturing

This US industry comprises establishments primarily engaged in manufacturing electronic components (except bare printed circuit boards; semiconductors and related devices; electronic capacitors; electronic resistors; coils, transformers and other inductors; connectors; and loaded printed circuit boards).

334512 Automatic Environmental Control Manufacturing for Residential, Commercial, and Appliance Use

This US industry comprises establishments primarily engaged in manufacturing automatic controls and regulators for applications, such as heating, air-conditioning, refrigeration and appliances.

334513 Instruments and Related Products Manufacturing for Measuring, Displaying, and Controlling Industrial Process Variables

This US industry comprises establishments primarily engaged in manufacturing instruments and related devices for measuring, displaying, indicating, recording, transmitting, and controlling industrial process variables. These instruments measure, display or control (monitor, analyze, and so forth) industrial process variables, such as temperature, humidity, pressure, vacuum, combustion, flow, level, viscosity, density, acidity, concentration, and rotation.

334514 Totalizing Fluid Meter and Counting Device Manufacturing

This US industry comprises establishments primarily engaged in manufacturing totalizing (i.e., registering) fluid meters and counting devices. Examples of products made by these establishments are gas consumption meters, water consumption meters, parking meters, taxi meters, motor vehicle gauges, and fare collection equipment.

334516 Analytical Laboratory Instrument Manufacturing

This US industry comprises establishments primarily engaged in manufacturing instruments and instrumentation systems for laboratory analysis of the chemical or physical composition or concentration of samples of solid, fluid, gaseous, or composite material.

334519 Other Measuring and Controlling Device Manufacturing

This US industry comprises establishments primarily engaged in manufacturing measuring and controlling devices (except search, detection, navigation, guidance, aeronautical, and nautical instruments and systems; automatic environmental controls for residential, commercial, and appliance use; instruments for measurement, display, and control of industrial process variables; totalizing fluid meters and counting devices; instruments for measuring and testing electricity and electrical signals; analytical laboratory instruments; irradiation equipment; and electromedical and electrotherapeutic apparatus).

336112 Light Truck and Utility Vehicle Manufacturing

This US industry comprises establishments primarily engaged in (1) manufacturing complete light trucks and utility vehicles (i.e., body and chassis) or (2) manufacturing light truck and utility vehicle chassis only. Vehicles made include light duty vans, pick-up trucks, minivans, and sport utility vehicles.

336120 Heavy Duty Truck Manufacturing

This industry comprises establishments primarily engaged in (1) manufacturing heavy duty truck chassis and assembling complete heavy duty trucks, buses, heavy duty motor homes, and other special purpose heavy duty motor vehicles for highway use or (2) manufacturing heavy duty truck chassis only.

336510 Railroad Rolling Stock Manufacturing

This industry comprises establishments primarily engaged in one or more of the following: (1) manufacturing and/or rebuilding locomotives, locomotive frames and parts; (2) manufacturing railroad, street, and rapid transit cars and car equipment for operation on rails for freight and passenger service; and (3) manufacturing rail layers, ballast distributors, rail tamping equipment and other railway track maintenance equipment.

Information technology

3341 Computer and Peripheral Equipment Manufacturing

This industry comprises establishments primarily engaged in manufacturing and/or assembling electronic computers, such as mainframes, personal computers, workstations, laptops, and computer servers; and computer peripheral equipment, such as storage devices, printers, monitors, input/output devices and terminals. Computers can be analog, digital, or hybrid. Digital computers, the most common type, are devices that do all of the following: (1) store the processing program or programs and the data immediately necessary for the execution of the program; (2) can be freely programmed in accordance with the requirements of the user; (3) perform arithmetical computations specified by the user; and (4) execute, without human intervention, a processing program that requires the computer to modify its execution by logical decision during the processing run. Analog computers are capable of simulating mathematical models and comprise at least analog, control, and programming elements.

5112 Software Publishers

This industry comprises establishments primarily engaged in computer software publishing or publishing and reproduction. Establishments in this industry carry out operations necessary for producing and distributing computer software, such as designing, providing documentation, assisting in installation,

and providing support services to software purchasers. These establishments may design, develop, and publish, or publish only.

5415 Computer Services

This industry comprises establishments primarily engaged in providing expertise in the field of information technologies through one or more of the following activities: (1) writing, modifying, testing, and supporting software to meet the needs of a particular customer; (2) planning and designing computer systems that integrate computer hardware, software, and communication technologies; (3) on-site management and operation of clients' computer systems and/or data processing facilities; and (4) other professional and technical computer-related advice and services.

Logistics

4821 Rail Transportation

This industry comprises establishments primarily engaged in operating railroads (except street railroads, commuter rail, urban rapid transit, and scenic and sightseeing trains). Line-haul railroads and short-line railroads are included in this industry.

483 Water Transportation

Industries in the Water Transportation subsector provide water transportation of passengers and cargo using watercraft, such as ships, barges, and boats. The subsector is composed of two industry groups: (1) one for deep sea, coastal, and Great Lakes; and (2) one for inland water transportation. This split typically reflects the difference in equipment used. Scenic and sightseeing water transportation services are not included in this subsector.

4841 General Freight Trucking

This industry group comprises establishments primarily engaged in providing general freight trucking. General freight establishments handle a wide variety of commodities, generally palletized, and transported in a container or van trailer. The establishments of this industry group provide a combination of the following network activities: local pickup, local sorting and terminal operations, line-haul, destination sorting and terminal operations, and local delivery.

486 Pipeline Transportation

Industries in the Pipeline Transportation subsector use transmission pipelines to transport products, such as crude oil, natural gas, refined petroleum products, and slurry. Industries are identified based on the products transported (i.e., pipeline transportation of crude oil, natural gas, refined petroleum products, and other products).

Materials

3312 Steel Product Manufacturing from Purchased Steel

This industry group comprises establishments primarily engaged in manufacturing iron and steel tube and pipe, drawing steel wire, and rolling or drawing shapes from purchased iron or steel.

423 Merchant Wholesalers, Durable Goods

Industries in the Merchant Wholesalers, Durable Goods subsector sell capital or durable goods to other businesses. Merchant wholesalers generally take title to the goods that they sell; in other words, they

buy and sell goods on their own account. Durable goods are new or used items generally with a normal life expectancy of three years or more. Durable goods merchant wholesale trade establishments are engaged in wholesaling products, such as motor vehicles, furniture, construction materials, machinery and equipment (including household-type appliances), metals and minerals (except petroleum), sporting goods, toys and hobby goods, recyclable materials, and parts:

- 4233 Lumber and Other Construction Materials Merchant Wholesalers
- 4235 Metal and Mineral (except Petroleum) Merchant Wholesalers
- 4236 Household Appliances and Electrical and Electronic Goods Merchant Wholesalers
- 4237 Hardware, and Plumbing and Heating Equipment and Supplies Merchant Wholesalers
- 4246 Chemical and Allied Products Merchant Wholesalers: this industry group comprises establishments primarily engaged in the merchant wholesale distribution of chemicals, plastics materials and basic forms and shapes, and allied products.

212321 Construction Sand and Gravel Mining

This US industry comprises establishments primarily engaged in one or more of the following: (1) operating commercial grade (i.e., construction) sand and gravel pits; (2) dredging for commercial grade sand and gravel; and (3) washing, screening, or otherwise preparing commercial grade sand and gravel.

325120 Industrial Gas Manufacturing

This industry comprises establishments primarily engaged in manufacturing industrial organic and inorganic gases in compressed, liquid, and solid forms.

325180 Other Basic Inorganic Chemical Manufacturing

This industry comprises establishments primarily engaged in manufacturing basic inorganic chemicals (except industrial gases and synthetic dyes and pigments).

327310 Cement Manufacturing

This industry comprises establishments primarily engaged in manufacturing portland, natural, masonry, pozzolanic, and other hydraulic cements. Cement manufacturing establishments may calcine earths or mine, quarry, manufacture, or purchase lime.

327320 Ready-Mix Concrete Manufacturing

This industry comprises establishments, such as batch plants or mix plants, primarily engaged in manufacturing concrete delivered to a purchaser in a plastic and unhardened state. Ready-mix concrete manufacturing establishments may mine, quarry, or purchase sand and gravel.

327331 Concrete Block and Brick Manufacturing

This US industry comprises establishments primarily engaged in manufacturing concrete block and brick.

331110 Iron and Steel Mills and Ferroalloy Manufacturing

This industry comprises establishments primarily engaged in one or more of the following: (1) direct reduction of iron ore; (2) manufacturing pig iron in molten or solid form; (3) converting pig iron into steel; (4) making steel; (5) making steel and manufacturing shapes (e.g., bar, plate, rod, sheet, strip, wire);

(6) making steel and forming pipe and tube; and (7) manufacturing electrometallurgical ferroalloys. Ferroalloys add critical elements, such as silicon and manganese for carbon steel and chromium, vanadium, tungsten, titanium, and molybdenum for low- and high-alloy metals. Ferroalloys include iron-rich alloys and more pure forms of elements added during the steel manufacturing process that alter or improve the characteristics of the metal being made.

331315 Aluminum Sheet, Plate, and Foil Manufacturing

This US industry comprises establishments primarily engaged in (1) flat rolling or continuous casting sheet, plate, foil and welded tube from purchased aluminum; and/or (2) recovering aluminum from scrap and flat rolling or continuous casting sheet, plate, foil, and welded tube in integrated mills.

332996 Fabricated Pipe and Pipe Fitting Manufacturing

This US industry comprises establishments primarily engaged in fabricating, such as cutting, threading, and bending metal pipes and pipe fittings made from purchased metal pipe.

Professional and other services

2213 Water, Sewage and Other Systems

This industry comprises establishments primarily engaged in:

- Operating water treatment plants and/or operating water supply systems. The water supply system may include pumping stations, aqueducts, and/or distribution mains. The water may be used for drinking, irrigation, or other uses.
- Operating sewer systems or sewage treatment facilities that collect, treat, and dispose of waste.
- Providing steam, heated air, or cooled air. The steam distribution may be through mains.

4931 Warehousing and Storage

This industry comprises establishments primarily engaged in:

- Operating merchandise warehousing and storage facilities. These establishments generally handle goods in containers, such as boxes, barrels, and/or drums, using equipment, such as forklifts, pallets, and racks. They are not specialized in handling bulk products of any particular type, size, or quantity of goods or products.
- Operating refrigerated warehousing and storage facilities. Establishments primarily engaged in the storage of furs for the trade are included in this industry. The services provided by these establishments include blast freezing, tempering, and modified atmosphere storage services.
- Operating bulk farm product warehousing and storage facilities (except refrigerated). Grain elevators primarily engaged in storage are included in this industry.
- Operating warehousing and storage facilities (except general merchandise, refrigerated, and farm product warehousing and storage).

52 Finance and Insurance

The Finance and Insurance sector comprises establishments primarily engaged in financial transactions (transactions involving the creation, liquidation, or change in ownership of financial assets) and/or in facilitating financial transactions. Three principal types of activities are identified:

1. Raising funds by taking deposits and/or issuing securities and, in the process, incurring liabilities. Establishments engaged in this activity use raised funds to acquire financial assets by making loans and/or purchasing securities. Putting themselves at risk, they channel funds from lenders to borrowers and transform or repackage the funds with respect to maturity, scale, and risk. This activity is known as financial intermediation.

2. Pooling of risk by underwriting insurance and annuities. Establishments engaged in this activity collect fees, insurance premiums, or annuity considerations; build up reserves; invest those reserves; and make contractual payments. Fees are based on the expected incidence of the insured risk and the expected return on investment.

3. Providing specialized services facilitating or supporting financial intermediation, insurance, and employee benefit programs.

In addition, monetary authorities charged with monetary control are included in this sector.

The subsectors, industry groups, and industries within the NAICS Finance and Insurance sector are defined on the basis of their unique production processes. As with all industries, the production processes are distinguished by their use of specialized human resources and specialized physical capital. In addition, the way in which these establishments acquire and allocate financial capital, their source of funds, and the use of those funds provides a third basis for distinguishing characteristics of the production process. For instance, the production process in raising funds through deposit-taking is different from the process of raising funds in bond or money markets. The process of making loans to individuals also requires different production processes than does the creation of investment pools or the underwriting of securities.

Most of the Finance and Insurance subsectors contain one or more industry groups of (1) intermediaries with similar patterns of raising and using funds and (2) establishments engaged in activities that facilitate, or are otherwise related to, that type of financial or insurance intermediation. Industries within this sector are defined in terms of activities for which a production process can be specified, and many of these activities are not exclusive to a particular type of financial institution. To deal with the varied activities taking place within existing financial institutions, the approach is to split these institutions into components performing specialized services. This requires defining the units engaged in providing those services and developing procedures that allow for their delineation. These units are the equivalents for finance and insurance of the establishments defined for other industries.

The output of many financial services, as well as the inputs and the processes by which they are combined, cannot be observed at a single location and can only be defined at a higher level of the organizational structure of the enterprise. Additionally, a number of independent activities that represent separate and distinct production processes may take place at a single location belonging to a multilocation financial firm. Activities are more likely to be homogeneous with respect to production characteristics than are locations, at least in financial services. The classification defines activities broadly enough that it can be used both by those classifying by location and by those employing a more top-down approach to the delineation of the establishment.

Establishments engaged in activities that facilitate, or are otherwise related to, the various types of intermediation have been included in individual subsectors, rather than in a separate subsector dedicated to services alone because these services are performed by intermediaries, as well as by specialist establishments, the extent to which the activity of the intermediaries can be separately identified is not clear.

The Finance and Insurance sector has been defined to encompass establishments primarily engaged in financial transactions; that is, transactions involving the creation, liquidation, change in ownership of financial assets; or in facilitating financial transactions. Financial industries are extensive users of electronic means for facilitating the verification of financial balances, authorizing transactions,

transferring funds to and from transactors' accounts, notifying banks (or credit card issuers) of the individual transactions, and providing daily summaries. Since these transaction processing activities are integral to the production of finance and insurance services, establishments that principally provide a financial transaction processing service are classified to this sector, rather than to the data processing industry in the Information sector.

Legal entities that hold portfolios of assets on behalf of others are significant and data on them are required for a variety of purposes. Thus for NAICS, these funds, trusts, and other financial vehicles are the fifth subsector of the Finance and Insurance sector. These entities earn interest, dividends, and other property income, but have little or no employment and no revenue from the sale of services. Separate establishments and employees devoted to the management of funds are classified in Industry Group 5239, Other Financial Investment Activities.

5241 Insurance Carriers[1]

This industry group comprises establishments primarily engaged in underwriting (assuming the risk, assigning premiums, and so forth) annuities and insurance policies and investing premiums to build up a portfolio of financial assets to be used against future claims. Direct insurance carriers are establishments that are primarily engaged in initially underwriting and assuming the risk of annuities and insurance policies. Reinsurance carriers are establishments that are primarily engaged in assuming all or part of the risk associated with an existing insurance policy (or set of policies) originally underwritten by another insurance carrier.

5413 Architectural, Engineering, and Related Services

This industry comprises establishments primarily engaged in:

- Planning and designing residential, institutional, leisure, commercial, and industrial buildings and structures by applying knowledge of design, construction procedures, zoning regulations, building codes, and building materials.

- Planning and designing the development of land areas for projects, such as parks and other recreational areas; airports; highways; hospitals; schools; land subdivisions; and commercial, industrial, and residential areas, by applying knowledge of land characteristics, location of buildings and structures, use of land areas, and design of landscape projects.

- Applying physical laws and principles of engineering in the design, development, and utilization of machines, materials, instruments, structures, processes, and systems. The assignments undertaken by these establishments may involve any of the following activities: provision of advice, preparation of feasibility studies, preparation of preliminary and final plans and designs, provision of technical services during the construction or installation phase, inspection and evaluation of engineering projects, and related services.

- Drawing detailed layouts, plans, and illustrations of buildings, structures, systems, or components from engineering and architectural specifications.

- Providing building inspection services. These establishments typically evaluate all aspects of the building structure and component systems and prepare a report on the physical condition of the property, generally for buyers or others involved in real estate transactions. Building inspection bureaus and establishments providing home inspection services are included in this industry.

- Gathering, interpreting, and mapping geophysical data. Establishments in this industry often specialize in locating and measuring the extent of subsurface resources, such as oil, gas, and minerals, but they

1 For the purpose of the supply chain model, we have segmented NAICS 5241 (Insurance Carriers) out of the overall NAICS 52 to assess a more granular assessment.

may also conduct surveys for engineering purposes. Establishments in this industry use a variety of surveying techniques depending on the purpose of the survey, including magnetic surveys, gravity surveys, seismic surveys, or electrical and electromagnetic surveys.

- Performing surveying and mapping services of the surface of the earth, including the sea floor. These services may include surveying and mapping of areas above or below the surface of the earth, such as the creation of view easements or segregating rights in parcels of land by creating underground utility easements.

- Performing physical, chemical, and other analytical testing services, such as acoustics or vibration testing, assaying, biological testing (except medical and veterinary), calibration testing, electrical and electronic testing, geotechnical testing, mechanical testing, nondestructive testing, or thermal testing. The testing may occur in a laboratory or on-site.

5419 Other Professional, Scientific, and Technical Services

This industry group comprises establishments engaged in professional, scientific, and technical services (except legal services; accounting, tax preparation, bookkeeping, and related services; architectural, engineering, and related services; specialized design services; computer systems design and related services; management, scientific, and technical consulting services; scientific research and development services; and advertising, public relations and related services).

532412 Construction, Mining, and Forestry Machinery and Equipment Rental and Leasing

This US industry comprises establishments primarily engaged in renting or leasing heavy equipment without operators that may be used for construction, mining, or forestry, such as bulldozers, earthmoving equipment, well-drilling machinery and equipment, or cranes.

562219 Other Nonhazardous Waste Treatment and Disposal

This US industry comprises establishments primarily engaged in (1) operating nonhazardous waste treatment and disposal facilities (except landfills, combustors, incinerators and sewer systems or sewage treatment facilities) or (2) the combined activity of collecting and/or hauling of nonhazardous waste materials within a local area and operating waste treatment or disposal facilities (except landfills, combustors, incinerators and sewer systems, or sewage treatment facilities). Compost dumps are included in this industry.

811310 Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance

This industry comprises establishments primarily engaged in the repair and maintenance of commercial and industrial machinery and equipment. Establishments in this industry either sharpen/install commercial and industrial machinery blades and saws or provide welding (e.g., automotive, general) repair services; or repair agricultural and other heavy and industrial machinery and equipment (e.g., forklifts and other materials handling equipment, machine tools, commercial refrigeration equipment, construction equipment, and mining machinery).