



AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
<http://ageconsearch.umn.edu>
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

Oil and Gas Industry's Economic Contribution to North Dakota in 2021



Dean A. Bangsund
Department of Agribusiness and Applied Economics
and
Nancy M. Hodur, PhD
Center for Social Research

North Dakota State University
Fargo, North Dakota 58105

NDSU NORTH DAKOTA
STATE UNIVERSITY

ACKNOWLEDGMENTS

Special thanks are extended to the following for their assistance in soliciting industry cooperation and outreach of study results:

Ron Ness, President, North Dakota Petroleum Council
Reva Kautz, North Dakota Petroleum Council
Tessa Sandstrom, North Dakota Petroleum Foundation

Several individuals were helpful at various stages of the study. Our appreciation and thanks are extended to:

Justin Kringstad (North Dakota Pipeline Authority)
Bruce Hicks (North Dakota Department of Mineral Resources)
Bryan Bittner (North Dakota Office of State Tax Commissioner)
Kristy McCuster (North Dakota Department of Trust Lands)
Patrick Finken (Consultant)

The study authors and study sponsors would like to thank all the companies and individuals that took the time to complete and return the survey materials. This study, with its reliance on industry data, would not have been possible without industry cooperation.

Thanks are extended to Edie Nelson for document preparation, and to our colleagues for reviewing this manuscript.

Financial support was provided by the North Dakota Petroleum Council. We express our appreciation for their support.

The authors assume responsibility for any errors of omission, logic, or otherwise. Any opinions, findings, or conclusions expressed in this publication are those of the authors and do not necessarily reflect the views of the North Dakota Petroleum Council, the NDSU Department of Agribusiness and Applied Economics or NDSU Center for Social Research.

A single copy of this publication is available free of charge. Please address your inquiry to the Department of Agribusiness and Applied Economics, North Dakota State University, PO Box 5636, Fargo, ND 58105-5636, phone (701-231-7441), fax (701-231-7400), or e-mail: edie.nelson@ndsu.edu. This publication is also available electronically at the following web site: <http://ageconsearch.umn.edu/>

NDSU is equal opportunity institution.

Copyright © 2023 by Bangsund and Hodur. All rights reserved. Readers may make verbatim copies of this document for non-commercial purposes by any means, provided this copyright notice appears on all such copies.

TABLE OF CONTENTS

	<u>Page</u>
List of Tables	iii
List of Figures	iv
List of Appendix Tables	v
List of Appendix Figures	viii
Executive Summary.....	ix
North Dakota Oil Production Statistics	2
Procedures	5
Industry Survey	5
IMPLAN Industry Profiles	5
Input-Output Analysis	5
Key Economic Metrics.....	7
Exploration and Development	7
Oil and Gas Production	8
Processing and Transportation	9
Government Revenues	10
Economic Contribution	11
Employment.....	11
Exploration and Development	14
Oil and Gas Production	14
Processing and Transportation	15
Capital Expenditures	17
Government Revenues	20
Total Economic Contribution	22
Comparison of Previous Economic Assessments.....	25
Summary and Conclusions.....	27
References	28
Appendices	
Appendix A: Survey Questionnaires.....	31
Appendix B: Economic Impact Modeling	34
Appendix C: Reconstructed Economic Sectors for IMPLAN, Oil and Gas Industry, North Dakota, 2015, 2017, 2019, and 2021.....	59
Appendix D: Economic Impacts by Industry Segments, Delineated by 2 Digit NAICS Codes, Oil and Gas Industry, North Dakota, 2017, 2019, and 2021	72

LIST OF TABLES

<u>Table</u>	<u>Page</u>
1	Selected Statistics and Economic Metrics, Oil and Gas Industry North Dakota, 2017, 2019, and 2021 8
2	Comparison of Economic Estimates, Government Revenues, Oil and Gas Industry, North Dakota, 2017, 2019, and 2021..... 10
3	Estimates of Direct Employment, Selected NAICS Codes and Job Service North Dakota Analysis, Oil and Gas Industry, North Dakota, 2003 through 2021 12
4	Oil and Gas Industry Employment and Employment Compensation, NAICS Code 21, North Dakota, 2010 through 2021..... 13
5	Employment, Direct and Secondary Economic Activity, Oil and Gas Industry, North Dakota, 2011 through 2021..... 14
6	Direct, Indirect, and Induced Economic Effects, Well Development, Oil and Gas Industry, North Dakota, 2021 14
7	Direct, Indirect, and Induced Economic Effects, Oil and Gas Production, Oil and Gas Industry, North Dakota, 2021 15
8	Direct, Indirect, and Induced Economic Effects, Processing and Transportation, Oil and Gas Industry, North Dakota, 2021 16
9	Capital Expenditures (Infrastructure), Oil and Gas Industry, North Dakota, 2011 through 2021..... 18
10	Direct, Indirect, and Induced Economic Effects, Infrastructure, Oil and Gas Industry, North Dakota, 2021 19
11	State and Local Government Revenues from Indirect and Induced Economic Activity, Oil and Gas Industry, North Dakota, 2019 and 2021 21
12	Total Economic Contribution, All Segments, Oil and Gas Industry, North Dakota, 2021 22
13	Direct, Indirect, and Induced Employment, by Economic Sector, Oil and Gas Industry, North Dakota, 2021..... 23
14	Gross Business Volume, by Economic Sector, Oil and Gas Industry, North Dakota, 2021 24
15	Key Economic Values, Oil and Gas Industry, North Dakota, Selected Years, 2005 through 2021 26

LIST OF FIGURES

<u>Figure</u>		<u>Page</u>
1	Oil Producing Counties, North Dakota.....	4
2	Crude Oil Production, North Dakota, 1951 through 2021	5
3	Production and Market Value of Crude Oil, North Dakota, 2000 through 2021	5
4	State and Local Government Revenues, Paid Directly by Oil and Gas Industry, North Dakota, 2005 through 2021.....	24

LIST OF APPENDIX TABLES

<u>Appendix Table</u>	<u>Page</u>
C1	Input-Output Modeling Industry Components, Default IMPLAN Data and Customized Values, Well Development and Oil and Gas Extraction, Oil and Gas Industry, North Dakota, 2021 60
C2	Input-Output Modeling Industry Components, Default IMPLAN Data and Customized Values, Support Activities, Oil and Gas Industry, North Dakota, 2021 61
C3	Input-Output Modeling Industry Components, Estimation of Well Drilling and Oil Field Service Shares, Oil and Gas Industry, North Dakota, 2021 62
C4	Input-Output Modeling Industry Components, Default IMPLAN Data and Customized Values, Well Development and Oil and Gas Extraction, Oil and Gas Industry, North Dakota, 2019 63
C5	Input-Output Modeling Industry Components, Default IMPLAN Data and Customized Values, Support Activities, Oil and Gas Industry, North Dakota, 2019 64
C6	Input-Output Modeling Industry Components, Estimation of Well Drilling and Oil Field Service Shares for IMPLAN Sector 38, Oil and Gas Industry, North Dakota, 2019 65
C7	Input-Output Modeling Industry Components, Default IMPLAN Data and Customized Values, Well Development and Oil and Gas Extraction, Oil and Gas Industry, North Dakota, 2017 66
C8	Input-Output Modeling Industry Components, Default IMPLAN Data and Customized Values, Oil and Gas Industry, Support Activities, North Dakota, 2017 67
C9	Input-Output Modeling Industry Components, Estimation of Well Drilling and Oil Field Service Shares for IMPLAN Sector 38, Oil and Gas Industry, North Dakota, 2017 68
C10	Input-Output Modeling Industry Components, Default IMPLAN Data and Customized Values, Well Development and Oil and Gas Extraction, Oil and Gas Industry, North Dakota, 2015 69
C11	Input-Output Modeling Industry Components, Default IMPLAN Data and Customized Values, Support Activities, Oil and Gas Industry, North Dakota, 2015 70
C12	Input-Output Modeling Industry Components, Estimation of Well Drilling and Oil Field Service Shares for IMPLAN Sector 38, Oil and Gas Industry, North Dakota, 2015 71
D1	Employment, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Development, Oil and Gas Industry, North Dakota, 2021 73
D2	Labor Income, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Development, Oil and Gas Industry, North Dakota, 2021 73

LIST OF APPENDIX TABLES (continued)

<u>Appendix Table</u>	<u>Page</u>
D3	Value-added Activity, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Development, Oil and Gas Industry, North Dakota, 2021 74
D4	Business Volume, Direct, Indirect, and Induced Economic Effects, by Economic Sector Oil and Gas Development, Oil and Gas Industry, North Dakota, 2021 74
D5	Employment, Direct, Indirect, and Induced Economic Effects, by Economic Sector Oil and Gas Production, Oil and Gas Industry, North Dakota, 2021 75
D6	Labor Income, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Production, Oil and Gas Industry, North Dakota, 2021 75
D7	Value-added Activity, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Production, Oil and Gas Industry, North Dakota, 2021 76
D8	Business Volume, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Production, Oil and Gas Industry, North Dakota, 2021 76
D9	Employment, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Processing and Transportation, Oil and Gas Industry, North Dakota, 2021 77
D10	Labor Income, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Processing and Transportation, Oil and Gas Industry, North Dakota, 2021 77
D11	Value-added Activity, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Processing and Transportation, Oil and Gas Industry, North Dakota, 2021 78
D12	Business Volume, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Processing and Transportation, Oil and Gas Industry, North Dakota, 2021 78
D13	Employment, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Development, Oil and Gas Industry, North Dakota, 2019 79
D14	Employment Compensation, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Development, Oil and Gas Industry, North Dakota, 2019 79
D15	Business Volume, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Development, Oil and Gas Industry, North Dakota, 2019 80
D16	Value-added Activity, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Development, Oil and Gas Industry, North Dakota, 2019 80
D17	Employment, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Production, Oil and Gas Industry, North Dakota, 2019 81

LIST OF APPENDIX TABLES (Continued)

<u>Appendix Table</u>	<u>Page</u>
D18	Employment Compensation, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Production, Oil and Gas Industry, North Dakota, 2019 81
D19	Business Volume, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Production, Oil and Gas Industry, North Dakota, 2019 82
D20	Value-added Activity, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Production, Oil and Gas Industry, North Dakota, 2019 82
D21	Employment, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Processing and Transportation, Oil and Gas Industry, North Dakota, 2019..... 83
D22	Employment Compensation, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Processing and Transportation, Oil and Gas Industry, North Dakota, 2019..... 83
D23	Business Volume, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Processing and Transportation, Oil and Gas Industry, North Dakota, 2019..... 84
D24	Value-added Activity, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Processing and Transportation, Oil and Gas Industry, North Dakota, 2019..... 84
D25	Employment, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Development, Oil and Gas Industry, North Dakota, 201785
D26	Employment Compensation, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Development, Oil and Gas Industry, North Dakota, 201785
D27	Business Volume, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Development, Oil and Gas Industry, North Dakota, 2017 86
D28	Value-added Activity, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Development, Oil and Gas Industry, North Dakota, 2017 86
D29	Employment, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Production, Oil and Gas Industry, North Dakota, 2017 87
D30	Employment Compensation, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Production, Oil and Gas Industry, North Dakota, 2017 87
D31	Business Volume, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Production, Oil and Gas Industry, North Dakota, 2017 88
D32	Value-added Activity, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Production, Oil and Gas Industry, North Dakota, 2017 88

LIST OF APPENDIX TABLES (Continued)

<u>Appendix Table</u>	<u>Page</u>
D33 Employment, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Processing and Transportation, Oil and Gas Industry, North Dakota, 2017.....	89
D34 Employment Compensation, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Processing and Transportation, Oil and Gas Industry, North Dakota, 2017.....	89
D35 Business Volume, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Processing and Transportation, Oil and Gas Industry, North Dakota, 2017.....	90
D36 Value-added Activity, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Processing and Transportation, Oil and Gas Industry, North Dakota, 2017.....	90

LIST OF APPENDIX FIGURES

<u>Appendix Figure</u>	<u>Page</u>
D1 Gross Business Volume, Indirect and Induced Activity, by 2-digit NAICS, North Dakota, 2021	91
D2 Employment, Indirect and Induced Activity, by 2-digit NAICS, North Dakota, 2021.....	91

EXECUTIVE SUMMARY

The purpose of this study was to estimate the economic contribution of crude oil and natural gas exploration, extraction, transportation, processing, and capital investments in North Dakota in 2021. Total in-state expenditures in 2021 for oil and gas exploration (e.g., seismic testing, well drilling, fracking, well completions) were estimated from industry data and statewide drilling statistics. A total of 680 wells were completed in 2021, at a total cost of \$4.5 billion. Of the \$4.5 billion associated with well completions in 2021, \$2.2 billion were expenditures made in North Dakota. The gross business volume from exploration was estimated at \$3.3 billion and was estimated to support 8,500 jobs in the state.

The state had 16,307 producing wells (average monthly) which produced 409.1 million barrels of oil and 1.08 billion mcf (produced) of natural gas in 2021. Estimates of oil and gas extraction/production expenses, general business expenses for firms that own wells, private and public mineral royalties, and state severance taxes were derived from industry data and secondary information obtained from various government agencies. Sales of crude oil and natural gas sales in 2021 totaled \$29.8 billion, \$2.25 billion in state severance taxes, and \$2.6 billion of in-state private and public oil and gas royalties. The in-state gross business volume of oil and gas extraction/production was estimated at \$34.6 billion and supported 31,700 jobs in 2021.

Transportation of crude oil, pipeline operations, crude oil rail loading facilities, natural gas processing, and crude oil refining were estimated to have a direct impact in North Dakota of \$4.6 billion in 2021. Processing and transporting crude oil and natural gas generated a gross business volume of \$4.6 billion and supported about 8,100 jobs in 2021.

Infrastructure spending, as defined in this report, would represent additional economic activity beyond that created by the exploration, production, processing, and transportation segments of the industry. The oil and gas industry was estimated to have spent about \$370 million on capital projects located in the state in 2019. After adjustments for economic leakage (the portion of expenditures not captured in the North Dakota economy) and reconciliation with construction-related employment reported by Job Service North Dakota, it was estimated that about \$96 million of the total capital expenditures of \$370 million was captured in the North Dakota economy. The gross business volume associated with infrastructure spending in North Dakota was estimated at \$150 million.

The gross business volume for the entire industry, including infrastructure spending, in North Dakota in 2021 was estimated at \$42.6 billion, of which \$29 billion represented sales of crude oil and natural gas. The industry supported over 49,400 jobs with labor income of \$3.9 billion. The industry was estimated to make direct contributions to local and state government tax revenues of \$3.6 billion. Secondary business activity generated an additional \$145 million in government revenues in 2021.

Biennial economic contribution studies for the oil and gas industry have been conducted since 2005. From 2005 through 2013, biennial studies were measuring the substantial growth occurring in the industry from shale development. Subsequent to the industry's peak economic contribution in 2014, the industry has been heavily influenced by substantial price volatility which has subsequently created large swings in economic output, employment, and government revenues.

OIL AND GAS INDUSTRY'S ECONOMIC CONTRIBUTION TO NORTH DAKOTA IN 2019

Dean A. Bangsund and Nancy M. Hodur*

North Dakota's largest basic sector industries, which include agriculture, manufacturing, and energy, provide much of the economic stimuli for the state's economy. These large industries are comprised of distinct sectors or economic groups. For example, agriculture in North Dakota often is considered a combination of crop production and livestock. The energy industry in North Dakota also is comprised of several distinct sectors that are commonly treated as separate activities. North Dakota's energy industries can be conveniently separated into the activities that produce and distribute electricity, coal, oil and gas, and renewable fuels.

While separating the energy industry into similar activities is relatively straight forward, identifying the firms within those sectors is less clear. In the case of electricity generation, a handful of firms and generating facilities exist within the state. The same with coal production – a handful of companies operate at a few locations. However, the industrial organization of the oil and natural gas industry is very different. Rather than having just a small number of firms and a limited number of site-specific facilities and locations, the oil and gas industry involves hundreds of firms and a multitude of facilities spread throughout the western third of North Dakota.

North Dakota has been a top 10 oil-producing state for over a decade. However, even prior to the industry's recent expansion, the oil and gas sector was an important part of the state's economic base. In 2006 during the beginning of the latest expansion of oil field development, the first comprehensive economic assessment of the oil and gas industry in the state was conducted (Bangsund and Leistritz 2007). Another assessment was conducted two years later (Bangsund and Leistritz 2009). From 2006 through 2015, North Dakota witnessed an unprecedented increase in oil production. Production dropped in the latter half of 2015 and through 2016, but increased in 2017 and 2018. While North Dakota has recently been recording state records for monthly oil production, the state is third in oil production behind Texas and New Mexico (U.S. Department of Energy 2023).

The rapid expansion of the industry grew the industry well beyond the historical size of the industry. The industry was beginning to stabilize and the state was adjusting to more stable and consistent when a price collapse at the end of 2014 caused a substantial roll back in shale oil development, and substantially impacted employment, personal income, and government revenues in North Dakota. Subsequent to the industry's peak economic contribution in 2014, the industry has been heavily influenced by substantial price volatility which has subsequently created large swings in economic output, employment, and government revenues.

*Research scientist, Department of Agribusiness and Applied Economics and Director, Center for Social Research, respectively, North Dakota State University, Fargo.

Determining the economic contribution of a given industry quantifies its importance to state and local economies. Not only can the economic contribution to the state and local economies be measured, but the effects on specific economic sectors and related industries also can be identified. In addition, economic studies can demonstrate the susceptibility of the North Dakota economy to fluctuations in factors affecting oil and gas development and production, demonstrate the economic dependence of the state on natural resource-based industries, and indicate the economic consequences that could result from potential changes in policies which affect the oil and gas industry.

NORTH DAKOTA OIL PRODUCTION STATISTICS

Oil and gas production is limited to the western third of North Dakota (Figure 1). Crude oil is currently produced in 17 counties in western North Dakota (North Dakota Department of Mineral Resources 2023). Of the 17 counties producing oil, production is concentrated in Billings, Dunn, Bowman, McKenzie, Mountrail and Williams counties (North Dakota Department of Mineral Resources 2023). Production in key counties has fluctuated over the past 50 years as new oil deposits are found and developed in various locations in the state. Since 2002, major increases in oil production have occurred in Bowman, McKenzie, Dunn, and Mountrail counties.

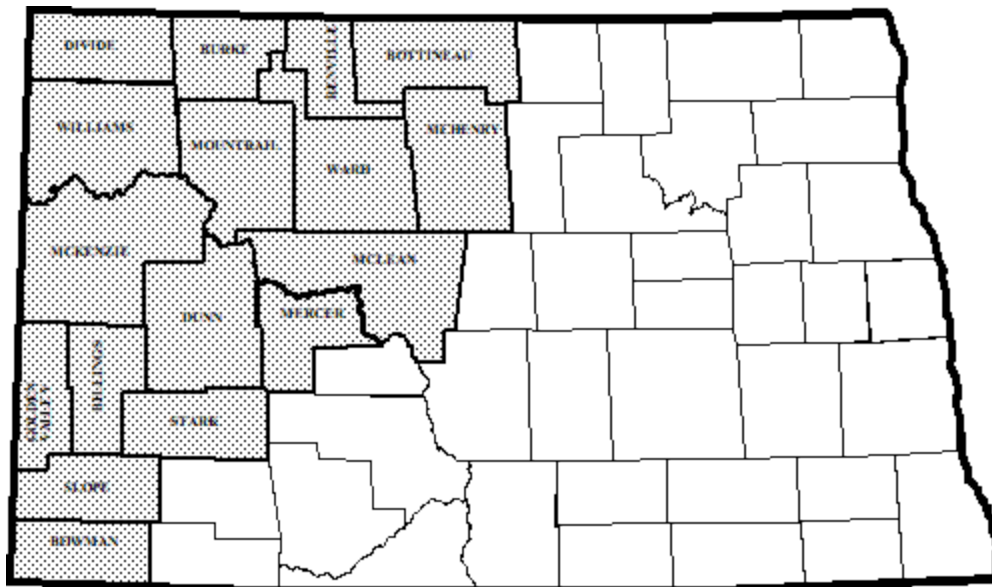
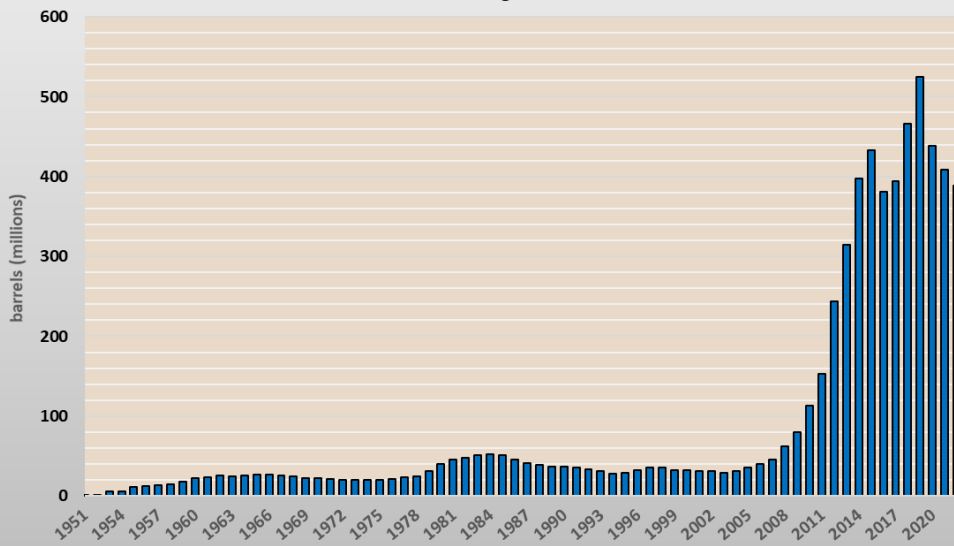


Figure 1. Oil Producing Counties, North Dakota

Oil production in North Dakota has fluctuated substantially since commercial production began in the early 1950s (Figure 2). Overall, there have been four periods of rapid growth in oil production in North Dakota. The first period was from 1951 through 1962, the second period occurred from 1974 to 1984, the third period from 1994 to 1997, and the current period which began in 2003. After historic highs in 1984, oil production in the state declined rapidly for 10 years. More recently, the price collapse in late 2014 and the covid-19 pandemic of 2020 resulted in curtailed production.

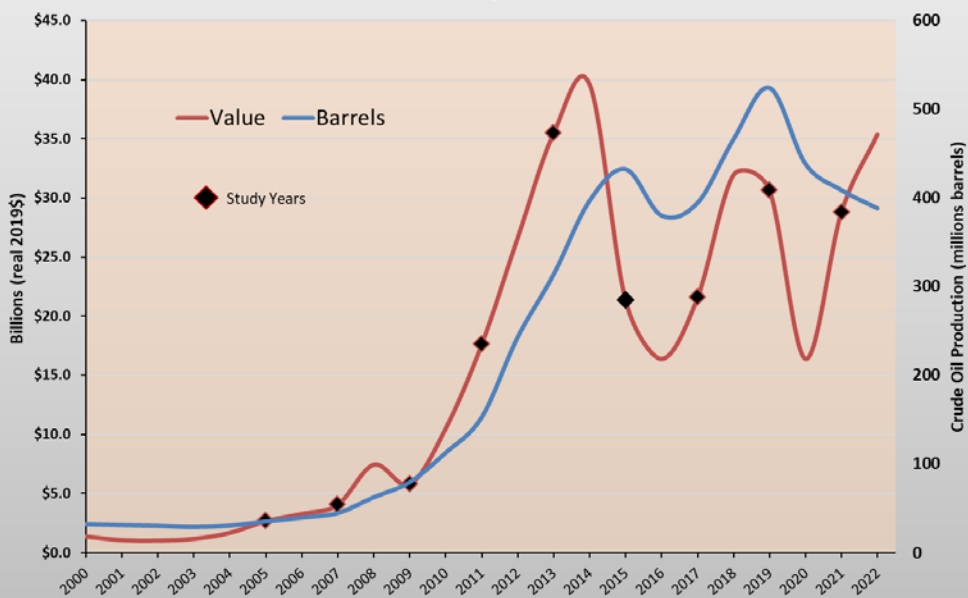
The annual value of oil production in North Dakota was estimated using monthly average price and production data from the North Dakota Department of Mineral Resources (2023). The overall value of oil production in North Dakota, in nominal terms, has generally paralleled oil production despite price fluctuations over time (Figure 3). Nominal oil prices were converted to real dollars (2023) using the Gross Domestic Product-Implicit Price Deflator (U.S. Bureau of Economic Analysis 2023).

Figure 2. Crude Oil Production, North Dakota, 1951 through 2022



Source: ND Department of Mineral Resources (2023).

Figure 3. Production and Market Value of Crude Oil, North Dakota, 2000 through 2022



Sources: ND Department of Mineral Resources (2023), ND Office of State Tax Commissioner (2023b), U.S. Bureau of Economic Analysis (2023).

PROCEDURES

An economic contribution analysis, as defined in this study, represents an estimate of all relevant in-state expenditures and returns associated with an industry. The economic contribution approach to estimating economic activity has been used for several other industries in North Dakota (Bangsund and Hodur 2017, 2019a, 2019b, 2020, 2021a, 2021b; Coon et al. 2012).

Industry Survey

Previous studies from 2005 through 2015 used an expenditure-based approach to estimating the economic contribution of the oil and gas industry. Those studies were almost entirely driven by survey data, combined with the ND Input-Output Model to estimate statewide economic effects. In 2015 the more robust IMPLAN modeling system replaced the ND Input-Output Model, and survey questionnaires were modified in the 2017 study to align more closely with the IMPLAN modeling platform. In this study, industry questionnaires were designed to only provide data on key industry parameters (Appendix A).

A sample of firms active in the oil and gas industry in North Dakota were asked to provide key financial information for operations in North Dakota. Oil operators (i.e., firms owning oil wells) represented one segment of the industry. Firms involved with natural gas collection and processing represented another segment of the industry. Finally, firms involved with rail loading and pipeline operations were surveyed. The North Dakota Petroleum Council provided contact information for the industry survey.

IMPLAN Industry Profiles

In previous studies, survey data combined with other publicly available statistics were used to set the level and distribution of spending by the industry. These estimates were based on relating various expenditures to levels of production (e.g., utilities expense per barrel of oil equivalent² (BOE) produced) to estimate direct impacts. In previous studies, expenditures (and other cash outlays such as royalty payments) represented the direct impacts for the contribution analysis. Those expenditures were considered analogous to sales in the affected economic sectors.

IMPLAN treats industry sales (e.g., value of crude oil sold) as the primary direct or first-round effects. This differs from the methodology associated with the North Dakota I-O Model. The North Dakota I-O Model treated only in-state expenditures and other selected revenue streams (e.g., royalties) as the first-round effects. Those oil and gas industry expenditures were analogous to sales to various economic sectors (e.g., communications, transportation, manufacturing) and modeled as the direct or first-round effects.

IMPLAN uses sales, also referred to as output for an economic sector, and several other financial categories that are based on different classifications and economic requirements (Appendix B, Appendix Figure B1) to distinguish expenditures, payroll, taxes, and income. Expenditures for goods and services

²Barrel of oil equivalent places oil and gas production on a common basis, and is estimated by dividing mcf of natural gas by 6 and adding barrels of oil.

used to produce a product or service within IMPLAN are called ‘intermediate inputs’ and are treated as a function of sales. IMPLAN’s baseline data is generated using econometric techniques to estimate industry expenditures within a given economic sector and the percentage of those expenditures supplied by local vendors (i.e., other economic sectors). Those values also are treated within the model as a percentage of sales. IMPLAN arrives at an estimate of industry expenditures supplied by local sources within a given economic area (Appendix B, Appendix Figure B2), which was also the goal of methodologies used in previous oil and gas industry economic contribution studies in North Dakota.

Data used for economic contribution studies involving IMPLAN can be supplied by outside sources or rely on default IMPLAN data. However, IMPLAN baseline data greatly underestimates the size of the oil and gas industry in the state. Industry survey data was used to modify and create a custom matrix for the North Dakota oil and gas industry. Appendix C contains information on the reconstruction of IMPLAN sectors associated with oil and gas exploration, development, and production for 2015, 2017, 2019, and 2021.

Input-Output Analysis

Economic activity from a project, program, policy, or activity are categorized as either direct and secondary impacts. Direct impacts are those changes in output, employment, or income that represent the initial or first-round effects of the project, program, policy, or activity.

Secondary effects are the sum of indirect and induced effects that are the result of subsequent rounds of spending and respending within the economy (Appendix B contains a more detailed discussion). Indirect economic effects arise from the additional consumption of goods and services by businesses that supply inputs to firms in a given sector/industry. Indirect effects are the result of economic activity created through purchases of goods and services by businesses. Induced economic effects are the result of economic activity by households from changes in personal income associated with direct effects and indirect effects. Changes in personal income can come from payrolls of businesses that are directly impacted, changes in payrolls from businesses that supply goods and services to an impacted sector (induced effects), and proprietor income resulting from a change in sales volume of sole proprietorships. Induced effects measure the additional business activity as a result of changes in household income are translated into the purchase of goods and services for personal consumption.

I-O analysis is an accepted methodology to examine how initial changes in employment, income, and/or business activity translate into additional or subsequent rounds of economic output within a given economic unit. Economic units often represent individual economic sectors, groups of sectors that constitute industries, or an entire economy.

I-O models require an underlying database to calibrate the linkages among economic sectors, households, and governments. This study used the IMPLAN modeling platform and its proprietary data set and I-O methodologies. [See Appendix B for more discussion of the IMPLAN model].

KEY ECONOMIC METRICS

Key economic metrics were developed in previous studies and are used to describe the economic output of the oil and gas industry. The estimation of those metrics was continued in this study even though not all that information is directly used in the IMPLAN modeling system. The values reported in this section were used as direct effects in previous assessments. However, the values were used to re-construct the oil and gas sectors in the IMPLAN modeling system as part of the industry profiles, and were not necessarily considered a direct effect as used in previous assessments.

Exploration and Development

In-state expenditures for exploration in 2021 were estimated using data from the survey of industry firm involved in exploration and development and drilling statistics from the North Dakota Department of Mineral Resources (2023). Gross expenditures for exploration, drilling, and well completion were estimated at about \$6.6 million per well drilled in North Dakota in 2021. The oil and gas industry completed 1,181 new wells in North Dakota in 2021, yielding about \$7.8 billion in total financial outlays for well development. Financial data on expenses for well development from Bangsund and Hodur (2015, 2017) were used to adjust for in-state spending. Considering the rapid expansion of well drilling, and the volume of economic activity, adjustments to the capital costs to drill and complete a well were performed to reflect specific inputs only supplied by in-state sources. Examples of well development expenses that were determined to be primarily supplied by out-of-state firms included drill bits, well casing, well head equipment, conductor pipe, fuel, cement, packers, christmas tree, sucker rod, heater/treater, fracture materials, and emissions control. By adjusting for expenses for inputs supplied by out-of-state sources revealed that about 48 percent of the capital cost to complete a well came from in-state sources. Therefore, in 2021, of the \$6.6 million for completion cost per well in North Dakota in 2021 was about \$4.5 million of expenses captured in the North Dakota economy (Table 1).

Lease bonuses retained or paid to in-state entities were estimated at \$38 million in 2021, which included \$10.6 million for state leases and about \$27 million for private mineral leases. Net federal lease bonuses, reported by the Office of Natural Resource Revenues, were -\$255,000. Disbursements of lease bonuses from tribal lands back to North Dakota are not reported; however, tribal lease bonuses are contained within “gross” estimates of lease bonuses on Federal lands reported by the Office of Natural Resource Revenue, U.S. Department of the Interior.

Table 1. Selected Statistics and Economic Metrics, Oil and Gas Industry, North Dakota, 2017, 2019, and 2021

Metrics	2017	2019	2021
Number of wells drilled and completed	1,039	1,181	680
Cost per well completed (000s nominal \$) ^a	6,601	6,601	6,596
In-state expenditures per completed well (000s nominal \$)	3,285	3,285	4,485
Lease bonuses (000s nominal \$)			
Net federal and state	4,505	10,610	1,757
Private ^b	13,472	27,590	5,525
Crude oil (000s barrels) ^c	465,030	524,432	409,104
Natural gas produced (mmcf) ^c	688,771	933,850	1,075,571
Natural gas sold (mmcf) ^c	568,790	787,750	567,146
Crude oil and natural gas produced (000s Barrel of Oil Equivalents)	509,622	680,074	588,366
Number of operating/active wells (monthly average) ^c	13,951	15,412	16,307
Number of wells completed ^c	1,039	1,181	680
Crude oil price (first purchaser prices nominal \$ per bbl) ^d	\$45.67	\$50.91	64.94
Natural gas price (nominal \$ per mcf) ^c	\$2.54	\$2.12	3.45
Crude oil sales (millions nominal \$)	18,034	26,699	26,568
Natural gas sales (millions nominal \$)	1,445	1,701	3,271
Oil and gas combined (millions nominal \$)	19,478	28,400	29,839
Oil royalty rate ^e		18.26%	
Gas royalty rate ^e		18.17%	
Royalties (millions nominal \$) (not adjusted for payment of severance taxes)			
Net federal, state, and Tribal	649.2	830.6	1,056.7
Private			
Total	2,490.2	3,622.5	4,106.5
In-state	938.8	1,367.7	1,548.1
All net public and private royalties	1,588.0	2,206.2	2,604.8
Severance taxes (millions nominal \$) ^d	1,637.7	2,418.8	2,251.0
Mmcf = 1,000,000 cubic feet. Mcf = 1,000 cubic feet.			
^a Well costs in 2019 obtained from 2017 survey data.			
^b Private lease bonuses represented only payments to in-state mineral owners.			
^c ND Department of Mineral Resources (2023).			
^d ND Office of State Tax Commissioner (2023b).			
^e Data obtained from industry surveys.			

Oil and Gas Production

Estimates of total in-state expenditures in 2021 for extraction/production and general business expenses were derived from the survey of oil operators and estimated on a BOE basis. Data obtained

from the survey of oil operators for general business expenses and oil and gas production expenses were specific to expenses paid to entities within North Dakota.

North Dakota produced 409.1 million barrels of oil and 1,075.6 million MCF of natural gas in 2021 (Table 1) (North Dakota Department of Mineral Resources 2023). State oil and gas royalties were about \$345.8 million (net of severance taxes) (North Dakota Department of Trust Lands 2023). Federal royalties returned to North Dakota were about \$657 million (net of severance taxes), which includes tribal royalties (Office of Natural Resources Revenue 2023). Separate estimates of tribal royalties are not published by the Office of Natural Resources Revenue.

Private royalties were based on production data obtained from industry surveys and information on the distribution of in-state and out-of-state mineral payments obtained from previous assessments. Average royalties were 18.26 percent for oil production and 18.17 percent for gas production (Table 1). The total value of oil and gas production was estimated at \$29.8 billion using data obtained from the North Dakota Department of Mineral Resources (2023) and the North Dakota Office of State Tax Commissioner (2023b) (Table 1). Total royalties were estimated by applying the industry-wide oil and gas royalty percentages to the gross sales value of crude oil and estimated sales value of natural gas. Private royalties were estimated by subtracting state and gross federal royalties from estimated total royalties. Gross private royalties (i.e., both in-state and out-of-state mineral owners) from oil and gas production in North Dakota in 2021 were estimated to be \$4.1 billion.

In-state payments of private royalties were estimated by applying the percentage of in-state versus out-of-state mineral owners' royalty payments (37.7 percent) to the estimated total private royalties (\$4.1 billion). The in-state percentage of mineral ownership (37.7%) was estimated using industry survey data on total private mineral payments from North Dakota wells (includes both mineral owners who reside in the state and those that live elsewhere) and total private in-state mineral payments from North Dakota wells (only private mineral payments going to North Dakota mailing addresses).

In-state private royalties in 2021 were estimated at \$1.5 billion (without adjustments for severance taxes) or about \$1.4 billion net of severance taxes (severance taxes were included as a separate component of direct impacts and subtracted from private in-state mineral royalty payments).

Total gross production tax and extraction tax in calendar year 2021 were \$1.18 billion and \$1.07 billion, respectively (North Dakota Office of State Tax Commissioner 2023a). Those tax collections were included in the extraction/production segment of the oil and gas industry.

Processing and Transportation

Business activity related to processing and transportation activities resulted in \$780 million in payments to in-state entities. Processing activities, which included pipeline transportation of unprocessed natural gas and crude oil, natural gas processing, crude oil rail loading, and crude oil refining were estimated to have in-state expenditures of \$2.89 billion (see Table 8). One-time spending for infrastructure by processors was included in processing expenditures prior to the 2011 industry assessments; however, infrastructure spending has been estimated separately since the 2011 assessment. Questionnaires used in the industry survey instructed processors to omit any infrastructure

spending from operational expenditures (Appendix A). To avoid double counting of potential economic effects, in-state purchases of crude oil and unprocessed natural gas by processors were excluded in the study.

Government Revenues

One of the most closely monitored measures of the oil and gas industry are estimates of government revenues. Government revenues attributable to the oil and gas industry stem from collections of property, sales and use, personal income, and corporate income taxes. Other direct revenue sources include royalties on oil and gas production and lease bonus payments. The largest single source of government revenue from the oil and gas industry in the state has been severance taxes. Total government revenues paid directly by the industry to governments in North Dakota was estimated at \$3.6 billion, of which severance taxes comprised \$2.25 billion or 62 percent of the total (Table 2). An additional \$145.5 million in tax revenues were estimated from indirect and induced economic effects. Total government revenues attributable to the oil and gas industry in 2021 were estimated to be \$3.8 billion.

Category	2017	2019	2021
Included in Direct Effects	----- 000s nominal \$ -----		
Sales and Use, Property, and Income Taxes	271.3	299.2	306.5
Royalties ^a (net of severance tax payments)	581,635	744,194	1,003,069
Severance Taxes	1,637,742	2,418,791	2,251,977
Lease Bonuses (net federal and state)	4,597	10,610	1,800
Licenses, Fees, Permits, Donations, and Undetermined Taxes	131.1	129.9	82.6
Totals	2,422,877	3,173,725	3,645,000
Estimated from Secondary Effects			
Sales and Use	50,420.0	49,033.0	53,700
Personal Income	16,026.8	13,559.4	15,400
Other taxes (IMPLAN analysis)	68,975.8	74,312.8	76,400
Direct and Secondary Generation Total	2,881,500	3,310,630	3,790,500
^a Net federal and state royalties from oil and gas production, and royalties from processing activities returned to North Dakota from federal mineral ownership.			

ECONOMIC CONTRIBUTION

The economic contribution of the oil and gas industry was based on estimates of total sales, gross and net (in-state) expenditures, government taxes, and payroll for exploration, extraction, transportation, and processing of crude oil and natural gas. In-state expenditures, oil and gas royalties, state severance taxes, and lease bonuses also were included to modify and customize the economic profile of the North Dakota oil and gas industry in the IMPLAN modeling system.

Employment

The oil and gas industry a variety of jobs. Those jobs are traditionally divided into direct and secondary employment when measuring the economic contribution of industries. Direct employment is a term used to describe jobs that are considered to be an integral part of an industry. For example, workers operating an oil drilling rig would represent direct employment in the oil and gas industry. Similarly, someone who works at a natural gas processing plant or crude oil refinery would be considered direct employment in the oil and gas industry.

Secondary employment represents employment supported by economic output using two different economic mechanisms. *Indirect* employment represents the employment supported through the business purchases of goods and services. An oil drilling firm contracting with a construction firm to build a road and drilling pad would be an example of indirect employment. *Induced* employment represents jobs that are supported by the purchase of goods and services by households. The jobs supported by the purchase of goods and services for personal consumption by employees of the drilling firm and those employees supported in the construction firm would constitute induced employment.

The U.S. Bureau of Labor Statistics (BLS) collects data from state agencies responsible for implementation of the QCEW. The BLS reporting of the employment within NAICS code 21 contains key divisions between oil and gas development and oil and gas production (Table 3 and 4). Employment in NAICS code 213 is often reported as a total for that sector. However, that sector includes jobs that support oil and gas development (drilling and fracking) and oil and gas production. The split in labor between those two groups was used in the development of the IMPLAN industry profiles, and has only recently been made available by the BLS (U.S. Bureau of Labor Statistics 2023) (see Appendix C for development of IMPLAN industry profiles and the approximate split in oil field services between oil and gas production and oil field development).

Table 3. Oil and Gas Extraction and Oil and Gas Industry Support Employment, Selected North American Industrial Classification System Codes, North Dakota, 2003 through 2021

Employment in Oil and Gas Industry^a				
Year	Statewide NAICS Code 211	Statewide NAICS Code 213^b	Total	Change from Previous Year
	----- jobs -----			
2003	443	1,334	1,777	---
2004	445	1,605	2,050	273
2005	474	2,090	2,564	514
2006	427	2,688	3,115	551
2007	432	3,103	3,535	420
2008	544	4,651	5,195	1,660
2009	704	4,608	5,312	117
2010	844	8,119	8,963	3,651
2011	1,167	13,759	14,926	5,963
2012	1,614	20,627	22,241	7,315
2013	1,980	22,032	24,012	1,771
2014	2,489	25,115	27,604	3,592
2015	2,906	18,111	21,017	-6,587
2016	2,738	10,437	14,215	-6,802
2017	2,548	13,263	15,811	1,596
2018	2,616	16,158	18,774	2,963
2019	2,742	16,598	19,340	566
2020	2,606	15,154	17,760	-1,580
2021	2,411	13,776	16,187	-1,573

NAICS 211—Oil and gas extraction activities.
NAICS 213—Provide support services, on a contract or fee basis, for the mining and quarrying of minerals and for the extraction of oil and gas.
^a Does not include transportation or processing employment in the oil and gas industry. Does not include distribution from processors to retail markets or sale of oil and gas products in retail outlets. Employment estimates do not include sole proprietors or self-employed individuals not contributing to unemployment insurance.
^b NAICS code 213 contains roughly 35 or fewer jobs, per year, that support mining industries other than oil and gas production.

Source: Job Service North Dakota (various years)

Table 4. Oil and Gas Industry Employment and Employment Compensation, NAICS Code 21, North Dakota, 2010 through 2021

NAICS Code and Description		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Employment		----- jobs -----											
21	Mining, Quarrying, Oil and Gas	10,660	16,786	24,376	26,196	29,836	23,248	15,303	17,841	20,804	21,380	15,154	13,776
211	Oil and Gas Extraction	844	1,167	1,614	1,980	2,489	2,906	2,738	2,548	2,616	2,742	2,606	2,411
2111	Oil and Gas Extraction	844	1,167	1,614	1,980	2,489	2,906	2,738	2,548	2,616	2,742	2,606	2,411
21112	Only oil and gas	na	na	na	na	na	2,654	2,501	2,327	2,408	2,516	2,376	2,204
21113	Only NGLs	na	na	na	na	na	252	237	221	208	226	230	208
213111	Drilling oil and gas wells	na	na	na	na	6,670	3,821	1,927	2,435	2,802	2,928	1,751	1,541
213112	Support activities for oil and gas	4,692	8,575	14,385	15,749	18,414	14,259	8,481	10,798	13,324	13,641	8,741	7,702
Total Wages and Salaries		----- millions nominal \$ -----											
21	Mining, Quarrying, Oil and Gas	852.5	1,506.2	2,354.0	2,568.3	3,127.0	2,362.0	1,473.5	1,804.0	2,216.4	2,326.8	1,618.2	1,462.9
211	Oil and Gas Extraction	81.0	113.9	181.5	220.7	297.8	359.6	329.7	326.8	352.1	389.8	364.7	318.1
2111	Oil and Gas Extraction	81.0	113.9	181.5	220.7	297.8	359.6	329.7	326.8	352.1	389.8	364.7	318.1
21112	Only oil and gas	na	na	na	na	na	327.5	300.2	297.6	325.5	363.2	197.5	173.8
21113	Only NGLs	na	na	na	na	na	32.1	29.4	29.2	26.7	26.5	848.4	762.6
213111	Drilling oil and gas wells	na	na	na	na	783.4	454.5	211.6	256.3	307.2	326.8	338.6	293.8
213112	Support activities for oil and gas	360.0	747.1	1335.0	1,466.8	1,852.0	1,351.3	741.0	1,035.2	1,362.0	1,405.9	26.0	24.4
Average Wages and Salaries per Job		----- nominal \$ per job -----											
21	Mining, Quarrying, Oil and Gas	80,000	89,700	96,600	98,000	104,700	101,600	96,300	101,100	106,500	108,800	106,800	106,200
211	Oil and Gas Extraction	96,000	97,600	112,500	111,500	119,700	123,800	120,400	128,200	134,600	142,200	139,900	132,000
2111	Oil and Gas Extraction	96,000	97,600	112,500	111,500	119,700	123,800	120,400	128,200	134,600	142,200	139,900	132,000
21112	Only oil and gas	na	na	na	na	na	123,400	120,100	127,900	135,200	144,400	112,800	112,800
21113	Only NGLs	na	na	na	na	na	127,500	124,000	132,100	128,200	117,500	97,100	99,000
213111	Drilling oil and gas wells	na	na	na	na	117,500	118,900	109,800	105,200	109,600	111,600	142,500	133,300
213112	Support activities for oil and gas	76,700	87,100	92,800	93,100	100,600	94,800	87,400	95,600	102,200	103,100	113,200	117,100
na=not available.													
Source: U.S. Bureau of Labor Statistics (various years).													

The oil and gas industry supported direct employment of 14,117 jobs and total employment (direct, indirect and induced employment of 49,306 jobs. Statewide, in 2021, the industry supported 9.3 percent of all wage and salary jobs covered by unemployment insurance and 8.7 percent of total (wage and salary and self-employed) public and private sector jobs for wage and salary positions and sole proprietors (i.e., self-employment) (Table 5).

Statewide Employment ^a			Oil and Gas Industry			Share of State		
Wage and Salary	Self-employed	Total	Wage and Salary	Self-employed	Total	Wage and Salary	Self-employed	Total
----- jobs -----						----- % -----		
Only Direct Employment								
434,811	122,691	557,502	13,328	850	14,178	3.1	0.6	2.5
Direct, Indirect, and Induced Employment								
			40,368	8,938	49,306	9.3	6.8	8.7

^aU.S. Bureau of Economic Analysis.

Exploration and Development

The economic effects of exploration and development come from activities that involve searching and discovering viable oil and gas resources. Exploration/development was defined to include, but not limited to, seismic testing, geological research, lease expenses, other environmental research, land survey work, excavation, road building, construction of drill site, construction and delivery of electricity, pipeline development, and all other activities associated with drilling and completing oil and/or gas wells (Appendix A).

Direct employment oil and gas exploration and development sector of the oil and gas industry was estimated at 3,100 jobs. Secondary business activity supported an additional 5,400 jobs (i.e., indirect and induced) Overall, exploration and development activities supported total employment (direct and secondary) 8,500 jobs in the state in 2021 (Table 6). Appendix D contains detailed data, by direct and secondary, by 2-digit NAICS, for oil field development.

Economic Effects	Employment	Labor Income	Value-added	Gross Business Volume
	--- jobs ---	----- millions nominal \$ -----		
Direct	3,100	262.3	810.8	2,211.2
Indirect	3,600	238.3	409.5	776.2
Induced	1,800	95.6	157.6	285.4
Total	8,500	596.2	1,377.9	3,272.8

Payroll associated with employment in the exploration and development sector was \$600 million. Business activity associated with exploration and development contributed \$1.4 billion to the

state's gross domestic product (value-added). Gross business volume related to activities of exploration and development across all economic sectors was estimated at \$3.3 billion in 2019 (Table 6).

Oil and Gas Production

The economic effects of extraction/production come from revenue streams associated with bringing crude oil and natural gas from underground formations to the earth's surface. Extraction/production was defined to include, but not limited to, all activities associated with the removal of crude oil and natural gas from the ground, and maintenance and periodic inspections of equipment used to extract oil and gas, and other production related activities, such as well work overs, well idling, shutdown, and abandonment activities. Also included in this segment of the industry are the general business expenditures incurred by oil operators in North Dakota. Examples of these expenditures include, but are not limited to, office rent, office supplies, wages and salaries, communications, public utilities, business and professional services, insurance, and interest expenses.

Royalty revenues, both private and public, are included in the industry balance sheets (i.e., IMPLAN sector descriptions) for oil and gas production. Collections from state severance taxes, which include the gross production tax and extraction tax, are also part of the economic profile for the sector (see Appendix C).

Activities associated with oil and gas production supported direct employment of 8,100 jobs and secondary employment (indirect and induced) of 23,600 jobs. Oil and gas production activities supported total (direct, indirect and induced) 31,700 jobs in the state in 2021 (Table 8).

Table 7. Direct, Indirect, and Induced Economic Effects, Oil and Gas Production, Oil and Gas Industry, North Dakota, 2021

Economic Effects	Employment	Labor Income	Value-added	Gross Business Volume
	--- jobs ---	----- millions nominal \$ -----		
Direct	8,100	1,002.1	20,670.9	29,327.0
Indirect	15,900	1,117.9	2,024.2	4,022.9
Induced	7,700	408.7	673.5	1,220.0
Total	31,700	2,528.7	23,368.6	34,569.9

Total payroll of employment supported by oil and gas production was \$2.5 billion, and the oil and gas production sector of the industry contributed \$23.4 billion to the state's gross domestic product (value-added). Gross business volume related oil and gas production activities across all economic sectors was estimated at \$34.6 billion in 2021 (Table 8). Appendix D contains detailed data, by direct and secondary activity by 2-digit NAICS, for oil and gas production.

Processing and Transportation

The processing and transportation segment of the oil and gas industry includes transportation of crude oil and natural gas by truck and pipeline to collection points and processing centers, natural gas processing, and crude oil refining. In-state transportation expenses paid by oil operators were estimated on a BOE equivalent and were extrapolated based on state production statistics. Estimates of in-state expenditures for natural gas pipeline operation, crude oil pipeline operation, natural gas

processing, crude oil rail loading facilities, and crude oil refining were obtained from the survey of processors.

Processing and transportation activities supported direct employment of 2,200 jobs and secondary (indirect and induced) employment of 5,900 jobs. Oil and gas processing activities supported total (direct, indirect and induced) of 8,100 jobs in the state in 2021 (Table 8).

Total payroll from employment supported by processing and transportation activities was \$716 million oil and gas processing and transportation contributed \$1.3 billion to the state’s gross domestic product (value-added). Gross business volume related to oil and gas industry processing and transportation activities across all economic sectors was estimated at \$4.6 billion in 2021 (Table 8). Appendix D contains detailed data, by economic causality by 2-digit NAICS, for processing and transportation.

Table 8. Direct, Indirect, and Induced Economic Effects, Processing and Transportation, Oil and Gas Industry, North Dakota, 2021

Economic Effects	Employment	Labor Income	Value-added	Gross Business Volume
	--- jobs ---		----- millions nominal \$ -----	
Direct	2,200	334.7	633.3	3,310.9
Indirect	3,700	266.3	482.4	930.2
Induced	2,200	115.5	190.4	344.8
Total	8,100	716.5	1,306.1	4,585.9

Capital Expenditures

The oil and gas industry in North Dakota has been adding infrastructure to the Williston Basin since the beginning stages of developing the Bakken/Three Forks Formations in 2006. Additional transportation capacity has been added to the region in the form of new export pipelines, expansions of existing crude oil pipelines, crude oil gathering systems, and crude oil rail loading facilities. New gas plants have been built and existing plants expanded as well as the development and expansion of new collection systems to capture and transport natural gas and natural gas liquids to processing locations. Office buildings, regional transportation and distribution centers, worker housing, fracking water recycling facilities, and general facility and building upgrades and renovations also represent capital investments and infrastructure development. Previous studies in 2007, 2009 and 2010 did not include industry capital expenditures (Bangsund and Leistritz 2007, 2009, 2010).

Industry survey data and published estimates of project costs was used to estimate capital expenditures for infrastructure. Some estimates of capital expenditures represent discrete projects (e.g., gas plant) whereas other estimates represent projects that have less definable start and finish dates and less site-specific designations (e.g., oil field gathering systems).

Estimating industry-wide infrastructure spending required addressing several key issues. First, timing of the start and completion of project-based infrastructure (e.g., gas plant) does not necessarily coincide with the study time frame. Projects can be initiated in one year and completed in another (e.g., started in 2021 while completion may not occur until 2022 or later). Survey data represented expenditures made for project(s) in 2021, while various secondary sources reporting estimates of project costs might represent multi-year expenditures. Therefore, secondary data on infrastructure costs was reconciled with the anticipated timing of project-based expenditures. A project's total cost does not necessarily require all spending to occur in a single year, or occur solely in 2021.

Information was not available, on an industry-wide basis or on a project basis, to determine what portion of capital expenditures was captured in the North Dakota economy. For example, a substantial portion of the cost of a new gas processing plant or pipeline represents specialized equipment that would likely be acquired from out-of-state sources. Other studies have confirmed that most specialized equipment for various types of processing facilities constructed in North Dakota are acquired from out-of-state sources which represent economic leakages (Bangsund et al. 2012; Coon et al. 2012a).

Based on published estimates of project expenditures, survey data, and extrapolation of survey data in combination with unpublished data, the oil and gas industry was estimated to have spent around \$370 million on infrastructure projects in the state in 2019 (Table 9).

Table 9. Capital Expenditures (Infrastructure), Oil and Gas Industry, North Dakota, 2011 through 2021

Industry Category	2011^a	2013^a	2015^a	2017^a	2019^a	2021
----- millions of nominal \$ -----						
Gas Processing	961.7	753.0	925.6	600.0	810.0	220.8
Gas Midstream (excluding processing plants)	252.9	490.7	325.2	236.2	338.0	30.0
Crude Oil Pipelines, Crude Oil Rail Loading Facilities, and Refineries	654.7	690.4	732.4	668.7	116.2	61.0
Gathering Systems	221.5	515.7	318.6	281.8	365.8	58.2
Water Re-cycling Facilities ^{b,c}	33.2	185.8	122.4	11.6	na	na
Housing and Lodging ^{b,c}	240.9	64.2	21.1	2.3	na	na
Office and Other Facilities ^{b,c}	184.9	263.2	162.2	170.2	na	na
Other (miscellaneous) ^{b,c,d}	50.3	241.1	13.8	0.0	na	na
Total	2,599.8	3,203.9	2,621.2	1,970.8	1,630.0	370.0
na=not available.						
^a Represent an estimate of capital expenditures spent in calendar year. Capital expenditures in any particular year will not necessarily equal the total estimated cost of any particular project(s).						
^b Estimated based on extrapolation of survey data.						
^c Only includes expenditures for firms surveyed as part of the oil and gas industry.						
^d Based on survey of firms providing service and support in the oil fields, and represented miscellaneous or unclassified infrastructure investments. This category also includes capital expenditures for development of the crude oil refinery in Dickinson.						
Sources: North Dakota Pipeline Authority (2022), North Dakota Department of Mineral Resources (2022), North Dakota Public Service Commission (2022), North Dakota Office of the State Tax Commissioner (2022c) and confidential survey data.						

Infrastructure spending, represents additional economic activity beyond that associated with the exploration, production, transportation, and processing segments of the industry. Within the IMPLAN modeling system, capital expenditures are not included with intermediate inputs (Appendix B). Therefore, capital expenditures are modeled as a separate component of the industry even though some of the construction activity would be specific to on the industry’s key segments (e.g., construction of gathering systems as part of oil and gas production).

The gross business volume associated with infrastructure spending in North Dakota was estimated at \$150 million in 2021 (Table 10). The estimate of gross business volume associated with infrastructure spending was adjust to reflect construction inputs obtained from out-of-state-state sources and use of out-of-state labor. Total employment related to oil and gas industry capital expenditures was estimated at about 1,100 jobs with labor income of \$707 million. Capital expenditures by the industry in 2021 was estimated to contribute \$85 million to the state’s GDP.

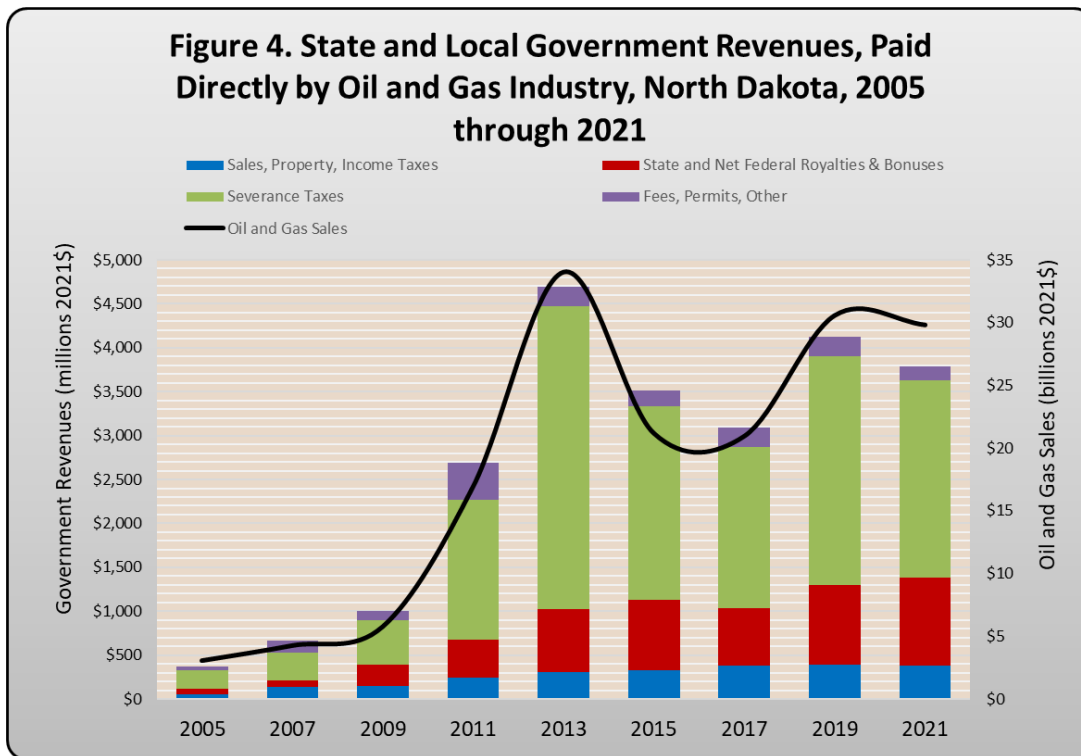
Table 10. Direct, Indirect, and Induced Economic Effects, Infrastructure, Oil and Gas Industry, North Dakota, 2021

Category	Employment	Labor Income	Value-added	Gross Business Volume
	--- jobs ---	----- millions nominal \$ -----		
Direct	800	53.2	56.1	95.7
Indirect	85	6.1	10.1	19.9
Induced	200	11.4	18.9	34.2
Total	1,085	707	85.1	149.8

Government Revenues

Governmental revenues, usually based on tax collections, are another important measure of the economic impact of an industry on an economy. The oil and gas industry in North Dakota, specifically oil and gas production, is responsible for substantial contribution to state and local government revenues. Unlike many other industries in North Dakota, severance taxes (taxes placed on the value of oil and gas removed from the ground) are collected based on gross revenues. Taxation for most other industries is usually limited to real property and net income. Another distinction is that governments can hold oil and gas leases and receive royalties as a result of oil and gas production. The oil and gas industry also generates revenues from traditional sources, such as personal income, corporate income, sales and use, and property tax collections.

Severance taxes, sales and use taxes, personal income taxes, corporate income taxes, property taxes, royalties, lease bonuses, charitable donations, and licenses, fees, and permits combined for \$3.6 billion in government revenues that were directly attributable to the oil and gas industry in North Dakota in 2021 (Figure 4). Severance taxes accounted for 61 percent of all government revenues from the oil and gas industry in North Dakota in 2021. Government royalties were the second largest source of government revenues followed by the most common general taxes (i.e., property, personal income, sales and use, and corporate income) with 24 at 10 percent of government revenues, respectively. The remainder of government revenues represented lease bonuses, permits/fees/licenses, and miscellaneous revenues.



Economic activity from indirect and induced economic effects also create revenues for state and local governments. Secondary economic effects generated about \$137 million in state and local government revenues in 2019 with sales tax accounting for \$51 million of government revenue from secondary effects.(Table 11). Secondary economic effects generated about \$145 million in government revenues in 2021, with over \$53 million of the total representing sales tax collections.

Table 11. State and Local Government Revenues from Indirect and Induced Economic Activity, Oil and Gas Industry, North Dakota, 2019 and 2021

Year and Revenue Category	Industry Segment				Total
	Exploration and Development	Oil and Gas Production	Transp. and Processing	Infrastructure	
----- 000s nominal \$ -----					
2019					
Corporate Income	1,494	2,588	580	199	4,860
Fines/Fees/Permits	1,506	2,694	614	194	5,008
Motor Vehicle	1,161	2,187	525	171	4,044
Miscellaneous	3,177	6,252	1,568	532	11,529
Personal Income	4,188	7,492	1,708	539	13,927
Property	9,399	19,890	5,283	1,821	36,393
Sales Tax	13,184	27,900	7,410	2,554	51,048
Social Insurance	2,973	5,497	1,231	394	10,095
Total	37,083	74,449	18,920	6,403	136,905
2021					
Corporate Income	4,797.7	923.0	959.6	45.9	6,726.2
Motor Vehicle	2,957.1	1,391.9	610.8	33.3	4,993.1
Miscellaneous	4,683.9	2,710.4	940.3	52.1	8,386.7
Personal Income	10,417.1	2,614.8	2,284.1	119.7	15,435.7
Property	24,270.3	18,493.1	4,619.5	265.4	47,648.3
Sales Tax	26,462.6	20,163.6	6,765.3	289.4	53,680.9
Social Insurance	5,859.2	1,445.7	1,270.5	67.7	8,643.1
Total	79,447.9	47,742.5	17,450.1	873.5	145,514.0
Note: Appendix B contains description of tax categories and methodology used by IMPLAN to estimate government revenues. Starting 2021, IMPLAN no longer reports Fines/Fees/Permits as a standalone measure.					

Total Economic Contribution

The oil and gas industry in North Dakota was defined to include exploration and drilling, oil and gas production, transportation and processing, and infrastructure development. Direct impacts were based on industry sales, in-state expenditures, private and public royalties, taxes, lease bonuses, and expenditures retained in North Dakota for infrastructure development.

The oil and gas industry's gross business volume in 2021 was estimated at \$42.6 billion. About 81 percent of the industry's overall economic contribution, \$34.5 billion was from oil and gas production (Table 12). Total economic contribution from exploration and drilling and transportation and processing were similar with total effects of \$3.2 and \$4.5 billion, respectively. [See Appendix D for more details on the distribution of economic activity across the state's key economic sectors].

Table 12. Total Economic Contribution, All Segments, Oil and Gas Industry, North Dakota, 2021					
Economic Metric and Type of Economic Effect	Industry Segment				Total
	Exploration and Drilling	Oil and Gas Production	Transp. and Processing	Infrastructure	
Employment	----- jobs -----				
Direct	3,100	8,100	2,200	800	14,200
Indirect	3,600	15,900	3,700	85	23,285
Induced	1,800	7,700	2,200	200	11,900
Total	8,500	31,700	8,100	1,085	49,385
Labor Income	----- millions \$ -----				
Direct	262.3	1,002.1	334.7	53.2	1,652.3
Indirect	238.3	1,117.9	266.3	6.1	1,628.6
Induced	95.6	408.7	115.5	11.4	631.2
Total	596.2	2,528.7	716.5	70.7	3,912.1
Value-added	----- millions \$ -----				
Direct	810.8	20,670.9	633.3	56.1	22,171.1
Indirect	409.5	2,024.2	482.4	10.1	2,926.2
Induced	157.6	673.5	190.4	18.9	1,040.4
Total	1,377.9	23,368.6	1,306.1	85.1	26,137.7
Gross Business Volume	----- millions \$ -----				
Direct	2,211.2	29,327.0	3,310.9	95.7	34,944.8
Indirect	776.2	4,022.9	930.2	19.9	5,749.2
Induced	285.4	1,220.0	344.8	34.2	1,884.4
Total	3,272.8	34,569.9	4,585.9	149.8	42,578.4

Table 13. Direct, Indirect, and Induced Employment, by Economic Sector, Oil and Gas Industry, North Dakota, 2021

NAICS code and Economic Sector		Industry Segments				Total
		Exploration and Drilling	Oil and Gas Production	Transp and Processing	Infrastruct-ure	
----- jobs -----						
11	Ag, Forestry, Fish & Hunting	9	38	11	1	59
21	Mining	3,121	8,109	948	1	12,178
22	Utilities	17	382	105	1	506
23	Construction	145	530	258	804	1,737
31-33	Manufacturing	39	176	371	12	599
42	Wholesale Trade	392	1,900	319	20	2,630
44-45	Retail trade	379	1,631	487	43	2,540
48-49	Transportation & Warehousing	278	1,312	1,726	19	3,335
51	Information	79	380	94	4	557
52	Finance & Insurance	651	3,193	436	18	4,298
53	Real Estate & Rental	362	1,735	245	16	2,359
54	Professional, Scientific & Technical Services	847	3,367	546	16	4,775
55	Management of Companies	40	172	39	2	253
56	Administrative & Waste Services	602	2,346	613	14	3,575
61	Educational Services	40	171	47	5	263
62	Health & Social Services	493	2,105	595	59	3,251
71	Arts, Entertainment & Recreation	72	305	72	6	455
72	Accommodation & Food Services	546	1,853	432	28	2,859
81	Other Services	382	1,381	570	29	2,361
92	Government	50	573	89	3	715
Totals		8,544	31,659	8,001	1,102	49,306

Table 14. Gross Business Volume, by Economic Sector, Oil and Gas Industry, North Dakota, 2021

NAICS code and Economic Sector		Industry Segments				Total
		Exploration and Drilling	Oil and Gas Production	Transp and Processing	Infrastruct-ure	
----- millions \$ -----						
11	Ag, Forestry, Fish & Hunting	1.3	5.4	1.5	0.2	8.4
21	Mining	2,219.7	29,343.4	514.7	0.3	32,078.1
22	Utilities	20.5	431.9	122.4	1.8	576.5
23	Construction	38.0	139.1	67.7	96.0	340.8
31-33	Manufacturing	16.7	75.1	2,267.2	4.1	2,363.1
42	Wholesale Trade	137.5	658.6	170.9	7.0	974.0
44-45	Retail trade	40.0	172.5	52.9	4.5	269.9
48-49	Transportation & Warehousing	38.3	221.1	759.7	3.1	1,022.2
51	Information	34.7	164.1	41.8	1.7	242.3
52	Finance & Insurance	208.6	1,089.4	132.1	5.4	1,435.4
53	Real Estate & Rental	152.4	677.0	99.5	7.3	936.2
54	Professional, Scientific & Technical Services	125.2	507.3	84.2	2.3	719.0
55	Management of Companies	9.2	39.4	8.8	0.5	58.0
56	Administrative & Waste Services	62.5	262.0	61.4	1.4	387.3
61	Educational Services	2.1	9.2	2.5	0.2	14.2
62	Health & Social Services	64.4	275.0	77.8	7.7	424.9
71	Arts, Entertainment & Recreation	4.4	19.0	4.7	0.4	28.5
72	Accommodation & Food Services	45.2	150.0	34.4	2.2	231.8
81	Other Services	41.5	147.7	58.7	2.8	250.7
92	Government	10.5	182.8	23.2	0.8	217.2
Totals		3,272.9	34,569.9	4,586.0	149.7	42,578.5

COMPARISON OF PREVIOUS INDUSTRY ASSESSMENTS

The first comprehensive economic evaluation of the oil and gas industry in North Dakota, conducted in 2006, was reflective of conditions present in the industry in calendar year 2005 (Bangsund and Leistriz 2007). Biennial assessments have been conducted since the 2005 study (Bangsund and Leistriz 2009, 2010; Bangsund and Hodur 2013, 2015, 2017, 2019, 2021). The results reported in this study were based on conditions present in the industry in calendar year 2021.

Biennial assessments from 2005 through 2021 have documented the meteoric rise in economic output as the industry ramped up development of shale oil resources and have measured the precipitous drop in output as the industry contracted from a price collapse at the end of 2014.

Methods and data sources among the nine studies have undergone several refinements in data collection and estimation techniques since the first economic assessment in 2005. In the 2007 study, a separate survey of lease/brokerage firms was initiated to help generate estimates of in-state lease bonuses on private land in North Dakota. Firms providing oil field services were not surveyed in the 2007, 2013, 2015, 2017 and 2019 studies, but those firms were surveyed in the 2005, 2009, and 2011 studies. Current study methodologies no longer rely on survey data from oil field service firms.

Detailed data on input sourcing for well drilling and well completions were obtained from oil operators to examine economic leakage associated with well drilling and well completion activities in the 2011 study and the same information was solicited in the 2021 study. Also, estimates of in-state mineral royalty revenues in 2011 were refined based on payment data obtained from oil operators in the state, and those refinements are present in the current study. Finally, the 2011 study collected survey data on infrastructure spending by the industry. The 2013 study expanded the survey of firms to include rail loading facilities. The 2013 and 2015 studies used data from Job Service North Dakota to estimate direct employment in the industry, rather than develop estimates from survey or other secondary data. The 2017, 2019, 2021, and the current study no longer merge Job Service North Dakota oil and gas industry employment data with traditional Input-output methodology.

The most significant change was made in 2017 when the North Dakota Input-Output Model was replaced with the IMPLAN modeling system. IMPLAN's analytical structure is similar to the North Dakota Input-Output model is structured in a more comprehensive manner and in a manner more closely reflecting the information in the National Income and Product Accounts produced by the U.S. Bureau of Economic Analysis. Many of the revenue flows estimated in the previous studies were retained, and used to shape the economic profile for several economic sectors within IMPLAN. One key difference between the North Dakota Input-Output model and IMPLAN is that IMPLAN uses sector revenue or sales as primary model inputs as opposed to industry expenditures in the North Dakota Input-Output model.; this is a departure from the previous studies' methodologies.

With the switch to the IMPLAN modeling platform, came the ability to access the underlying I-O matrix data for North Dakota. The dataset obtained from IMPLAN contains data not previously used in the 2005 through 2015 economic contribution studies. While many of the data sources in previous studies were retained in this study, the switch from the ND Input-Output Model to the IMPLAN modeling system does produce different estimates of economic output. As a result of those differences, data from the 2015 study and the 2015 IMPLAN input-output matrix were used to reconstruct the 2015 study economic contribution estimates using IMPLAN as the modeling platform. The goal of producing 2015 estimates using IMPLAN was to allow a more effective comparison of recent economic contributions from the oil and gas industry that are more reflective of changes in industry output than changes in modeling platforms (Table 15).

Table 15. Key Economic Values, Oil and Gas Industry, North Dakota, Selected Years 2005 through 2021

Category	2005 ^a	2007 ^a	2009 ^a	2011 ^a	2013 ^a	2015 ^a	2015 ^b	2017 ^b	2019 ^b	2021 ^b
----- millions nominal \$ -----										
Direct Economic Output										
Exploration and Drilling	445.1	1,536.3	2,802.7	6,141.1	7,609.4	5,301.0	5,733.9	3,381.4	3,843.6	2,211.2
Oil and Gas Production	819.8	1,308.4	1,799.4	3,976.6	7,676.8	6,211.1	19,964.0	22,214.6	27,430.3	29,327.0
Transp. and Processing	132.5	261.7	310.8	475.0	812.6	1,204.4	2,357.1	2,270.8	2,890.3	3,310.9
Infrastructure	not estimated	not estimated	not estimated	1,143.0	1,463.4	1,142.3	852.1	577.5	411.2	95.7
Total	1,397.4	3,106.4	4,912.9	11,736.7	17,562.2	13,858.9	28,907.1	28,444.3	34,575.4	34,944.8
Indirect and Induced Economic Output^c										
Exploration and Drilling	775.0	2,721.4	4,727.8	10,697.5	12,788.5	8,868.9	2,685.0	1,071.6	1,881.5	1,061.6
Oil and Gas Production	1,408.4	1,956.3	2,455.7	4,672.6	7,668.3	6,345.2	3,150.6	2,235.8	2,886.2	5,242.9
Transp. and Processing	238.1	445.5	566.3	895.1	1,510.0	2,241.8	462.1	566.1	598.3	1,275.0
Infrastructure	not estimated	not estimated	not estimated	2,419.0	3,098.6	2,414.6	394.2	299.4	249.3	54.1
Total	2,421.5	5,123.2	7,749.8	18,685.2	26,065.4	19,870.5	6,691.9	4,172.9	5,615.3	7,633.6
Gross Business Volume										
Exploration and Drilling	1,220.1	4,257.7	7,530.5	16,838.6	20,397.9	14,169.9	8,418.8	4,453.0	5,725.1	3,272.8
Oil and Gas Production	2,228.2	3,264.7	4,255.0	8,649.2	15,345.1	12,556.3	22,561.8	24,450.4	30,316.5	34,569.9
Transp. and Processing	370.6	707.2	877.1	1,370.1	2,322.6	3,146.2	2,819.3	2,836.8	3,488.6	4,585.9
Infrastructure	not estimated	not estimated	not estimated	3,562.0	4,562.0	3,556.8	1,246.3	876.9	660.5	149.8
Total	3,818.9	8,229.6	12,662.6	30,419.9	43,627.6	33,729.3	35,991.1	32,617.2	40,190.7	42,578.4
Government Revenues	336.3	629.8	1,010.1	2,647.8	4,496.8	3,362.6	3,167.1	2,881.5	3,825.3	3,763.2
----- jobs -----										
Total Jobs Supported in ND^d	20,022	29,425	36,057	59,559	81,407	72,353	72,353	51,428	59,068	49,385

^a Estimated using North Dakota Input-Output Model and associated methodologies.

^b Estimated using IMPLAN modeling platform and associated methodologies.

^c Indirect and induced effects in the IMPLAN analysis for 2015, 2017, and 2019 were adjusted downward to reflect the treatment of indirect business activity being counted as direct activity. The adjustments were conducted so that economic output would be similar and consistent with the differences between employment from the Job Service North Dakota (2016, 2017) studies and employment using traditional Input-output analysis.

^d Employment estimates in 2005, 2007, and 2009 were based on North Dakota Input-Output model's economic base dataset. Estimates in the 2011, 2013, 2015, and 2017 studies used traditional input-output approaches examining indirect and induced effects for supporting secondary employment in combination with information from Job Service North Dakota (2014, 2015, 2016, 2017). The 2019 and 2021 studies used conventional input-output approaches without reliance on specific oil and gas industry employment from Job Service North Dakota (2014, 2015, 2016, 2017).

SUMMARY and CONCLUSIONS

Over the past decade, the adoption of new technologies to extract oil and gas from shale has made the oil and gas industry one of the largest single basic-sector industries in the state. This study represents the eighth study to measure the economic contribution of oil and gas industry activities on North Dakota's economy.

The purpose of this study was to estimate the economic contribution of the oil and gas industry in North Dakota in 2019. The oil and gas industry was defined to include exploration and development, production, transportation, and processing of crude oil and natural gas. Also included in this study was an assessment of capital expenditures for infrastructure projects.

In previous studies, primary model inputs or direct impacts were expenditures made in North Dakota by oil and gas industry firms. In contrast the IMPLAN modeling system uses industry sales to represent the direct impacts of the industry. These changes, and other differences between the previous study's methodologies, make detailed comparisons between the two methodologies challenging.

The economic contribution of activities related to exploration and drilling was estimated to \$3.3 billion and supported 8,500 jobs. Statewide labor income from exploration and drilling activities was estimated at \$596 million.

The economic contribution of activities related to oil and gas production was estimated at \$34.6 billion and supported 31,700 jobs. Statewide labor income from oil and gas production was estimated at \$2.5 billion.

The economic contribution of activities related to processing and transportation was estimated at \$4.6 billion and supported 8,100 jobs. Statewide labor income from processing and transportation was estimated at \$716 million.

Development of infrastructure was estimated to support 1,100 jobs statewide and have an economic contribution of \$150 million.

Overall, the industry supported 49,385 jobs with labor income of \$3.9 billion. In 2021, The industry's total (direct and secondary) economic contribution (gross business volume) was estimated at \$42.6 billion and contributed \$26 billion to North Dakota's gross state product. The industry was responsible for \$3.76 billion in local and state government revenues.

Regardless of the economic measure used, the oil and gas industry is one of the largest basic-sector industries in North Dakota. While the economic size of the industry has not rebounded to the historical peak in 2014, the industry is clearly a major driver of economic activity in the state.

REFERENCES

- Bangsund, Dean A. and Nancy M. Hodur. 2021a. *Wind Energy Industry's Economic Contribution to the North Dakota Economy in 2019*. Agribusiness and Applied Economics Report No. 805. Department of Agribusiness and Applied Economics, North Dakota State University, Fargo.
- Bangsund, Dean A. and Nancy M. Hodur. 2021b. *Petroleum Industry's Economic Contribution to North Dakota in 2019*. Agribusiness and Applied Economics Report No. 807. Department of Agribusiness and Applied Economics, North Dakota State University, Fargo.
- Bangsund, Dean A. and Nancy M. Hodur. 2020. *Economic Contribution of the North Dakota Lignite Industry in 2019*. Agribusiness and Applied Economics Report No. 804. Department of Agribusiness and Applied Economics, North Dakota State University, Fargo.
- Bangsund, Dean A. and Nancy M. Hodur. 2019a. *Economic Contribution of the North Dakota Lignite Industry in 2017*. Agribusiness and Applied Economics Report No. 784. Department of Agribusiness and Applied Economics, North Dakota State University, Fargo.
- Bangsund, Dean A. and Nancy M. Hodur. 2019b. *Petroleum Industry's Economic Contribution to North Dakota in 2017*. Agribusiness and Applied Economics Report No. 792. Department of Agribusiness and Applied Economics, North Dakota State University, Fargo.
- Bangsund, Dean A. and Nancy M. Hodur. 2017. *Petroleum Industry's Economic Contribution to North Dakota in 2015*. Agribusiness and Applied Economics Report No. 766. Department of Agribusiness and Applied Economics, North Dakota State University, Fargo.
- Bangsund, Dean A. and Nancy M. Hodur. 2015. *Petroleum Industry's Economic Contribution to North Dakota in 2013*. Agribusiness and Applied Economics Report No. 736. Department of Agribusiness and Applied Economics, North Dakota State University, Fargo.
- Bangsund, Dean A. and Nancy M. Hodur. 2013. *Petroleum Industry's Economic Contribution to North Dakota in 2011*. Agribusiness and Applied Economics Report No. 710. Department of Agribusiness and Applied Economics, North Dakota State University, Fargo.
- Bangsund, Dean A., Nancy M. Hodur, and F. Larry Leistritz. 2012. *Economic Contribution of the Sugarbeet Industry in Minnesota and North Dakota*. Agribusiness and Applied Economics Report No. 688. Department of Agribusiness and Applied Economics, North Dakota State University, Fargo.
- Bangsund, Dean A. and F. Larry Leistritz. 2010. *Economic Contribution of the Petroleum Industry to North Dakota in 2009*. Agribusiness and Applied Economics Report No. 676 & 676-S. Department of Agribusiness and Applied Economics, North Dakota State University, Fargo.
- Bangsund, Dean A. and F. Larry Leistritz. 2009. *Petroleum Industry's Economic Contribution to North Dakota in 2007*. Agribusiness and Applied Economics Report No. 639. Department of Agribusiness and Applied Economics, North Dakota State University, Fargo.

- Bangsund, Dean A. and F. Larry Leistritz. 2007. *Economic Contribution of the Petroleum Industry to North Dakota in 2005*. Agribusiness and Applied Economics Report No. 599. Department of Agribusiness and Applied Economics, North Dakota State University, Fargo.
- Coon, Randal C., Nancy M. Hodur, and Dean A. Bangsund. 2012. *Renewable Energy Industries' Contribution to the North Dakota Economy*. AAE 702. . Department of Agribusiness and Applied Economics, North Dakota State University, Fargo.
- IMPLAN Group, LLC. 2020. <https://implan.com/> IMPLAN Group LLC, IMPLAN System (data and software), 16905 Northcross Dr., Suite 120, Huntersville, North Carolina.
- Job Service North Dakota. 2017. *2016 North Dakota Oil and Gas Employment Report*. <http://www.jobsnd.com/> Job Service North Dakota, Bismarck.
- Job Service North Dakota. 2016. *2015 North Dakota Oil and Gas Employment Report*. <http://www.jobsnd.com/> Job Service North Dakota, Bismarck.
- Job Service North Dakota. 2015. *2014 North Dakota Oil and Gas Employment Report*. <http://www.jobsnd.com/> Job Service North Dakota, Bismarck.
- Job Service North Dakota. 2014. *2013 North Dakota Oil and Gas Employment Report*. <http://www.jobsnd.com/> Job Service North Dakota, Bismarck.
- 7
- Job Service North Dakota. *Various years*. Quarterly Census of Employment and Wages. <http://www.jobsnd.com/> Job Service North Dakota, Bismarck.
- North Dakota Department of Mineral Resources. 2023. Unpublished data on oil and gas production, well drilling activity, and energy prices. Oil and Gas Division, Department of Mineral Resources, North Dakota Industrial Commission, Bismarck.
- North Dakota Department of Trust Lands. 2023. Oil and gas lease statistics. <http://www.land.state.nd.us/> Minerals Management Division, North Dakota Department of Trust Lands, Bismarck, ND.
- North Dakota Office of State Tax Commissioner. 2023a. Unpublished data on state collections of gross production tax and extraction tax. North Dakota Office of State Tax Commissioner, Bismarck, ND.
- North Dakota Office of State Tax Commissioner. 2023b. Unpublished data on average monthly crude oil prices received in North Dakota. North Dakota Office of State Tax Commissioner, Bismarck, ND.
- North Dakota Office of State Tax Commissioner. 2023c. Unpublished data on property taxes for pipelines and other centrally-assessed facilities for oil and gas activities. North Dakota Office of State Tax Commissioner, Bismarck, ND.
- North Dakota Pipeline Authority. 2023. Unpublished data on oil and gas industry infrastructure in North Dakota. North Dakota Pipeline Authority, North Dakota Industrial Commission, Bismarck.
- North Dakota Public Service Commission. 2023. Public Notices. <http://www.psc.nd.gov/index.php>. North Dakota Public Service Commission, Bismarck.

Office of Natural Resource Revenue. 2023. Mineral revenue collections and distributions.
<http://www.onrr.gov/ONRRWebStats/Home.aspx> Office of Natural Resource Revenue, U.S.
Department of the Interior, Denver, CO.

U.S. Bureau of Economic Analysis. 2023. Implicit Price Deflators for Gross Domestic Product.
<http://www.bea.gov/> U.S. Bureau of Economic Analysis, U.S. Department of Commerce, Washington,
D.C.

U.S. Bureau of Labor Statistics. 2023. Quarterly Census of Employment and Wages.
<https://www.bls.gov/bls/proghome.htm#employment> U.S. Bureau of Economic Analysis, U.S.
Department of Labor, Washington, D.C.

U.S. Department of Energy. 2023. <http://www.eia.doe.gov/> Energy Information Administration, U.S.
Department of Energy, Washington, D.C.

A blue horizontal bar with a right-pointing arrow shape, containing the text "Appendix A".

Appendix A

A large vertical rectangular area with a yellow-to-white gradient background, containing the text "Survey Questionnaires".

Survey Questionnaires

Economic Contribution of the Petroleum Industry to North Dakota

Industry Data Request

Funding for this study is provided by the **North Dakota Petroleum Council**

North Dakota Petroleum Industry

Confidentiality – only the project’s lead researcher (Dean Bangsund) will have access to this information, and the information is never shared with any interests during or after the study. A confidentiality agreement can be provided upon request.

Please address only the questions that fit with your firm’s activities, not all questions will apply.

Please use **2021** information.

Please complete the survey by **October 31**, 2022, if possible, to ensure study can be completed for ND’s 2023 Legislative Session.

Please **email** your information to Dean Bangsund d.bangsund@ndsu.edu

Upstream Operators

Operating Cost -- per barrel or BOE (please specify)	\$
Well Drilling and Completions (DCF)– typical or average Ballot Costs	\$/well
	wells drilled
	wells completed
Gathering Costs for Oil and Gas -- cost to move oil and gas from wells to first market or first processing	\$/BOE
	BOE transported

Midstream / Downstream Operators

Gas Processing Plant – operational cost per mmcf (please include only inputs and services purchased, please exclude payroll, natural gas purchases, and depreciation)	\$/mmcf
Refining Plant – operational cost per barrel (please include only inputs and services purchased, please exclude payroll, crude oil purchases, and depreciation)	\$/bbl
Transportation	
Crude Oil Pipeline – operational costs per barrel per mile (feel free to change the per-unit-distance if needed). Please include only inputs and services purchased. Please exclude payroll, crude oil purchases-if any, and depreciation	\$/bbl/mile
Transload Facilities	
Operational Costs -- please include only inputs and services purchased, please exclude payroll and depreciation	\$/bbl
Rail Tariffs – average tariff per rail car	\$/car
	rail cars shipped
Any other transportation costs not included above (please describe)	\$

Feel free to include any supporting information.

The graphic consists of a vertical dark blue bar on the left. A blue arrow points from this bar to the right, containing the text 'Appendix B'. To the right of the arrow is a large vertical rectangle with a yellow-to-white gradient background. The text 'Economic Impact Modeling' is centered within this rectangle.

Appendix B

Economic Impact Modeling

Outline for Economic Impact and Contribution Assessments

Overview

Input-Output Analysis

Types of Economic Evaluations

- Impact Assessments
- Contribution Assessments

Types of Economic Causality

- Direct Effects
- Indirect Effects
- Induced Effects

Types of Economic Activity

- Value Added
- Total Economic Output
- Employment and Employment Compensation
- Proprietor Income
- Labor Income
- Government Revenue
- Property-type Income
- Taxes on Production and Imports

Selection of Input-output Model

IMPLAN Modeling System

IMPLAN Economic Modeling

- Industry Change
- Industry Spending Patterns
- Labor Income Change
- Household Income Change
- Institutional Spending Patterns

IMPLAN Fiscal Methodology

IMPLAN Fiscal Data Sources and Treatment of Tax Data

- National Income and Product Account Tables
- Consumer Expenditure Survey (CES).
- Annual Survey of State and Local Government Finances (SLGF)
- Regional Economic Accounts (REA)
- Employee-paid portion for State/Local social insurance
- Employer-paid portion for State/Local social insurance funds.
- State/Local social insurance paid by self-employed.
- Sales Taxes on "Other Property Type Income" (TOPI) paid to State and Local Governments
- TOPI property taxes paid to State and Local Governments

(continued)

TOPI motor vehicle license taxes paid to State and Local Governments
TOPI severance taxes paid to State and Local Governments
TOPI other taxes paid to State and Local Governments
TOPI non-taxes paid to State and Local Governments
Personal income tax payments to State and Local Governments
Personal non-tax payments to State and Local Governments
Personal motor vehicle fee payments to State and Local Governments
Personal property tax payments to State and Local Governments
Personal other tax payments to State and Local Governments
State/Local Government Dividends
State/Local Government corporate profits tax
Employee-paid portion for Federal social insurance
Employer-paid portion for Federal social insurance
Self-Employed contribution to Federal social insurance
TOPI Federal Excise Taxes
TOPI Federal Custom Duties
TOPI Federal Non-taxes
Personal Income taxes paid to the Federal Government
Federal Corporate profits tax

Employment Sources and Measures

Covered Employment

Uncovered Employment

Overview

Economic impact and contribution assessments measure the economic activity from a project, program, policy, or activity. Economic activity is categorized into direct and secondary impacts. Direct impacts are those changes in output, employment, or income that represent the initial or first-round effects of a project, program, or event. Secondary impacts result from subsequent rounds of spending and re-spending within an economy.

Direct economic impacts are usually measured as injections (or reductions) of money into a specified economy. Direct impacts therefore represent inputs into an economic model to trace linkages among sectors of an economy and calculate various forms of business activity resulting from a direct impact in an economic sector.

Input-Output Analysis

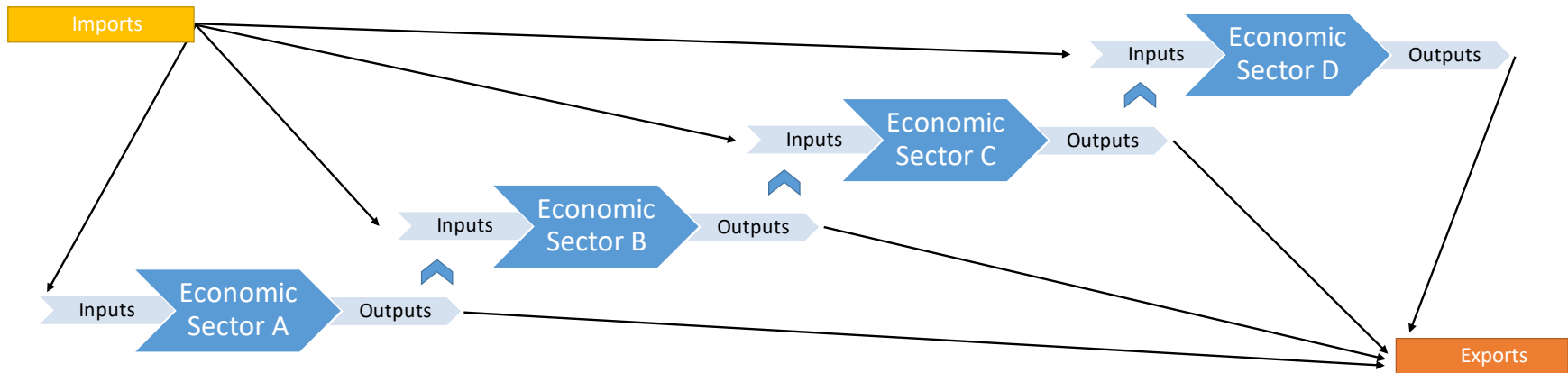
Input-output (I-O) analysis is a mathematical representation of the production and consumption of goods and services within a given economy. The basic premise to I-O modeling can be traced to economic base theory, or the understanding that a given economy is comprised of both 1) economic sectors or industries which produce goods/services for export outside the economy (basic sectors) and 2) economic sectors which produce goods/services within the economy for use by those exporting industries (non-basic sector). However, most current I-O modeling platforms do not limit economic activity in non-basic sectors to be driven or determined entirely by basic sector output.

Input-output analysis is premised on the notion of inter-industry transactions, where industries use products/services from other industries to generate their output, and outputs from one industry usually represent inputs to another industry. The basis for the interdependence (linkages) within I-O analysis between consuming and producing industries forms the foundation for development of multiplier effects. Multiplier effects can then be used to estimate how initial changes in economic activity result in economy-wide changes in a given area and represent the core component of input-output analysis.

While I-O analysis is a popular methodology used by a host of different stakeholders, the methodology has a number of fundamental assumptions or limitations. Key assumptions in I-O methodologies include 1) the economy is in equilibrium, 2) any expansion or contraction is linear, constant, and fixed, 3) no price and substitution effects, and 4) no supply constraints. This means that I-O models are a static representation of an economy and do not provide for dynamic adjustments that are likely to occur in an economy, especially those relating to large, fundamental changes in the size or structure of an area's key industries.

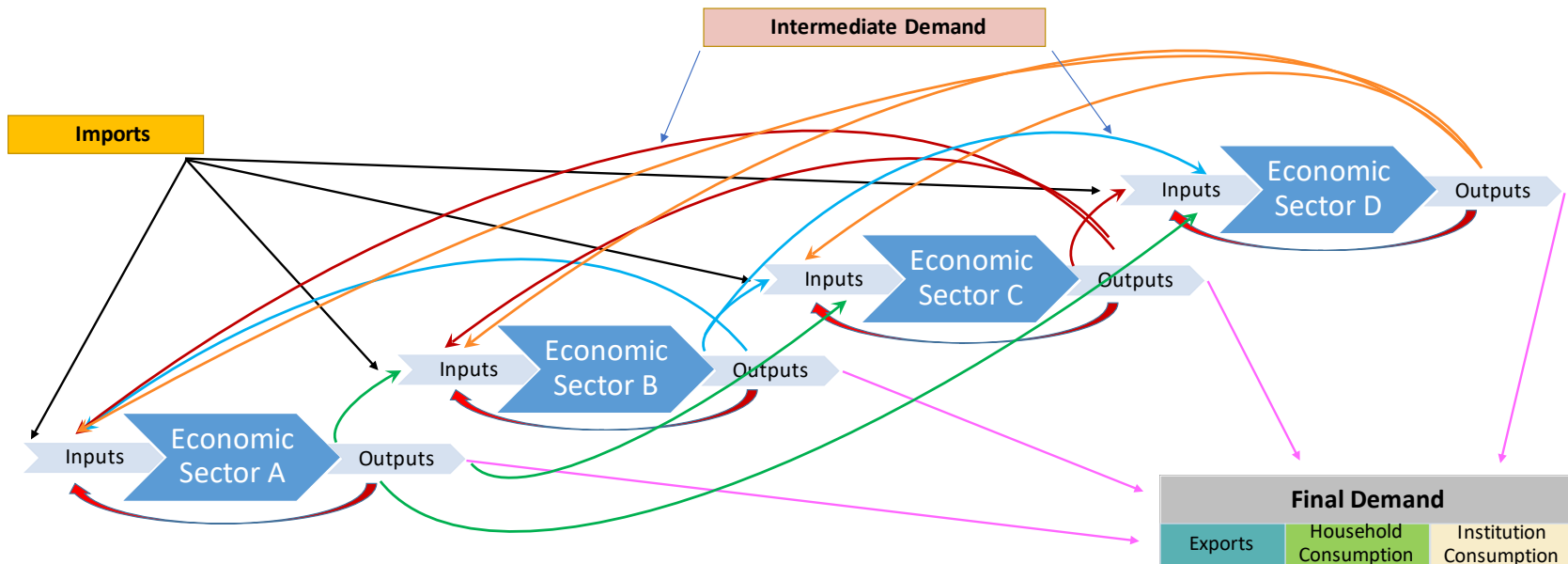
Since I-O models are widely available and used, output from those models is often accepted without much scrutiny. Despite development and use of other modeling processes (e.g., general equilibrium models) to mitigate the limitations and shortcomings of I-O modeling, I-O analysis remains the most widely used approach to conducting economic impact and contribution assessments.

Economic sectors are linked through production and consumption and economies are not self-contained



38

Tracking consumption and production is best handled using a matrix



		List of Consuming Sectors (called Industries)						Institutions (considered Final Users)				
		Industry A	Industry B	Industry C	Industry D	Industry E	Industry (n)	Private Consumption	Private Investment	Net Exports	Gov't	Total
List of Producing Industries (called Commodities)	Industry A	Intermediate Inputs						Final Use (Final Demand)				Total Gross Output
	Industry B											
	Industry C											
	Industry D											
	Industry E											
	Industry (n)											
Labor Compensation	Value-added						GDP					
Taxes												
Gross Surplus												
Total	Total Gross Output											

-) Each industry is measured for its production and for its consumption.
-) Rows are dollars spent on commodities (goods and services) by other economic sectors, households, and government.
-) Total gross output is the market value of all commodities and goods produced—total production must equal total consumption.
-) Column totals are expenditures (purchases) for commodities (goods and services), labor, and taxes for all consuming industries.
-) GDP can be measured by examining consumption (sum of rows) or through the net value-added from production (sum of columns).

Types of Economic Evaluations

Input-Output analysis provides a tool for economists to perform **economic impact** and **economic contribution** analyses. These analyses can be applied to programs, projects, developments, industries, and other economic activities. Key macro-economic indicators such as employment, employment compensation, labor income, value-added output, gross business activity, selected government tax volume, and secondary (**indirect** and **induced**) economic effects using the above metrics can be estimated using input-output analysis.

Economic impact analysis estimates the change in key economic indicators resulting from 'new' dollars (either gained or lost) associated with economic conditions within a given economy. An economic impact analysis measures the net effect of two or more possible situations—often these situations would be the presence or absence of some type of economic activity, development, or program. Measures of secondary business activity are included in economic impact figures.

Economic contribution analysis differs in that it includes all relevant revenues and expenditures in the generation of the amount of economic activity created in an economic unit. Economic contribution analyses attempt to capture all economic activity without regard to the net change or value of alternative economic activities; therefore, economic contribution assessments provide measures of the gross effects. Typically, an economic contribution analysis will show more economic activity than found in an economic impact study for the same industry or activity. Measures of the secondary business activity are included in economic contribution figures.

Types of Economic Causality

Direct Economic Effects: Direct economic effects represent the first-round of payments for services, labor, and materials. Direct effects can be interpreted to represent jobs, labor income, and business activity that comprise an industry.

Indirect Economic Effects: Indirect economic effects arise from the additional consumption of goods and services triggered by businesses that supply inputs to firms in a given sector/industry. Indirect effects can be interpreted as the additional economic activity created through purchases by businesses.

Induced Economic Effects: Induced economic effects arise from the additional spending by households from changes in personal income associated with direct effects and indirect effects. Changes in personal income can come from payrolls of businesses that are directly impacted, changes in payroll from businesses that supply goods and services to an impacted sector (induced effects), and proprietor income resulting from a change in business volume. Induced effects measure the additional business activity that is triggered as changes in personal income are translated into the purchase of goods and services for personal consumption.

Types of Economic Activity

Value-added Effects: Value-added economic activity is a measure of the payment to labor and capital, and includes labor income, business taxes, and business/proprietor income (profit). This economic effect is sometimes referred to a measure of the value that is added to purchased inputs by a business or industry, and is analogous to gross state product. The use or consumption of goods and services in the production of another good or service is not included in value-added measures.

Total Economic Output: Total output is a measure of the business activity created by summing direct economic effects, indirect economic effects, and induced economic effects. This economic measure is sometimes called *gross business volume*. Total output therefore represents the sum of gross receipts of all economic sectors.

Employment and Employment Compensation: Employment is perhaps one of the most important economic measures associated with impact and contribution assessments. Direct employment represents the jobs employed by the business or economic sector for which the activity or event is being modeled. I-O analysis also estimates employment associated with indirect and induced economic effects. Changes in employment compensation include wages, salaries, and employment benefits linked to changes in employment levels.

Proprietor Income: Income to individuals associated with sole proprietorships, partnerships, tax-exempt cooperatives, or other self-employment. Does not include any dividends, interest, or rental income, but does include capital consumption allowance found on Federal Tax form 1040C. Individuals receiving Tax Forms 1099 would be counted as sole-proprietors and compensation would be treated as proprietor income.

Labor Income: Labor income is often interchanged with employment compensation, but labor income is a broader measure of payments to labor since it includes employment compensation and proprietor income.

Government Revenue: Changes in revenues to state and local governments are another important measure in most contribution studies. I-O models estimate changes in selected government revenues such as personal income, sales and use, corporate income, severance, and property taxes, and a variety of miscellaneous revenues such as permits, fees, licenses, and dividends. Government revenues are not generally additive to economic effects, as most government revenues are either imputed internally or directly comprise a component of an industry balance sheet.

Property-type Income: These economic values can be defined as Gross Operating Surplus less Proprietor Income (BEA defines GOS as gross output less intermediate inputs, employee compensation, and taxes on production and imports less subsidies). The consumption of fixed capital (i.e., capital outlays for most depreciable assets) is included, along with corporate profits and business transfer payments (net of government subsidizes).

Taxes on Production and Imports. In the IMPLAN venacular, this category used to be call indirect business taxes. Taxes on production and imports can be generally considered as the sum of sales, property, and excise taxes. This category also includes fines, licenses, permits, and fees. Another perspective is that the category of indirect business taxes are those taxes/nontax liabilities (i.e., any business liability to governments than are treated like a tax) that can be included as business expenses when estimating business profit.

Selection of Input-output Model

The Department of Agribusiness and Applied Economics at NDSU developed an I-O model for North Dakota dating back to the 1960s and was an important tool examining energy development in the state during the 1970s. The basic data for the model came from surveys of firms and businesses in the state, and key economic statistics included a corresponding data set defining state-level net exports (economic base), employment productivity ratios, and tax coefficients. The model and supporting economic data were widely-used for examining economic impact and economic contribution effects in the region. Use of the North Dakota Input-output Model was suspended in 2018 as personnel and resources were no longer available to support the model. This prompted the impact assessment research team, spearheaded jointly by Dean Bangsund, Department of Agribusiness and Applied Economics, and Dr. Nancy Hodur, Director, Center for Social Research, to adopt a new modeling platform.

A number of commonly used input-output models are available for conducting impact assessments for North Dakota. Publicly available models include RIMS II (Regional Input-Output Modeling System), IMPLAN (Impact Analysis for Planning), REMI (Regional Economic Models Inc.), and EMSI Analytics (Economic Modeling Specialists). There are other commercial models that are 1) not available for state-level analysis (e.g., REdyn, which combines I-O factors with CGE processes but is only used for the U.S. national economy), 2) specialized in fiscal effects and do not provide the same degree of impact assessment as the more common I-O models (e.g., LOCI, which only examines government costs of various types of impacts), and 3) built with varying degrees of sophistication primarily targeting subject-matter issues (e.g., JEDI-NREL that examines some economic impacts of constructing and/or operating energy-based facilities).

REMI was considered the best option from an empirical capacity, but the cost of acquiring the model and subscribing to annual baseline data updates was prohibitive. RIMS II is inexpensive, but the analytical capacity is substantially limited, and does not have any baseline or supporting data sets. IMPLAN was chosen as the modeling system is supported with detailed baseline data, and cost was not prohibitive.

IMPLAN Modeling System

IMPLAN modeling system is a popular I-O methodology because of its flexibility and customizability for structuring economic scenarios and ease of access to key data sets used in the modeling process (IMPLAN Group, LLC 2020). IMPLAN can be structured to evaluate economic effects through a number of model operations. Those operations range from change in sales for an entire industry to personal spending patterns for households with a specific income level. The flexibility to structure an assessment using multiple economic criteria, along with customization of baseline data, allow IMPLAN to be tailored to most economic conditions.

IMPLAN modeling system uses a variety of data sets to construct the I-O model. In general, those data sets begin with federal data, work through regional and state-level economic statistics, and if available, attempt to combine information for counties or other smaller geographic units. [see www.implan.com for more detail regarding data sets used to construct the model].

Key Data Sources used by the IMPLAN Modeling Platform		
Agency	Program	Data Set(s)
U.S. Bureau of Labor Statistics	Unemployment Insurance Covered Employment and Wages Program	CEW (ES-202)
	Consumer Expenditure Survey	CE LABSTAT
U.S. Bureau of Economic Analysis	National Income and Product Accounts	SA7, SA27, SA06, SA05, SA25, CA05, CA06, CA25, KLEM
	Regional Economic Accounts Benchmark I-O Accounts	
U.S. Census Bureau	Numerous Census Surveys and Programs	ACES, ARTS, ASE, ASM, APES, ASPP, STC, AWTS, BES, COG, CBP, CIR, EC, IA, GUS, ICT, MHS, NES, QTAX, SAS
	Construction Definitions and Spending	
	Decennial Census and Population Surveys	CPS, Decennial Census, ACS
USDA -- National Agricultural Statistics Service and Economic Research Service	Quinquennial Assessments and Annual Surveys	Census of Agriculture Annual Agricultural Statistics Agriculture Resource Management Survey

Source: IMPLAN Group, LLC (2020).

IMPLAN modeling system is a widely used and well-recognized source of economic data—this process is desirable because it allows for consistency and compatibility across regional, state, and sub-state economies. However, not all industries within all economies are accurately represented using federal, state, and local secondary data in combination with IMPLAN baseline data generation techniques (Bangsund and Hodur 2018a,b; Bangsund and Hodur 2012; Downes 2012; Taylor 2013; Booz

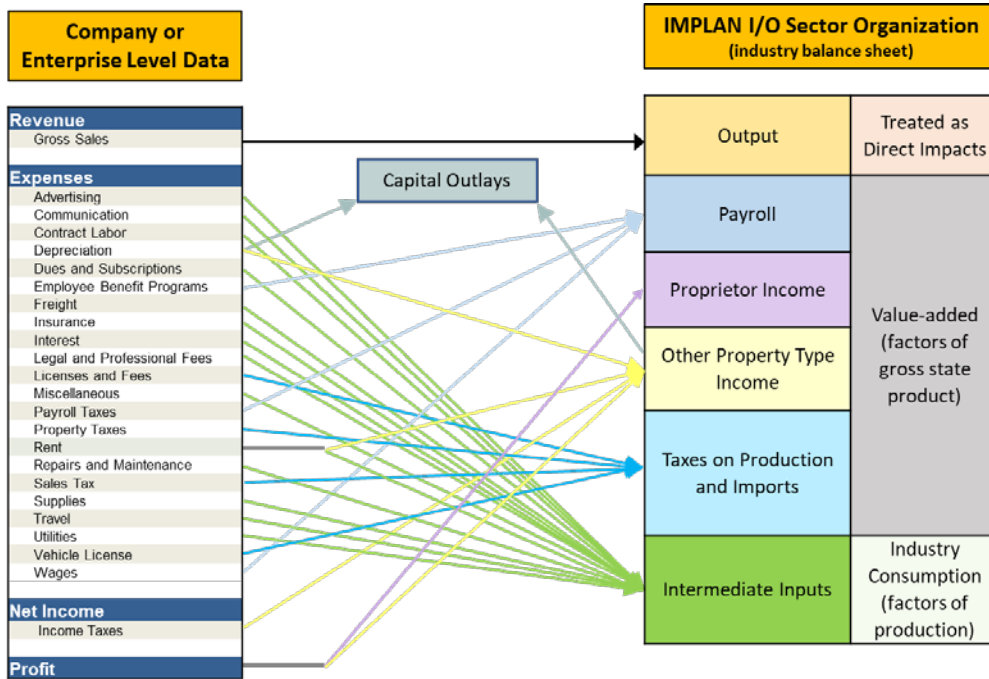
Allen 2008). To address potential problems, IMPLAN has built flexibility into the modeling system so that local or other primary data can be substituted for default values within the model.

IMPLAN uses a Double Constrained Gravity Model, along with several databases to estimate trade flows in various economic geographies. In the most general sense, gravity models work with the mass of demand and supply of commodities, and are constrained so that imports into a region do not exceed demand and exports from a region do not exceed available supply.

IMPLAN uses data from Center for Transportation Analysis at Oak Ridge National Laboratory (ORNL) on travel impedances (based on a commodity's modal mix as reported by the Commodity Flow Survey) to serve as the distances in IMPLAN's gravity model. ORNL also provides the circle distances between county centroids — those are used to calibrate the gravity model to Commodity Flow Survey data. Commodity Flow Survey (CFS) and Freight Analysis Framework (FAF) data are used to calibrate the gravity model to estimate trade flows between economic geographies. The two data sets contain information on the value, weight, distance traveled, transportation mode, and origin and destination (i.e., state) of the shippable commodities. These commodities are classified according to the standard classification of transported goods (SCTG) system, and the survey data are typically reported at the two-digit SCTG level.

Constructing or Adjusting Industry Balance Sheets

IMPLAN organizes financial information for industries in a manner different from traditional enterprise budgets or income statements. Despite these seemingly unrelated financial data, financial data for any particular business or economic sector can be used to customize an industry balance sheet. For some industries, such as production agriculture, cost-of-production budgets can be helpful in constructing industry balance sheets. Financial statements for firms or businesses also can serve to adjust or construct an industry balance sheet; however, accounting terms, income and expense categories, and treatment of debt, capital outlays, and taxes will not necessarily match perfectly to industry balance sheet components.



General Transposition of Financial Information into IMPLAN Economic Sector Profiles

Source: Bangsund, Department of Agribusiness and Applied Economics, NDSU

Components of Economic Profiles used in IMPLAN Modeling Platform	
Sales / Output	The value of an industry's production for the year and represents the sum of sales to final users in the economy (GDP) plus sales to other industries (intermediate inputs) and change in inventory.
Payroll	Includes all wages and salaries, all benefits, and all payroll taxes for employees.
Proprietor Income	Consists of payments received by self-employed individuals and unincorporated business owners. However, additional items include income of partnerships and tax-exempt cooperatives, dividends (payments in cash or other assets, monetary interest received by nonfinancial business, and rental income received by persons not primarily engaged in the real estate business).
Property Type Income	Represents gross operating surplus minus proprietor income, and includes consumption of fixed capital, corporate profits, and business current transfer payments (net), income derived from dividends, royalties, corporate profits, interest income, and is a source of income for households, business, and governments. PTI is treated as an economic leakage to the study region such that any PTI generated as part of an analysis will not generate any additional economic effects.
Taxes on Production and Imports	Includes sales and excise taxes, customs duties, property taxes, motor vehicle licenses, severance taxes, other taxes, and special assessments. This category is net of subsidies and therefore can be negative for an industry in a given year if that industry received more subsidies from the government than it paid out in the above taxes in that year. Social insurance taxes are placed in payroll and income taxes are part of Property Type Income.
Intermediate Inputs	Purchases of goods and services used for the production of other goods and services rather than used for final consumption. These inputs do not include capital purchases nor do they include the expenses for capital and labor.
Sources: IMPLAN Groups, LLC (2020); Bangsund, Agribusiness and Applied Economics, NDSU.	

Sector Profile	Descriptions and Role	
Output	Treated as Direct Effect	<ul style="list-style-type: none"> -) Sets level of direct effects -) Used to describe multipliers
Payroll	Value-added (factors of gross state product)	<ul style="list-style-type: none"> -) Used to measure contribution to Gross State Product -) <i>Payroll</i> and <i>Proprietor Income</i> primary driver of Induced Effects and contribute to business volume -) <i>Property type Income</i> provide insights on Capital Expenditures
Proprietor Income		
Property Type Income		
Taxes on Production and Imports		
Intermediate Inputs	Industry Consumption (factors of production)	<ul style="list-style-type: none"> -) Key driver of business volume -) Important in estimating output multipliers -) <i>Intermediate Inputs</i> driver of Indirect Effects

Economic Sector Organization and Use within IMPLAN
Source: Bangsund, Department of Agribusiness and Applied Economics, NDSU.

IMPLAN Economic Modeling

IMPLAN uses a variety of mechanisms, or economic triggers, to introduce a direct effect into a specified economy. Using a variety of mechanisms is one of the key attributes of the model that provide substantial flexibility in tailoring assessments to match expected economic changes.

An **Industry Change** represents adjusting the demand for the goods and services produced by an economic sector by varying that sector's revenue. Within this context, changes in sector gross revenues automatically result in changes in required labor, goods and services used to produce the sector's output (intermediate inputs), taxes on production and inputs (e.g., sales tax, property tax), labor income, and value-added.

Industry Spending Patterns can be used to change an economic sector's use of intermediate inputs without triggering changes in revenues, employment, labor income or value-added effects. The specific input is the sum of the total expenses that are expected to be changed by that economic sector.

Labor Income Change is not specific to an economic sector, rather it introduces an increase in the payment for labor inputs within an economy. This approach also by-passes the need to change other aspects of an industry's balance sheet to achieve a change in labor income; however, the *Labor Income Change* requires a manual (i.e., calculated outside of the IMPLAN model) estimate of the change in direct employment based on assumptions for payroll expenses per job.

Household Income Change is used when personal spending capacity within an economy is changed, but there is not necessarily any direct link to output changes in any particular economic sector or when personal spending capacity is not directly linked changes in labor income. These types of changes in household income might be represented by income from royalties, trusts, easements, gifts, inheritances, lotteries, and social transfer payments.

Institutional Spending Patterns are used to estimate how changes in public sector revenues influence the consumption of goods and services by government entities, educational institutions, non-profits and other non-governmental organizations. *Institutional Spending Patterns* also provide options for household spending patterns by income levels, which can be used to approximate the consumption of goods and services by households.

Commodity Events are used when there is an anticipated change in the demand for a good or service or a change in the supply of that good or service but it is unknown which economic sectors would meet the change in demand or produce the change in supply.

Industry Contribution Events are IMPLAN's first tool to estimate the value of an economic sector or industry by considering its current level of output. When using this event type, the size of the industry being measured is limited to its current size and will not be adjusted by secondary purchases (buybacks) from other economic sectors. Contribution events also can be used in combination with other event types to prevent an economic sector or industry from being influenced by an analysis that considers a broader change in another economic sector or industry. For example, in ND, a change in a manufacturing sector is likely to require additional electricity consumption; however, electricity from lignite coal is not going to materially change due to the potential increase in demand for electricity as this industry operates at a fixed capacity.

Mechanisms for Introducing Economic Effects into an Economy, IMPLAN Modeling Platform

IMPLAN Activity	Description
Industry Change	Represents a change in sales or revenue to an economic sector. Increases/decreases in sales, unless manually overrode within the model, will automatically produce increases/decreases in employment, employment compensation, purchases of intermediate inputs, and gross operating surplus based on the economic sector's balance sheet.
Industry Spending Pattern	Represents the expenses for goods and services used by an economic sector, and provides for adjustments in the percentage of those individual goods and services acquired within a specified economy.
Labor Income Change	Represents a general change in wages, salaries, and benefits within a specified economy.
Household Income Change	Represents a general change in the amount of personal income available to households in the specified economy.
Institutional Spending Pattern	Represents the proportional consumption of goods and services by governments, schools, and non-profits per unit of revenue. Includes spending patterns estimating personal consumption of goods and services by households.
Commodity Event	Model the change that might occur in an economy when the demand for a particular good or service changes but it is unknown what economics might change output to meet the change in demand
Contrtribution Event	When using this event type, the size of the industry being measured is limited to its current size or can be limited to predetermined share of its existing size.

Source: Bangsund, Agribusiness and Applied Economics, NDSU

IMPLAN Fiscal Methodology

IMPLAN estimates fiscal impacts by examining total government revenues from a variety of data sources. The model then estimates the share of government revenues based on the individual source of revenue (e.g., sales tax, income tax, severance tax, fees, and licenses). IMPLAN compares total government revenues, from all sources, with total industry output from all sectors in the economy. That process produces an estimate of tax revenue per unit of average industry output (e.g., gross sales, state gross product). The model does not estimate tax collections stemming from individual economic sectors or industries. Therefore, to estimate the fiscal impacts of a project, program, or activity, IMPLAN estimates the change in economy-wide business output, and then estimates the fiscal effects by multiplying that change in business output by the ratio of government revenues to economy-wide output. This process produces a direct relationship between expected new government revenues and a change in industrial or economic output.

Shortcomings and limitations of IMPLAN's fiscal impact methodology in North Dakota include:

A. IMPLAN's fiscal impact methodology is locked on the premise that all government revenues are intrinsically linked to changes in economy-wide economic output. This relationship is embedded within IMPLAN's default tax ratios and leads IMPLAN to generate large changes in some tax revenues even when direct causation is not contained in the economic assessment (i.e., without linking an economic impact to a specific change in a tax base or tax rate, or linking tax revenues on a per-sector basis). For some tax revenues, such as severance taxes, that methodology produces erroneous estimates. For other tax revenues, general economic output is a reasonable proxy for estimated changes in tax revenues.

B. IMPLAN's fiscal impact methodology cannot be adjusted internally to reflect state rules and stipulations affecting the specific taxes relating to unique conditions or special treatment that adjusts the tax base or tax rate. For example, the default matrix cannot be instructed to only generate coal conversion taxes if the electricity from fossil fuels sector is modeled or include changes in severance taxes when the changes in oil and gas production are modeled.

IMPLAN Fiscal Data Sources and Treatment of Tax Data

The following discussion of data sources is provided by IMPLAN Group LLC (2020).

IMPLAN's tax impact report values are based on the existing relationships of the data found in the IMPLAN database. The sources for these data are listed below, followed by description of each data element in the tax impact report.

- **NIPA Tables.** All items in the IMPLAN data sets are ultimately controlled to the U.S. level values from the Bureau of Economic Analysis' (BEA) National Income and Product Accounts (NIPA). Section 3 of the NIPA tables covers Government Current Receipts and Expenditures.
- **Consumer Expenditure Survey (CES).** The U.S. Census Bureau annually conducts surveys and daily samplings of household expenditure patterns (the CES). The survey data are reported for nine different categories of household income, which we control to the NIPA's Personal Consumption Expenditure (PCE) totals (which are not split out by income category). From these data, we can establish the tax-to-income relationships for the nine different household income categories. It is based on these relationships that we can distribute many of the national-level

tax data to states and state-level tax data to counties, using the number of households in each of the nine household categories in the state or county.

- **Annual Survey of State and Local Government Finances (SLGF).** The U.S. Census Bureau also collects annual State/Local Government receipts and expenditures data. These data act as preliminary controls for state-level values (subject to controlling to the national NIPA values). They also provide the proportional split of the TOPI value amongst the various types (sales, property, etc.). The actual value of total TOPI (at the state level) comes from the BEA's Regional Economic Accounts series.
 - The annual survey also provides local government collections by tax type. We use these data to estimate, for the total state/local tax receipts, the share of each type of tax that belongs to local government. We then use data for each local government to apportion that local total (at the state level) to each county. Since we know the local total for each county, we can distinguish the state and local tax revenue in the tax impact report. In IMPLAN Online, the tax impact report includes four types of governments that compose State/Local Government:
 - State government
 - County government
 - Sub-county general government, which includes city and township governments, for example
 - Sub-county special government, examples include fire and public school districts
 - IMPLAN supplements gaps in the SLGF with 5-year Census of Governments data, and supplements the SLGF state tax revenue with current-year state tax collections data from Census.
- **Regional Economic Accounts (REA).** The Bureau of Economic Analysis collects and reports income, wealth, tax, and employment data on a regional, state and county basis. The REA data from these two tables are used to distribute the U.S. NIPA values to states and counties:
 - Table CA05 -- Personal Income by Major Source and Earnings by Industry
 - Table SA50 -- Personal Tax and Non-tax Payments

Tax Identification Scheme, IMPLAN Modeling Platform					
Description	Employee Compensation	Proprietor Income	Tax on Production and Import	House holds	Corporations
State and Local Taxes					
Dividends					O
Social Insurance Tax- Employee Contribution	A	C			
Social Insurance Tax- Employer Contribution	B				
Tax on Production and Imports: Sales Tax			D		
Tax on Production and Imports: Property Tax			E		
Tax on Production and Imports: Motor Vehicle License			F		
Tax on Production and Imports: Severance Tax			G		
Tax on Production and Imports: Other Taxes			H		
Tax on Production and Imports: S/L NonTaxes			I		
Corporate Profits Tax					P
Personal Tax: Income Tax				J	
Personal Tax: NonTaxes (Fines- Fees				K	
Personal Tax: Motor Vehicle License				L	
Personal Tax: Property Taxes				M	
Personal Tax: Other Tax (Fish/Hunt)				N	
Federal Taxes					
Social Ins Tax- Employee Contribution	Q	S			
Social Ins Tax- Employer Contribution	R				
Tax on Production and Imports: Excise Taxes			T		
Tax on Production and Imports: Custom Duty			U		
Tax on Production and Imports: Fed NonTaxes			V		
Corporate Profits Tax					X
Personal Tax: Income Tax				W	
Source: IMPLAN Group LLC (2020).					

The following definitions and sources are provided by IMPLAN Group LLC (2020) and correspond with labeling in the IMPLAN Tax Identification Scheme.

Employee-paid portion for State/Local social insurance. This represents retirement plans and temporary disability insurance. The U.S. value comes from National Income and Products Accounts (NIPA) Table 3.6. This value is distributed to states based on each state's share of the following items from the State and Local Government Finances report (SLGF).

Employee Retirement – Local Employee Contribution;
Employee Retirement – State Employee Contribution;
Workers Compensation – Other Contributions.

These state values are distributed to counties based on each county's proportion of the state's State/Local Government Non-Education Employee Compensation. The county-level State/Local Employee Compensation figures come from U.S. Bureau of Economic Analysis. These are then split into Education vs. Non-Education using various data from the U.S. Census Bureau and the U.S. Department of Education.

Employer-paid portion for State/Local social insurance funds. This represents workers' compensation and temporary disability insurance. The U.S. value comes from NIPA Table 3.6. This value is distributed to states and based on each state's share of the following items from the SLGF:

Employee Retirement – From Local Government;
Employee Retirement – From State Government;
Unemployment Compensation – Contribution;
Workers Compensation – Own Contributions.

County distribution is based on county portion of state and local government non- education employee compensation from IMPLAN.

State/Local social insurance paid by self-employed. Self-employed individuals do not make payments to State/Local government, so this entry will always have a value of \$0.

Sales Taxes on "Other Property Type Income" (TOPI) paid to State and Local Governments. The U.S. value comes from NIPA Table 3.5. The U.S. value is distributed to states based on each state's proportion of Total General Sales Tax from the SLGF. State government values are then distributed to counties based on total retail output.

TOPI property taxes paid to State and Local Governments. The U.S. value comes from NIPA Table 3.5. The U.S. value is distributed to states based on each state's proportion of Total Property Tax from the SLGF. State government values are then distributed to counties based on total Personal Income from the BEA's CA05 table.

TOPI motor vehicle license taxes paid to State and Local Governments. The U.S. value comes from NIPA Table 3.5. The U.S. value is distributed to states based on each state's proportion of Motor Vehicle Operator's License Tax and Motor Vehicle License Tax from the SLGF. State government values are then distributed to counties based on total Personal Income from the BEA's CA05 table.

TOPI severance taxes paid to State and Local Governments. The U.S. value comes from NIPA Table 3.5. The U.S. value is distributed to states based on each state's proportion of Severance Tax from the SLGF.

State government values are then distributed to counties based on total Personal Income from the BEA's CA05 table.

TOPI other taxes paid to State and Local Governments. This item consists largely of business licenses and documentary and stamp taxes. The U.S. value comes from NIPA Table 3.5. The U.S. value is distributed to states based on each state's proportion of the following tax items from the SLGF: Corporation License; Amusement License; Other License; Documentary & Stock Transfer; Public Utility License; Alcoholic Beverage License; Occupation & Business License, NEC; and NEC. State government values are then distributed to counties based on total Personal Income from the BEA's CA05 table.

TOPI non-taxes paid to State and Local Governments. This item includes rents and royalties, special assessments, fines, settlements, and donations. The U.S. value comes from NIPA Table 3.5. The U.S. value is distributed to states based on each state's proportion of the following tax items from the SLGF: Miscellaneous – Rents; Miscellaneous – Special Assessments; Miscellaneous – Royalties; and Miscellaneous – Donations from Private Sources. State government values are then distributed to counties based on total Personal Income from the BEA's CA05 table.

Personal income tax payments to State and Local Governments. The U.S. value comes from NIPA Table 3.3. The U.S. value is distributed to states based on Individual Income Tax from the SLGF. State government values are then distributed to counties based on total Personal Income from the BEA's CA05 table.

Personal non-tax payments to State and Local Governments. This item includes payments for fines and donations. The U.S. value comes from NIPA Table 3.3. The U.S. value is distributed to states based on Motor Vehicle License Tax from the SLGF. State government values are then distributed to counties based on total Personal Income from the BEA's CA05 table.

Personal motor vehicle fee payments to State and Local Governments. The U.S. value comes from NIPA Table 3.4. The U.S. value is distributed to states based on Miscellaneous – Fines & Forfeits from the SLGF. State government values are then distributed to counties based on total Personal Income from the BEA's CA05 table.

Personal property tax payments to State and Local Governments. The U.S. value comes from NIPA Table 3.4. The U.S. value is distributed to states based on Property Tax from the SLGF. State government values are then distributed to counties based on total Personal Income from the BEA's CA05 table.

Personal other tax payments to State and Local Governments. This item consists largely of hunting, fishing, and other personal licenses. The U.S. value comes from NIPA Table 3.4. The U.S. value is distributed to states based on Hunting and Fishing License Tax from the SLGF. State government values are then distributed to counties based on total Personal Income from the BEA's CA05 table.

State/Local Government Dividends. This item represents net dividend payments to government by corporations from investments. The U.S. value comes from NIPA Table 3.3. The U.S. value is distributed to states based on the following items from the SLGF:
Employee Retirement – Securities – Mortgages
Employee Retirement – Securities – Corporate Stocks
Employee Retirement – Securities – Corporate Bonds
Employee Retirement – Total Other Securities

State government values are distributed to counties is based on their proportion of state Other Property Income (from IMPLAN database).

State/Local Government corporate profits tax. The U.S. value comes from NIPA Table 3.3. The U.S. value is distributed to states based on Corporate Net Income Tax from the SLGF. State government values are then distributed to counties is based on counties based on their proportion of the state's Other Property Income (from IMPLAN database).

Employee-paid portion for Federal social insurance. This item includes social security, survivors insurance, disability insurance, hospital insurance, supplemental medical insurance, unemployment insurance, veterans' life insurance, and railroad retirement plans. The U.S. value comes from NIPA Table 3.6. The U.S. value is distributed to states and counties based on Personal Contribution for Social Insurance from the BEA's CA05 table.

Employer-paid portion for Federal social insurance. This item includes social security, survivors insurance, disability insurance, hospital insurance, military medical insurance, unemployment insurance, pension benefit guaranty, veterans' life insurance, and railroad retirement plans. The U.S. value comes from NIPA Table 3.6. The U.S. value is distributed to states and counties based on Personal Contribution for Social Insurance from the BEA's CA05 table.

Self-Employed contribution to Federal social insurance. This item includes social security, survivors insurance, disability insurance, and hospital insurance. The U.S. value comes from NIPA Table 3.6. The U.S. value is distributed to states and counties based on Personal Contribution for Social Insurance from the BEA's CA05 table.

TOPI Federal Excise Taxes. This item includes federally levied excise taxes on alcohol, tobacco, telephones, coal, fuels, air transportation, vehicles, etc. The U.S. value comes from NIPA Table 3.2. The U.S. value is distributed to states and counties based on IMPLAN estimates of total TOPI for all industries in relationship to U.S. total TOPI.

TOPI Federal Custom Duties. These are gross collections less refunds. The U.S. value comes from NIPA Table 3.2. The U.S. value is distributed to states and counties based on IMPLAN estimates of total TOPI for all industries in relationship to U.S. total TOPI.

TOPI Federal Non-taxes. This item includes rents and royalties⁴. The U.S. value comes from NIPA Table 3.2. The U.S. value is distributed to states and counties based on IMPLAN estimates of total TOPI for all industries in relationship to U.S. total TOPI.

Personal Income taxes paid to the Federal Government. These are taxes paid through withholding, declarations and final settlement less refunds. The U.S. value comes from NIPA Table 3.2. The same value can also be found in NIPA Table 3.4. The U.S. value is distributed to states based on each state's value of "Federal government: Individual Income taxes (net of refunds)" from the BEA's SA50 table. State values are then distributed to counties based on total Personal Income from the BEA's CA05 table.

Federal Corporate profits tax. The U.S. value comes from NIPA Table 3.2. The U.S. value is distributed to states and counties based on their proportion of U.S. Other Property Income (from IMPLAN database).

Definition of Government Revenues, IMPLAN Modeling Platform	
Government Unit and Applicable Government Revenue	Definition
State and Local Government Revenues	
Dividends	State and Local government dividends represent dividend payments to government by corporations from investments.
Social Insurance Taxes: Employee Contribution	The social insurance contributions paid by state employees towards State sponsored pensions, in lieu of social security.
Social Insurance Taxes: Employer Contribution	The social insurance contributions paid by the State towards State sponsored pensions, in lieu of social security.
Indirect Business Tax: Sales Tax	Sales taxes paid to State and Local government.
Indirect Business Tax: Property Tax	Real estate-based property taxes paid by firms to State and Local governments. Because of the special situation encountered with Sector 361, this includes payments of property taxes made on homes.
Indirect Business Tax: Motor Vehicle	Motor vehicle license taxes paid by firms to State and Local governments.
Indirect Business Tax: Severance Tax	Taxes imposed by a State on the extraction of natural resources.
Indirect Business Tax: Other Taxes	Other taxes paid to State and Local governments include business licenses, documentary and stamp taxes.
Indirect Business Tax: S/L Non-taxes	IBT state and local non-tax payments include fines (such as parking and speeding tickets), fees (State and County park passes or day fees) and donated funds.
Corporate Profits Tax	Corporate profits taxes paid to State and Local governments.
Personal Tax: Income Tax	Income taxes paid by individuals to State and Local Government through withholding, declarations and final settlement, less refunds.
Personal Tax: Non-taxes (fines and fees)	Household personal nontax payments to State and Local governments include fines, donations, passport and immigration fees, and migratory bird-hunting stamps.
Personal Tax: Motor Vehicle Licenses	Household personal motor vehicle fee payments to State and Local governments.
Personal Tax: Property Taxes	Household personal property tax payments to State and Local governments. Dividend, interest, and rental income of persons with capital consumption adjustment are sometimes referred to as property income.
Personal Tax: Other Tax (Fishing/Hunting)	Other taxes consist of miscellaneous fees and licenses (such as hunting and fishing licenses, marriage licenses, registration of pleasure boats, and licenses for pets) to State and Local governments.

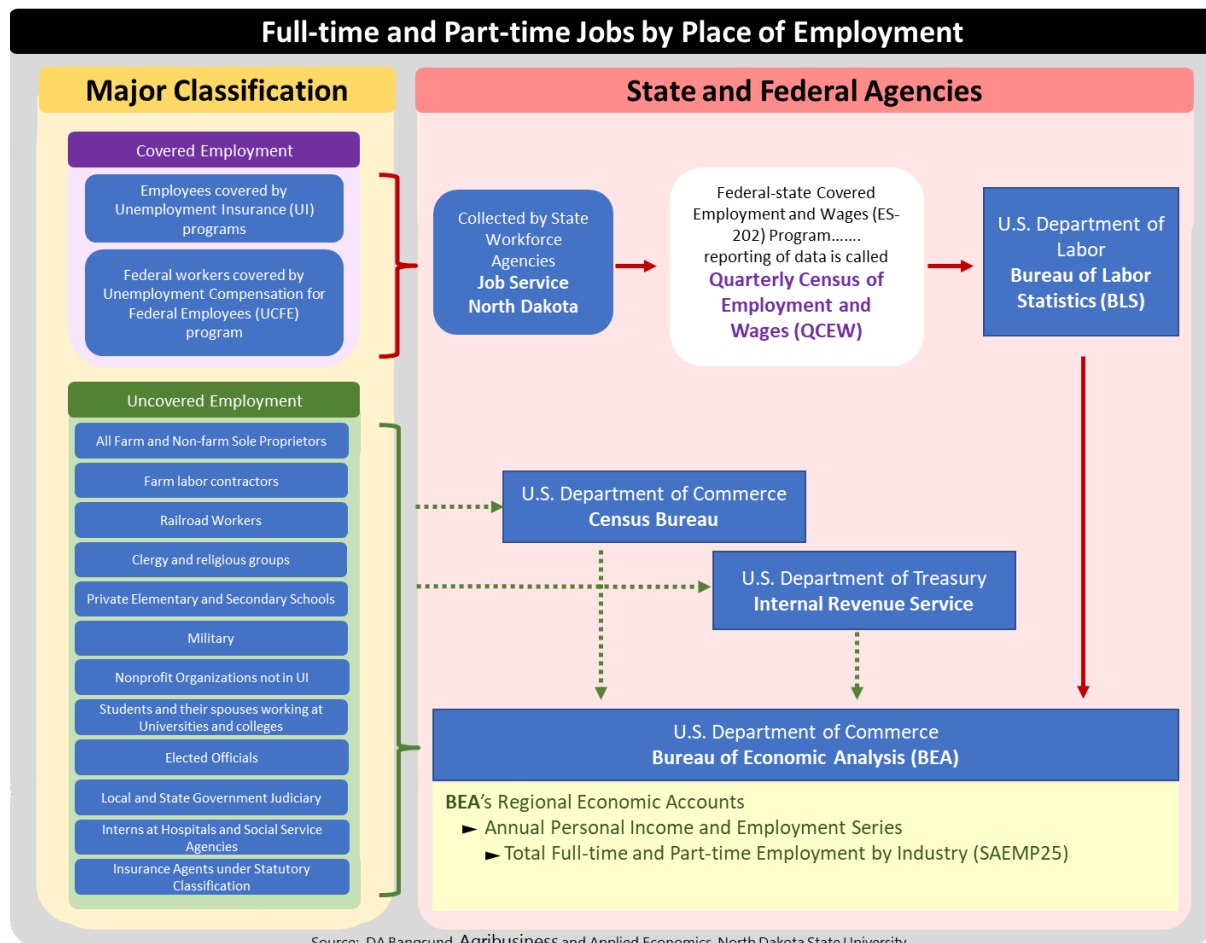
Federal Government Revenues	
Social Insurance Taxes: Employee Contribution	The employee paid portion for Federal social insurance. These contributions include payments by employees, the self-employed, and other individuals who participate in the following government programs: Old-age, survivors, and disability insurance (social security, FICA); hospital insurance; supplementary medical insurance; unemployment insurance; railroad retirement; veterans life insurance; and temporary disability insurance.
Social Insurance Taxes: Employer Contribution	The employer paid portion for Federal social insurance. This includes social security, unemployment insurance, medical and retirement plans.
Indirect Business Tax: Excise Taxes	Includes Federally levied excise taxes on alcohol, tobacco, telephones, coal, fuels, air transportation, vehicles, etc.
Indirect Business Tax: Custom Duty	Custom duties are gross collections net refunds.
Indirect Business Tax: Non-Taxes	IBT Federal non-tax payments include oil and gas royalties, fines, regulatory fees, forfeitures and donated funds.
Corporate Profits Tax:	Corporate profits taxes paid to Federal governments.
Personal Income Tax	Income taxes paid by individuals to the Federal Government through withholding, declarations and final settlement, less refunds.
Source: IMPLAN Group LLC (2020).	

Employment Sources and Measures

Government measures of employment are broadly measured in two distinct categories: covered and uncovered. Further, the responsibilities of employment measurements are shared among several government agencies and programs.

Covered Employment

Covered workers are those that are employed by a business, institution, or government agency, receive a wage or salary, and are subject to unemployment insurance (UI). Jobs that fall under an UI program are called 'covered' employment. Quarterly Census of Employment and Wages (QCEW) employment reported by Job Service North Dakota and by Minnesota Department of Employment and Economic Development is 'covered' employment. QCEW data are collected for each state and reported by the U.S. Bureau of Labor Statistics (BLS). Therefore, employment statistics for self-employed individuals cannot be derived from QCEW data.



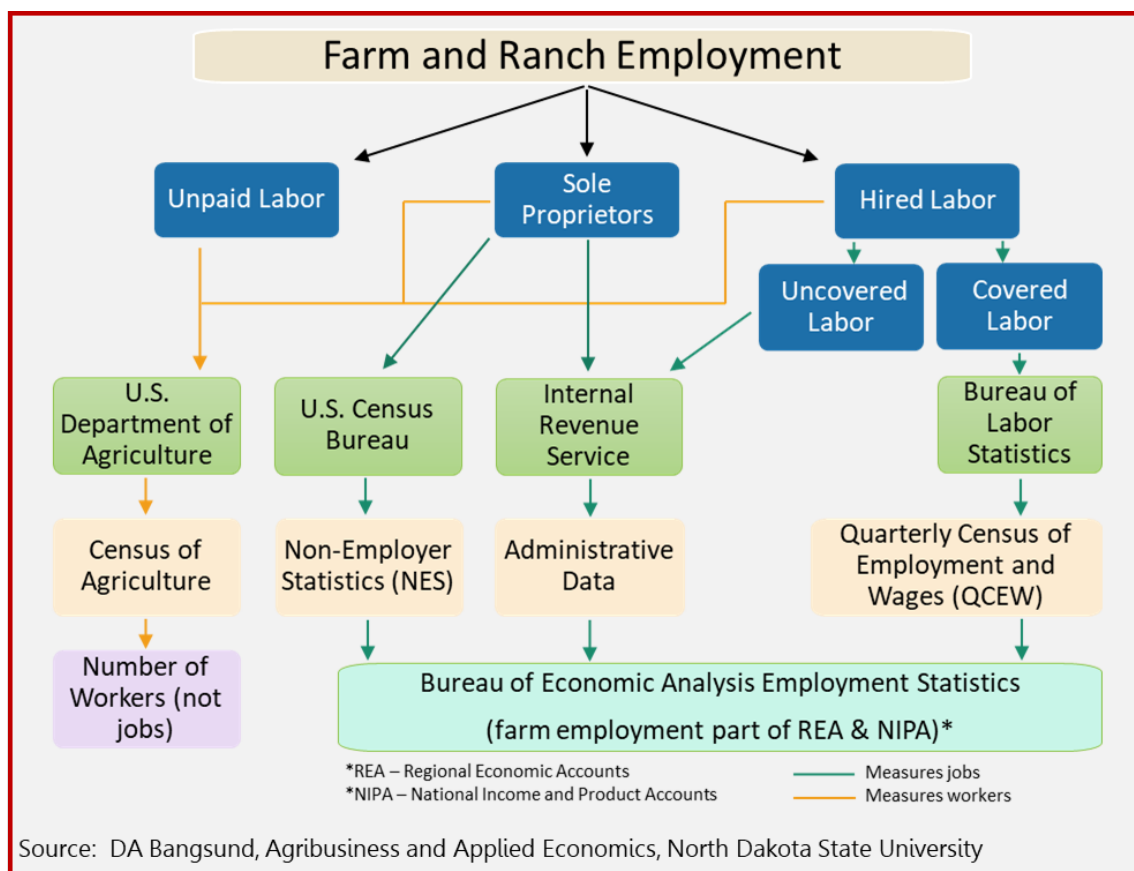
Source: DA Bangsund, Agribusiness and Applied Economics, North Dakota State University

Uncovered Employment

By contrast, 'uncovered' employment largely includes self-employed and sole-proprietors not enrolled in a state's UI program (enrollment is voluntary for self-employed individuals). The majority of on-farm employment is self-employed with only a small portion of on-farm employment qualifying as covered employment.


The U.S. Bureau of Economic Analysis (BEA) reports uncovered employment in conjunction with QCEW employment from BLS. The only source of on-farm employment that includes covered and uncovered hired labor, self-employed, and sole proprietors is the BEA's Regional Economic Accounts. The U.S. Department of Agriculture's Census of Agriculture collects information on individuals, not jobs, and cannot be directly substituted for BEA employment statistics.

For most 'industries', sole proprietors are not the predominate form of employment, and QCEW is often used to measure employment in those industries. In some economic 'sectors', sole proprietors represent a meaningful level of employment, such as independent truckers, construction and repair, retail shops, personal service providers, among others, but do not represent a meaningful share of employment at a broader 'industry' level. Crop production is largely unique among industries in that the majority of employment is represented by sole proprietors



A blue arrow-shaped bar pointing to the right, containing the text "Appendix C".

Appendix C

A large vertical rectangular area with a yellow-to-white gradient background, containing the main title text.

**Reconstructed Economic Sectors
for IMPLAN, Petroleum
Industry, North Dakota, 2015,
2017, 2019, and 2021**

Appendix Table C1. Input-Output Modeling Industry Components, Default IMPLAN Data and Customized Values, Well Development and Oil and Gas Extraction, Oil and Gas Industry, North Dakota, 2021

IMPLAN Industries (sectors) and Industry Balance Sheet Components	IMPLAN Default	Study Values	Estimation and Adjustment	Data Sources
Sector 20 (Extraction of Natural Gas and Crude Oil)				
Employment	3,840	2,411	Use of BLS QCEW data to remove royalty and investment individuals from IMPLAN data	BLS data NAICS 2111
Output (sales)	6,765,949,414	25,572,840,621	Oil and gas quantity x value (first purchaser prices) less oil field services' share of IMPLAN sector 36	NDDRM / NDOSTC
Employee Compensation (EC)	286,884,533	375,834,796	Wages/salaries adjusted to obtain employment compensation	BLS/IMPLAN
Proprietor Income (PI)	64,186,902	1,431,352,280	Sole proprietor income plus private and tribal royalties (net of severance taxes)*	ONRR/NDSU Survey
Other Property-type Income (OPTI)	3,588,273,686	14,455,943,685	Sales minus (EC, PI, TPI, & Intermediate Inputs)	calculation
Tax on Production and Imports (TPI)	1,131,779,579	2,722,491,034	Severance tax, property tax, sales taxes, public royalties, misc. government fees	NDOSTC/NDSU Survey
Total Value-added (VA)	5,071,124,700	18,985,621,795	Sum of EC, OPTI, PI & TPI	calculation
Intermediate Inputs	1,694,824,715	6,587,218,826	\$/BOE production expenses x BOE produced, Intermediate Inputs plus VA must equal Sales	NDSU Survey
*Royalties would normally be assigned to OPTI, but royalties were run through as proprietor income, and output for induced effects were subsequently reduced by the share of induced going to proprietor income, and those values were subsequently adjusted to account for only rates of in-state spending for royalties received by in-state mineral owners.				
Sector 37 (Drilling Oil and Gas Wells)				
Employment	1,967	1,541	Use of BLS QCEW data to remove uncovered workers from IMPLAN data	BLS data NAICS 2111
Output (sales)	1,527,497,626	717,632,366	Estimate of the portion of total well drilling costs allocated between IMPLAN sectors 37 and 38. Just for clarification, not all welling drilling costs are allocated to sectors 37 and 38.	NDSU Survey / NDDMR/IMPLAN
Employee Compensation (EC)	220,254,161	205,302,261	Wages/salaries adjusted to obtain employment compensation	BLS/IMPLAN
Proprietor Income (PI)	41,343,829	19,423,709	Ratio analysis using IMPLAN data	IMPLAN
Other property-type Income (OPTI)	720,593,751	-10,034,065	Sales minus (EC, TPI, & Intermediate Inputs)	calculation
Tax on Production and Imports (TPI)	79,905,990	37,540,566	Ratio analysis using IMPLAN data	IMPLAN
Total Value-added (VA)	1,062,097,731	252,232,471	Sum of EC, OPTI, & TPI	calculation
Intermediate Inputs	465,399,895	465,399,895	Retained IMPLAN default values	IMPLAN

Appendix Table C2. Input-Output Modeling Industry Components, Default IMPLAN Data and Customized Values, Support Activities, Oil and Gas Industry, North Dakota, 2021

IMPLAN Industries (sectors) and Industry Balance Sheet Components	IMPLAN Default	Study Values	Estimation and Adjustment	Data Sources
Sector 38 (Support activities for oil and gas operations)				
Employment	8,265	7,702	Use of BLS QCEW data to remove uncovered workers from IMPLAN data	BLS data NAICS 2111
Output (sales)	2,838,207,193	5,760,170,142	Combined analysis, see Table C3	BLS/IMPLAN/NDSU/DMR
Employee Compensation (EC)	879,229,911	900,878,776	Wages/salaries adjusted to obtain employment compensation	BLS/IMPLAN
Proprietor Income (PI)	161,518,183	327,802,782	Ratio analysis using IMPLAN data	IMPLAN
Other property-type Income (OPTI)	480,589,428	975,361,095	Sales minus (EC, TPI, & Intermediate Inputs)	calculation
Tax on Production and Imports (TPI)	105,884,393	214,893,444	Represents a combination of taxes from various sources	NDOSTC & NDSU Survey
Total Value-added (VA)	1,627,221,914	2,418,936,097	Sum of EC, OPTI, & TPI	calculation
Intermediate Inputs	1,210,985,279	3,341,234,045	Combined analysis, see Table C3	NDSU Survey

Appendix Table C3. Input-Output Modeling Industry Components, Estimation of Well Drilling and Oil Field Service Shares for IMPLAN Sector 38, Oil and Gas Industry, North Dakota, 2021

IMPLAN Industries (sectors) and Industry Balance Sheet Components	Study Values for IMPLAN Sector 38		Estimation and Adjustment	Data Sources
	Well Drilling	Oil Field Service		
Employment	1,410	6,292	Computed based on NDDMR data on rig counts and well counts, BLS labor division by NAICS codes, combined with Job Service North Dakota information on employment in related sectors.	BLS, NDDMR, & Job Service North Dakota
Output (sales)	1,493,572,361	4,266,597,781	Well drilling revenues represented share of reported drilling expenditures that represent spending in IMPLAN Sector 38. The share was estimated from secondary sources. Total well drilling expenses estimated from number of wells drilled and NDSU survey data. Revenues for oil field service is ratio of sales to employment from default IMPLAN data multiplied by new estimate of employment.	NDSU (2013), HIS (2014), BLM WY (2014), Eagle Ford (2011) & NDDMR & NDSU Survey IMPLAN
Employee Compensation (EC)	164,905,165	735,973,610	BLS data used to estimated employment compensation	BLS & IMPLAN
Proprietor Income (PI)	84,996,999	242,805,783	Based on ratio from IMPLAN default data and new estimate of sales for IMPLAN Sector 38	IMPLAN
Other property-type Income (OPTI)	252,904,400	722,456,695	Based on ratio from IMPLAN default data and new estimate of sales for IMPLAN Sector 38	IMPLAN
Tax on Production and Imports (TPI)	55,720,387	159,173,057	Based on ratio from IMPLAN default data and new estimate of sales for IMPLAN Sector 38	IMPLAN
Total Value-added (VA)	558,526,951	1,860,409,145	Sum of EC, OPTI, & TPI	calculation
Intermediate Inputs	935,045,410	2,406,188,635	Sales less Value-added	calculation

Appendix Table C4. Input-Output Modeling Industry Components, Default IMPLAN Data and Customized Values, Well Development and Oil and Gas Extraction, Oil and Gas Industry, North Dakota, 2019

IMPLAN Industries (sectors) and Industry Balance Sheet Components	IMPLAN Default	Study Values	Estimation and Adjustment	Data Sources
Sector 20 (Extraction of Natural Gas and Crude Oil) and Sector 21 (Extraction of Natural Gas Liquids)				
Employment	5,249	2,742	Use of BLS QCEW data to remove royalty and investment individuals from IMPLAN data	BLS data NAICS 2111
Output (sales)	3,554,660,222	25,803,824,311	Oil and gas quantity x value (first purchaser prices) less oil field services' share of IMPLAN sector 36	NDDRM / NDOSTC
Employee Compensation (EC)	365,695,631	460,481,033	Wages/salaries adjusted to obtain employment compensation	BLS/IMPLAN
Proprietor Income (PI)	52,788,369	4,117,786,733	Sole proprietor income plus private and tribal royalties (net of severance taxes)*	ONRR/NDSU Survey
Other Property-type Income (OPTI)	421,374,587	14,869,424,270	Sales minus (EC, PI, TPI, & Intermediate Inputs)	calculation
Tax on Production and Imports (TPI)	939,570,585	3,026,594,652	Severance tax, property tax, sales taxes, public royalties, misc. government fees	NDOSTC/NDSU Survey
Total Value-added (VA)	1,779,429,172	22,474,286,688	Sum of EC, OPTI, PI & TPI	calculation
Intermediate Inputs	1,775,231,049	3,329,537,623	\$/BOE production expenses x BOE produced, Intermediate Inputs plus VA must equal Sales	NDSU Survey
*Royalties would normally be assigned to OPTI, but royalties were run through as proprietor income, and output for induced effects were subsequently reduced by the share of induced going to proprietor income, and those values were subsequently adjusted to account for only rates of in-state spending for royalties received by in-state mineral owners.				
Sector 37 (Drilling Oil and Gas Wells)				
Employment	3,448	2,928	Use of BLS QCEW data to remove uncovered workers from IMPLAN data	BLS data NAICS 2111
Output (sales)	1,630,686,465	1,247,411,311	Estimate of the portion of total well drilling costs allocated between IMPLAN sectors 37 and 38. Just for clarification, not all welling drilling costs are allocated to sectors 37 and 38.	NDSU Survey / NDDMR/IMPLAN
Employee Compensation (EC)	399,133,856	386,070,503	Wages/salaries adjusted to obtain employment compensation	BLS/IMPLAN
Proprietor Income (PI)	22,144,991	16,940,051	Ratio analysis using IMPLAN data	IMPLAN
Other property-type Income (OPTI)	435,158,339	90,552,383	Sales minus (EC, TPI, & Intermediate Inputs)	calculation
Tax on Production and Imports (TPI)	86,797,910	66,397,003	Ratio analysis using IMPLAN data	IMPLAN
Total Value-added (VA)	943,235,095	559,959,940	Sum of EC, OPTI, & TPI	calculation
Intermediate Inputs	687,451,370	687,451,370	Retained IMPLAN default values	IMPLAN

Appendix Table C5. Input-Output Modeling Industry Components, Default IMPLAN Data and Customized Values, Support Activities, Oil and Gas Industry, North Dakota, 2019

IMPLAN Industries (sectors) and Industry Balance Sheet Components	IMPLAN Default	Study Values	Estimation and Adjustment	Data Sources
Sector 38 (Support activities for oil and gas operations)				
Employment	14,726	13,641	Use of BLS QCEW data to remove uncovered workers from IMPLAN data	BLS data NAICS 2111
Output (sales)	4,378,860,311	5,491,621,799	Combined analysis, see Table C3	BLS/IMPLAN/NDSU/DMR
Employee Compensation (EC)	1,630,725,016	1,478,858,850	Wages/salaries adjusted to obtain employment compensation	BLS/IMPLAN
Proprietor Income (PI)	93,454,308	117,203,034	Ratio analysis using IMPLAN data	IMPLAN
Other property-type Income (OPTI)	668,715,026	838,649,729	Sales minus (EC, TPI, & Intermediate Inputs)	calculation
Tax on Production and Imports (TPI)	161,145,649	202,096,183	Represents a combination of taxes from various sources	NDOSTC & NDSU Survey
Total Value-added (VA)	2,554,039,999	2,636,807,797	Sum of EC, OPTI, & TPI	calculation
Intermediate Inputs	1,824,820,312	2,854,814,003	Combined analysis, see Table C6	NDSU Survey

Appendix Table C6. Input-Output Modeling Industry Components, Estimation of Well Drilling and Oil Field Service Shares for IMPLAN Sector 38, Oil and Gas Industry, North Dakota, 2019

IMPLAN Industries (sectors) and Industry Balance Sheet Components	Study Values for IMPLAN Sector 38		Estimation and Adjustment	Data Sources
	Well Drilling	Oil Field Service		
Employment	3,904	9,737	Computed based on NDDMR data on rig counts and well counts, BLS labor division by NAICS codes, combined with Job Service North Dakota information on employment in related sectors.	BLS, NDDMR, & Job Service North Dakota
Output (sales)	2,596,174,790	2,895,447,009	Well drilling revenues represented share of reported drilling expenditures that represent spending in IMPLAN Sector 38. The share was estimated from secondary sources. Total well drilling expenses estimated from number of wells drilled and NDSU survey data. Revenues for oil field service is ratio of sales to employment from default IMPLAN data multiplied by new estimate of employment.	NDSU (2013), HIS (2014), BLM WY (2014), Eagle Ford (2011) & NDDMR & NDSU Survey IMPLAN
Employee Compensation (EC)	475,329,074	1,003,529,776	BLS data used to estimated employment compensation	BLS & IMPLAN
Proprietor Income (PI)	55,407,960	61,795,074	Based on ratio from IMPLAN default data and new estimate of sales for IMPLAN Sector 38	IMPLAN
Other property-type Income (OPTI)	396,473,276	442,176,453	Based on ratio from IMPLAN default data and new estimate of sales for IMPLAN Sector 38	IMPLAN
Tax on Production and Imports (TPI)	95,541,360	106,554,823	Based on ratio from IMPLAN default data and new estimate of sales for IMPLAN Sector 38	IMPLAN
Total Value-added (VA)	1,022,751,671	1,614,056,126	Sum of EC, OPTI, & TPI	calculation
Intermediate Inputs	1,573,423,119	1,281,390,883	Sales less Value-added	calculation

Appendix Table C7. Input-Output Modeling Industry Components, Default IMPLAN Data and Customized Values, Well Development and Oil and Gas Extraction, Oil and Gas Industry, North Dakota, 2017

IMPLAN Industries (sectors) and Industry Components	IMPLAN Default	Study Values	Estimation and Adjustment	Data Sources
Sector 20 (Extraction of Natural Gas and Crude Oil) and Sector 21 (Extraction of Natural Gas Liquids)				
Employment	7,642	2,548	Use of BLS QCEW data to remove royalty and investment individuals from IMPLAN data	BLS data NAICS 2111
Output (sales)	\$3,060,469,360	\$19,478,833,957	Oil and gas quantity x value (first purchaser prices)	NDDRM / NDOSTC
Employee Compensation (EC)	\$398,927,585	\$386,007,356	Wages/salaries adjusted to obtain employment compensation	BLS/IMPLAN
Proprietor Income (PI)	\$308,860,260	\$2,274,233,380	Private and tribal royalties (net of severance taxes)	ONRR/NDSU Survey
Other Property-type Income (OPTI)	\$780,389,921	\$12,067,289,874	Sales minus (EC, PI, TPI, & Intermediate Inputs)	calculation
Tax on Production and Imports (TPI)	\$874,194,366	\$2,049,230,902	Severance tax, property tax, sales taxes, public royalties, misc. government fees	NDOSTC/NDSU Survey
Total Value-added (VA)	\$2,401,905,587	\$16,992,750,157	Sum of EC, OPTI, PI & TPI	calculation
Intermediate Inputs	\$658,563,773	\$2,486,083,800	\$/BOE production expenses x BOE produced, Intermediate Inputs plus VA must equal Sales	NDSU Survey
Sector 37 (Drilling Oil and Gas Wells)				
Employment	3,446	2,435	Use of BLS QCEW data to remove uncovered workers from IMPLAN data	BLS data NAICS 2111
Output (sales)	\$2,563,396,240	\$1,097,426,208	Estimate of total well drilling cost for well owners allocated between IMPLAN sectors 37 and 38	NDSU Survey / NDDMR/IMPLAN
Employee Compensation (EC)	\$354,037,628	\$302,728,914	Wages/salaries adjusted to obtain employment compensation	BLS/IMPLAN
Proprietor Income (PI)	\$54,680,013	\$23,280,853	Ratio analysis using IMPLAN data	IMPLAN
Other property-type Income (OPTI)	\$1,811,608,887	\$500,912,199	Sales minus (EC, TPI, & Intermediate Inputs)	calculation
Tax on Production and Imports (TPI)	\$127,412,613	\$5,454,7143	Ratio analysis using IMPLAN data	IMPLAN
Total Value-added (VA)	\$2,347,439,141	\$881,469,109	Sum of EC, OPTI, & TPI	calculation
Intermediate Inputs	\$215,957,099	\$215,957,099	Retained IMPLAN default values	IMPLAN

Appendix Table C8. Input-Output Modeling Industry Components, Default IMPLAN Data and Customized Values, Support Activities, Oil and Gas Industry, North Dakota, 2017

IMPLAN Industries (sectors) and Industry Components	IMPLAN Default	Study Values	Estimation and Adjustment	Data Sources
Sector 38 (Support activities for oil and gas operations)				
Employment	11,419	10,798	Use of BLS QCEW data to remove uncovered workers from IMPLAN data	BLS data NAICS 2111
Output (sales)	\$2,012,027,100	\$3,647,465,361	Combined analysis, see Table C6	
Employee Compensation (EC)	\$1,205,441,895	\$1,222,970,174	Wages/salaries adjusted to obtain employment compensation	BLS/IMPLAN
Proprietor Income (PI)	\$135,051,849	\$244,826,196	Based on ratio from IMPLAN default data and new estimate of sales for IMPLAN Sector 38	IMPLAN
Other property-type Income (OPTI)	\$311,447,083	\$564,600,967	Sales minus (EC, TPI, & Intermediate Inputs)	calculation
Tax on Production and Imports (TPI)	\$70,684,410	\$128,138,899	Based on ratio from IMPLAN default data and new estimate of sales for IMPLAN Sector 38	NDOSTC & NDSU Survey
Total Value-added (VA)	\$1,722,625,237	\$2,160,536,236	Sum of EC, OPTI, & TPI	calculation
Intermediate Inputs	\$289,401,863	\$1,486,929,125	Combined analysis, see Table C9	NDSU Survey

Appendix Table C9. Input-Output Modeling Industry Components, Estimation of Well Drilling and Oil Field Service Shares for IMPLAN Sector 38, Oil and Gas Industry, North Dakota, 2017

IMPLAN Industry Components	Study Values for IMPLAN Sector 38		Estimation and Adjustment	Data Sources
	Well Drilling	Oil Field Service		
Employment	3,060	7,738	Computed based on NDDMR data on rig counts and well counts, BLS labor division by NAICS codes, combined with Job Service North Dakota information on employment in related sectors.	BLS, NDDMR, & Job Service North Dakota
Output (sales)	\$2,284,018,295	\$1,363,447,066	Well drilling revenues represented share of reported drilling expenditures that represent spending in IMPLAN Sector 38. The share was estimated from secondary sources. Total well drilling expenses estimated from number of wells drilled and NDSU survey data. Revenues for oil field service is ratio of sales to employment from default IMPLAN data multiplied by new estimate of employment.	NDSU (2013), HIS (2014), BLM WY (2014), Eagle Ford (2011) & NDDMR, NDSU Survey, & IMPLAN
Employee Compensation (EC)	\$346,572,396	\$876,397,778	BLS data used to estimated employment compensation	BLS & IMPLAN
Proprietor Income (PI)	\$153,308,519	\$91,517,677	Based on ratio from IMPLAN default data and new estimate of sales for IMPLAN Sector 38	IMPLAN
Other property-type Income (OPTI)	\$353,549,331	\$211,051,636	Based on ratio from IMPLAN default data and new estimate of sales for IMPLAN Sector 38	IMPLAN
Tax on Production and Imports (TPI)	\$80,239,717	\$47,899,182	Based on ratio from IMPLAN default data and new estimate of sales for IMPLAN Sector 38	IMPLAN
Total Value-added (VA)	\$933,669,963	\$1,226,866,273	Sum of EC, OPTI, & TPI	calculation
Intermediate Inputs	\$1,350,348,332	\$136,580,792	Sales less Value-added	calculation

Appendix Table C10. Input-Output Modeling Industry Components, Default IMPLAN Data and Customized Values, Well Development and Oil and Gas Extraction, Oil and Gas Industry, North Dakota, 2015

IMPLAN Industries (sectors) and Industry Components	IMPLAN Default	Study Values	Estimation and Adjustment	Data Sources
Sector 20 (Extraction of Natural Gas and Crude Oil) and Sector 21 (Extraction of Natural Gas Liquids)				
Employment	6,075	2,906	Use of BLS QCEW data to remove royalty and investment individuals from IMPLAN data	BLS data NAICS 2111
Output (sales)	\$2,648,208,939	\$18,292,074,198	Oil and gas quantity x value (first purchaser prices)	NDDRM / NDOSTC
Employee Compensation (EC)	\$422,629,761	\$424,864,859	Wages/salaries adjusted to obtain employment compensation	BLS/IMPLAN
Proprietor Income (PI)	\$247,734,333	\$2,468,318,104	Private and tribal royalties (net of severance taxes)	ONRR/NDSU Survey
Other Property-type Income (OPTI)	\$581,582,474	\$9,774,084,285	Sales minus (EC, PI, TPI, & Intermediate Inputs)	calculation
Tax on Production and Imports (TPI)	\$996,906,441	\$2,369,550,948	Severance tax, property tax, sales taxes, public royalties, misc. government fees	NDOSTC/NDSU Survey
Total Value-added (VA)	\$2,248,853,009	\$15,036,818,195	Sum of EC, OPTI, PI & TPI	calculation
Intermediate Inputs	\$399,355,930	\$3,255,256,002	\$/BOE production expenses x BOE produced, Intermediate Inputs plus VA must equal Sales	NDSU Survey
Sector 37 (Drilling Oil and Gas Wells)				
Employment	4,663	3,821	Use of BLS QCEW data to remove uncovered workers from IMPLAN data	BLS data NAICS 2111
Output (sales)	\$1,731,619,019	\$1,752,482,384	Estimate of total well drilling cost for well owners allocated between IMPLAN sectors 37 and 38	NDSU Survey / NDDMR/IMPLAN
Employee Compensation (EC)	\$569,077,576	\$536,893,793	Wages/salaries adjusted to obtain employment compensation	BLS/IMPLAN
Proprietor Income (PI)	\$33,568,954	\$33,568,954	Ratio analysis using IMPLAN data	IMPLAN
Other property-type Income (OPTI)	\$533,624,573	\$533,624,573	Sales minus (EC, TPI, & Intermediate Inputs)	calculation
Tax on Production and Imports (TPI)	\$136,789,063	\$136,789,063	Ratio analysis using IMPLAN data	IMPLAN
Total Value-added (VA)	\$1,273,060,165	\$1,240,876,383	Sum of EC, OPTI, & TPI	calculation
Intermediate Inputs	\$458,558,853	\$511,606,001	Retained IMPLAN default values	IMPLAN

Appendix Table C11. Input-Output Modeling Industry Components, Default IMPLAN Data and Customized Values, Support Activities, Oil and Gas Industry, North Dakota, 2015

IMPLAN Industries (sectors) and Industry Components	IMPLAN Default	Study Values	Estimation and Adjustment	Data Sources
Sector 38 (Support activities for oil and gas operations)				
Employment	14,858	14,259	Use of BLS QCEW data to remove uncovered workers from IMPLAN data	BLS data NAICS 2111
Output (sales)	\$2,947,731,201	\$5,319,282,459	Combined analysis, see Table C9	
Employee Compensation (EC)	\$1,498,621,338	\$1,596,411,520	Wages/salaries adjusted to obtain employment compensation	BLS/IMPLAN
Proprietor Income (PI)	\$26,206,831	\$47,291,129	Ratio analysis using IMPLAN data	IMPLAN
Other property-type Income (OPTI)	\$564,930,176	\$1,019,435,956	Sales minus (EC, TPI, & Intermediate Inputs)	calculation
Tax on Production and Imports (TPI)	\$51,547,386	\$93,019,033		NDOSTC & NDSU Survey
Total Value-added (VA)	\$2,141,305,731	\$2,756,157,638	Sum of EC, OPTI, & TPI	calculation
Intermediate Inputs	\$806,425,470	\$2,563,124,820	Combined analysis, see Table C12	NDSU Survey

Appendix Table C12. Input-Output Modeling Industry Components, Estimation of Well Drilling and Oil Field Service Shares for IMPLAN Sector 38, Oil and Gas Industry, North Dakota, 2015

IMPLAN Industry Components	Study Values for IMPLAN Sector 38		Estimation and Adjustment	Data Sources
	Well Drilling	Oil Field Service		
Employment	5,832	8,427	Computed based on NDDMR data on rig counts and well counts, BLS labor division by NAICS codes, combined with Job Service North Dakota information on employment in related sectors.	BLS, NDDMR, & Job Service North Dakota
Output (sales)	\$3,647,353,962	\$1,671,928,497	Well drilling revenues represented share of reported drilling expenditures that represent spending in IMPLAN Sector 38. The share was estimated from secondary sources. Total well drilling expenses estimated from number of wells drilled and NDSU survey data. Revenues for oil field service is ratio of sales to employment from default IMPLAN data multiplied by new estimate of employment.	NDSU (2013), IHS (2014), BLM WY (2014), Eagle Ford (2011) & NDDMR, NDSU Survey, & IMPLAN
Employee Compensation (EC)	\$652,898,865	\$943,512,655	BLS data used to estimate employment compensation	BLS & IMPLAN
Proprietor Income (PI)	\$32,426,833	\$14,864,295	Based on ratio from IMPLAN default data and new estimate of sales for IMPLAN Sector 38	IMPLAN
Other property-type Income (OPTI)	\$699,012,282	\$320,423,673	Based on ratio from IMPLAN default data and new estimate of sales for IMPLAN Sector 38	IMPLAN
Tax on Production and Imports (TPI)	\$63,781,787	\$29,237,247	Based on ratio from IMPLAN default data and new estimate of sales for IMPLAN Sector 38	IMPLAN
Total Value-added (VA)	\$1,448,119,768	\$1,308,037,870	Sum of EC, OPTI, & TPI	calculation
Intermediate Inputs	\$2,199,234,194	\$363,890,626	Sales less Value-added	calculation

The graphic features a vertical dark blue bar on the left side. A blue arrow-shaped banner points to the right from this bar, containing the text 'Appendix D'. To the right of the banner is a large vertical rectangle with a yellow-to-white gradient background.

Appendix D

**Economic Impacts by Industry
Segments, Delineated by 2-Digit
NAICS Codes, Oil and Gas
Industry, North Dakota, 2017,
2019, and 2021**

Appendix Table D1. Employment, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Development, Oil and Gas Industry, North Dakota, 2021

NAICS Code and Economic Sector	Direct	Indirect	Induced	Total
	----- jobs -----			
11 Ag, Forestry, Fishing & Hunting		1	8	9
21 Mining	3,114	7	0	3,121
22 Utilities		9	8	17
23 Construction		135	10	145
31-33 Manufacturing		33	6	39
42 Wholesale Trade		352	40	392
44-45 Retail trade		58	321	379
48-49 Transportation & Warehousing		224	54	278
51 Information		56	23	79
52 Finance & insurance		536	115	651
53 Real Estate & Rental		287	75	362
54 Professional, Scientific & Tech Services		800	47	847
55 Management of Companies		31	9	40
56 Administrative & Waste Services		546	55	602
61 Educational Services		3	37	40
62 Health & Social Services		0	493	493
71 Arts, Entertainment & Recreation		27	44	72
72 Accommodation & Food Services		322	224	546
81 Other Services		179	203	382
92 Government		31	19	50
Totals	3,114	3,639	1,791	8,544

Appendix Table D2. Labor Income, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Development, Oil and Gas Industry, North Dakota, 2021

NAICS Code and Economic Sector	Direct	Indirect	Induced	Total
	----- 000s \$ -----			
11 Ag, Forestry, Fishing & Hunting	0	59	399	458
21 Mining	262,321	662	4	262,988
22 Utilities	0	1,564	1,319	2,883
23 Construction	0	9,166	632	9,797
31-33 Manufacturing	0	2,591	403	2,993
42 Wholesale Trade	0	34,871	3,895	38,766
44-45 Retail trade	0	2,838	11,811	14,649
48-49 Transportation & Warehousing	0	12,613	3,246	15,859
51 Information	0	5,511	2,469	7,981
52 Finance & insurance	0	38,672	7,347	46,019
53 Real Estate & Rental	0	22,551	2,663	25,214
54 Professional, Scientific & Tech Services	0	58,731	3,137	61,868
55 Management of Companies	0	3,623	1,049	4,672
56 Administrative & Waste Services	0	22,447	2,526	24,973
61 Educational Services	0	81	1,088	1,169
62 Health & Social Services	0	2	36,120	36,122
71 Arts, Entertainment & Recreation	0	336	767	1,103
72 Accommodation & Food Services	0	8,156	5,716	13,872
81 Other Services	0	11,500	9,492	20,992
92 Government	0	2,352	1,560	3,912
Totals	262,321	238,325	95,644	596,290

Appendix Table D3. Value-added, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Development, Oil and Gas Industry, North Dakota, 2021

NAICS Code and Economic Sector	Direct	Indirect	Induced	Total
	----- 000s \$ -----			
11 Ag, Forestry, Fishing & Hunting	0	74	531	605
21 Mining	810,759	6,291	14	817,064
22 Utilities	0	3,995	3,357	7,352
23 Construction	0	14,966	1,065	16,031
31-33 Manufacturing	0	5,662	662	6,324
42 Wholesale Trade	0	71,167	7,556	78,723
44-45 Retail trade	0	4,604	17,219	21,823
48-49 Transportation & Warehousing	0	16,341	3,881	20,221
51 Information	0	11,380	5,246	16,625
52 Finance & insurance	0	86,827	14,771	101,598
53 Real Estate & Rental	0	64,817	32,936	97,752
54 Professional, Scientific & Tech Services	0	67,946	4,105	72,050
55 Management of Companies	0	4,102	1,187	5,289
56 Administrative & Waste Services	0	27,493	2,928	30,421
61 Educational Services	0	89	1,192	1,281
62 Health & Social Services	0	2	39,560	39,562
71 Arts, Entertainment & Recreation	0	600	1,349	1,949
72 Accommodation & Food Services	0	12,613	8,539	21,151
81 Other Services	0	13,951	10,771	24,722
92 Government	0	-3,431	736	-2,695
Totals	810,759	409,487	157,602	1,377,849

Appendix Table D4. Business Volume, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Development, Oil and Gas Industry, North Dakota, 2021

NAICS Code and Economic Sector	Direct	Indirect	Induced	Total
	----- 000s \$ -----			
11 Ag, Forestry, Fishing & Hunting	0	151	1,129	1,280
21 Mining	2,211,205	8,504	23	2,219,732
22 Utilities	0	11,244	9,268	20,511
23 Construction	0	35,519	2,524	38,042
31-33 Manufacturing	0	14,412	2,326	16,738
42 Wholesale Trade	0	123,284	14,222	137,506
44-45 Retail trade	0	7,449	32,581	40,030
48-49 Transportation & Warehousing	0	30,941	7,368	38,309
51 Information	0	24,769	9,910	34,679
52 Finance & insurance	0	174,301	34,329	208,630
53 Real Estate & Rental	0	106,595	45,809	152,405
54 Professional, Scientific & Tech Services	0	118,118	7,041	125,159
55 Management of Companies	0	7,103	2,056	9,159
56 Administrative & Waste Services	0	56,796	5,742	62,538
61 Educational Services	0	185	1,963	2,148
62 Health & Social Services	0	4	64,435	64,439
71 Arts, Entertainment & Recreation	0	1,427	2,977	4,404
72 Accommodation & Food Services	0	27,515	17,714	45,229
81 Other Services	0	22,637	18,830	41,467
92 Government	0	5,274	5,186	10,460
Totals	2,211,205	776,226	285,433	3,272,864

Appendix Table D5. Employment, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Production, Oil and Gas Industry, North Dakota, 2021

NAICS Code and Economic Sector	Direct	Indirect	Induced	Total
	----- jobs -----			
11 Ag, Forestry, Fishing & Hunting		5	33	38
21 Mining	8,097	12	0	8,109
22 Utilities		348	34	382
23 Construction		488	42	530
31-33 Manufacturing		150	26	176
42 Wholesale Trade		1,729	171	1,900
44-45 Retail trade		259	1,371	1,631
48-49 Transportation & Warehousing		1,083	229	1,312
51 Information		280	100	380
52 Finance & insurance		2,699	494	3,193
53 Real Estate & Rental		1,416	320	1,735
54 Professional, Scientific & Tech Services		3,165	202	3,367
55 Management of Companies		134	38	172
56 Administrative & Waste Services		2,109	237	2,346
61 Educational Services		12	159	171
62 Health & Social Services		0	2,105	2,105
71 Arts, Entertainment & Recreation		116	190	305
72 Accommodation & Food Services		895	958	1,853
81 Other Services		512	869	1,381
92 Government		490	83	573
Totals	8,097	15,902	7,660	31,659

Appendix Table D6. Labor Income, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Production, Oil and Gas Industry, North Dakota, 2021

NAICS Code and Economic Sector	Direct	Indirect	Induced	Total
	----- 000s \$ -----			
11 Ag, Forestry, Fishing & Hunting	0	227	1,703	1,930
21 Mining	1,002,075	1,137	19	1,003,230
22 Utilities	0	56,740	5,625	62,366
23 Construction	0	33,076	2,703	35,779
31-33 Manufacturing	0	11,941	1,720	13,662
42 Wholesale Trade	0	168,500	16,630	185,130
44-45 Retail trade	0	12,204	50,467	62,671
48-49 Transportation & Warehousing	0	75,399	13,886	89,285
51 Information	0	27,618	10,545	38,163
52 Finance & insurance	0	199,088	31,432	230,519
53 Real Estate & Rental	0	100,433	11,337	111,771
54 Professional, Scientific & Tech Services	0	227,428	13,420	240,847
55 Management of Companies	0	15,636	4,483	20,120
56 Administrative & Waste Services	0	91,243	10,804	102,047
61 Educational Services	0	313	4,719	5,033
62 Health & Social Services	0	6	154,193	154,198
71 Arts, Entertainment & Recreation	0	1,415	3,288	4,704
72 Accommodation & Food Services	0	22,778	24,457	47,235
81 Other Services	0	32,627	40,600	73,227
92 Government	0	40,137	6,656	46,793
Totals	1,002,075	1,117,947	408,687	2,528,708

Appendix Table D7. Value-added, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Production, Oil and Gas Industry, North Dakota, 2021

NAICS Code and Economic Sector	Direct	Indirect	Induced	Total
	----- 000s \$ -----			
11 Ag, Forestry, Fishing & Hunting	0	263	2,269	2,532
21 Mining	20,670,927	12,168	58	20,683,153
22 Utilities	0	142,744	14,312	157,056
23 Construction	0	54,047	4,555	58,603
31-33 Manufacturing	0	25,737	2,827	28,564
42 Wholesale Trade	0	338,999	32,261	371,260
44-45 Retail trade	0	20,437	73,573	94,010
48-49 Transportation & Warehousing	0	101,590	16,600	118,190
51 Information	0	55,993	22,398	78,391
52 Finance & insurance	0	448,273	63,138	511,411
53 Real Estate & Rental	0	280,593	140,912	421,505
54 Professional, Scientific & Tech Services	0	278,851	17,558	296,409
55 Management of Companies	0	17,703	5,076	22,778
56 Administrative & Waste Services	0	115,827	12,523	128,350
61 Educational Services	0	356	5,168	5,524
62 Health & Social Services	0	7	168,870	168,877
71 Arts, Entertainment & Recreation	0	2,694	5,770	8,464
72 Accommodation & Food Services	0	34,703	36,528	71,231
81 Other Services	0	41,276	46,089	87,365
92 Government	0	51,927	3,063	54,990
Totals	20,670,927	2,024,188	673,549	23,368,664

Appendix Table D8. Business Volume, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Production, Oil and Gas Industry, North Dakota, 2021

NAICS Code and Economic Sector	Direct	Indirect	Induced	Total
	----- 000s \$ -----			
11 Ag, Forestry, Fishing & Hunting	0	613	4,825	5,439
21 Mining	29,327,048	16,225	99	29,343,372
22 Utilities	0	392,405	39,515	431,919
23 Construction	0	128,265	10,795	139,060
31-33 Manufacturing	0	65,144	9,929	75,072
42 Wholesale Trade	0	597,886	60,723	658,609
44-45 Retail trade	0	33,288	139,215	172,503
48-49 Transportation & Warehousing	0	189,558	31,521	221,079
51 Information	0	121,772	42,305	164,076
52 Finance & insurance	0	942,563	146,841	1,089,404
53 Real Estate & Rental	0	480,996	196,003	676,999
54 Professional, Scientific & Tech Services	0	477,153	30,124	507,277
55 Management of Companies	0	30,655	8,790	39,444
56 Administrative & Waste Services	0	237,409	24,562	261,971
61 Educational Services	0	718	8,499	9,217
62 Health & Social Services	0	12	275,002	275,014
71 Arts, Entertainment & Recreation	0	6,266	12,741	19,007
72 Accommodation & Food Services	0	74,225	75,754	149,980
81 Other Services	0	67,074	80,610	147,684
92 Government	0	160,643	22,108	182,751
Totals	29,327,048	4,022,871	1,219,961	34,569,879

Appendix Table D9. Employment, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Processing and Transportation, Oil and Gas Industry, North Dakota, 2021

NAICS Code and Economic Sector	Direct	Indirect	Induced	Total
11 Ag, Forestry, Fishing & Hunting		1	9	11
21 Mining	946	2	0	948
22 Utilities		95	10	105
23 Construction		246	12	258
31-33 Manufacturing	341	23	7	371
42 Wholesale Trade		270	48	319
44-45 Retail trade		100	388	487
48-49 Transportation & Warehousing	878	783	65	1,726
51 Information		65	28	94
52 Finance & insurance		296	140	436
53 Real Estate & Rental		155	91	245
54 Professional, Scientific & Tech Services		489	57	546
55 Management of Companies		28	11	39
56 Administrative & Waste Services		546	67	613
61 Educational Services		3	45	47
62 Health & Social Services		0	595	595
71 Arts, Entertainment & Recreation		19	54	72
72 Accommodation & Food Services		161	271	432
81 Other Services		324	245	570
92 Government		65	24	89
Totals	2,165	3,672	2,165	8,001

Appendix Table D10. Labor Income, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Processing and Transportation, Oil and Gas Industry, North Dakota, 2021

NAICS Code and Economic Sector	Direct	Indirect	Induced	Total
11 Ag, Forestry, Fishing & Hunting	0	48	481	529
21 Mining	123,480	178	5	123,663
22 Utilities	0	16,151	1,591	17,742
23 Construction	0	16,669	764	17,433
31-33 Manufacturing	62,381	1,742	486	64,609
42 Wholesale Trade	0	25,339	4,702	30,041
44-45 Retail trade	0	4,070	14,267	18,336
48-49 Transportation & Warehousing	148,857	73,768	3,924	226,549
51 Information	0	6,635	2,982	9,617
52 Finance & insurance	0	20,413	8,882	29,295
53 Real Estate & Rental	0	8,498	3,209	11,706
54 Professional, Scientific & Tech Services	0	34,854	3,792	38,646
55 Management of Companies	0	3,232	1,267	4,499
56 Administrative & Waste Services	0	23,772	3,053	26,826
61 Educational Services	0	67	1,328	1,395
62 Health & Social Services	0	2	43,602	43,603
71 Arts, Entertainment & Recreation	0	226	929	1,154
72 Accommodation & Food Services	0	4,109	6,911	11,020
81 Other Services	0	21,077	11,474	32,551
92 Government	0	5,462	1,882	7,345
Totals	334,718	266,311	115,531	716,560

Appendix Table D11. Value-added, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Processing and Transportation, Oil and Gas Industry, North Dakota, 2021

NAICS Code and Economic Sector	Direct	Indirect	Induced	Total
	----- 000s \$ -----			
11 Ag, Forestry, Fishing & Hunting	0	55	642	696
21 Mining	260,782	1,714	16	262,512
22 Utilities	0	41,083	4,048	45,132
23 Construction	0	27,220	1,287	28,508
31-33 Manufacturing	166,269	3,056	799	170,125
42 Wholesale Trade	0	107,742	9,122	116,864
44-45 Retail trade	0	7,720	20,799	28,519
48-49 Transportation & Warehousing	206,293	101,787	4,691	312,770
51 Information	0	14,057	6,333	20,390
52 Finance & insurance	0	43,163	17,847	61,009
53 Real Estate & Rental	0	23,395	39,818	63,213
54 Professional, Scientific & Tech Services	0	44,004	4,962	48,965
55 Management of Companies	0	3,659	1,435	5,093
56 Administrative & Waste Services	0	27,984	3,539	31,523
61 Educational Services	0	77	1,454	1,531
62 Health & Social Services	0	2	47,753	47,755
71 Arts, Entertainment & Recreation	0	479	1,631	2,110
72 Accommodation & Food Services	0	6,182	10,322	16,504
81 Other Services	0	23,308	13,023	36,332
92 Government	0	5,674	873	6,547
Totals	633,344	482,359	190,394	1,306,097

Appendix Table D12. Business Volume, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Processing and Transportation, Oil and Gas Industry, North Dakota, 2021

NAICS Code and Economic Sector	Direct	Indirect	Induced	Total
	----- 000s \$ -----			
11 Ag, Forestry, Fishing & Hunting	0	128	1,364	1,492
21 Mining	512,391	2,314	28	514,733
22 Utilities	0	111,185	11,178	122,363
23 Construction	0	64,601	3,051	67,652
31-33 Manufacturing	2,256,033	8,337	2,808	2,267,178
42 Wholesale Trade	0	153,767	17,170	170,937
44-45 Retail trade	0	13,534	39,355	52,889
48-49 Transportation & Warehousing	542,524	208,246	8,907	759,677
51 Information	0	29,868	11,963	41,831
52 Finance & insurance	0	90,563	41,497	132,060
53 Real Estate & Rental	0	44,104	55,385	99,489
54 Professional, Scientific & Tech Services	0	75,706	8,512	84,219
55 Management of Companies	0	6,336	2,484	8,820
56 Administrative & Waste Services	0	54,416	6,941	61,357
61 Educational Services	0	153	2,393	2,546
62 Health & Social Services	0	3	77,769	77,773
71 Arts, Entertainment & Recreation	0	1,084	3,600	4,684
72 Accommodation & Food Services	0	12,942	21,409	34,351
81 Other Services	0	35,976	22,774	58,750
92 Government	0	16,937	6,254	23,192
Totals	3,310,948	930,202	344,842	4,585,992

Appendix Table D13. Employment, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Development, Oil and Gas Industry, North Dakota, 2019

NAICS Code and Economic Sector	Direct	Indirect	Induced	Total
11 Ag, Forestry, Fishing & Hunting	0	8	20	28
21 Mining	6,832	27	1	6,860
22 Utilities	0	14	21	35
23 Construction	0	192	36	228
31-33 Manufacturing	0	44	18	62
42 Wholesale Trade	0	440	127	567
44-45 Retail trade	0	72	1,009	1,081
48-49 Transportation & Warehousing	0	290	193	482
51 Information	0	84	77	161
52 Finance & insurance	0	1,081	389	1,470
53 Real Estate & Rental	0	422	245	667
54 Professional, Scientific & Tech Services	0	1,409	145	1,554
55 Management of Companies	0	165	27	192
56 Administrative & Waste Services	0	708	169	876
61 Educational Services	0	0	1,315	1,315
62 Health & Social Services	0	3	111	114
71 Arts, Entertainment & Recreation	0	37	173	210
72 Accommodation & Food Services	0	392	690	1,082
81 Other Services	0	236	571	807
92 Government	0	33	49	82
Totals	6,832	5,656	5,386	17,874

Appendix Table D14. Employment Compensation, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Development, Oil and Gas Industry, North Dakota, 2019

NAICS Code and Economic Sector	Direct	Indirect	Induced	Total
11 Ag, Forestry, Fishing & Hunting	0	54	232	286
21 Mining	861,400	1,990	90	863,480
22 Utilities	0	2,138	3,149	5,288
23 Construction	0	10,301	1,865	12,167
31-33 Manufacturing	0	2,898	1,006	3,904
42 Wholesale Trade	0	37,972	10,280	48,253
44-45 Retail trade	0	2,842	28,323	31,165
48-49 Transportation & Warehousing	0	14,558	8,754	23,311
51 Information	0	5,826	5,805	11,630
52 Finance & insurance	0	56,174	22,749	78,923
53 Real Estate & Rental	0	17,432	3,021	20,452
54 Professional, Scientific & Tech Services	0	97,134	8,406	105,540
55 Management of Companies	0	18,720	3,061	21,781
56 Administrative & Waste Services	0	22,513	5,846	28,359
61 Educational Services	0	2	81,359	81,361
62 Health & Social Services	0	66	2,815	2,881
71 Arts, Entertainment & Recreation	0	354	2,576	2,930
72 Accommodation & Food Services	0	8,211	14,594	22,804
81 Other Services	0	10,675	18,808	29,483
92 Government	0	1,862	3,564	5,425
Total	861,400	311,719	226,303	1,399,422

Appendix Table D15. Business Volume, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Development, Oil and Gas Industry, North Dakota, 2019

NAICS Code and Economic Sector	Direct	Indirect	Induced	Total
	----- millions \$ -----			
11 Ag, Forestry, Fishing & Hunting	0	0	2	3
21 Mining	3,844	16	0	3,860
22 Utilities	0	16	23	39
23 Construction	0	44	8	52
31-33 Manufacturing	0	19	6	25
42 Wholesale Trade	0	142	39	181
44-45 Retail trade	0	8	84	92
48-49 Transportation & Warehousing	0	40	23	63
51 Information	0	32	27	59
52 Finance & insurance	0	258	104	362
53 Real Estate & Rental	0	152	140	291
54 Professional, Scientific & Tech Services	0	214	20	235
55 Management of Companies	0	36	6	41
56 Administrative & Waste Services	0	59	15	74
61 Educational Services	0	0	163	163
62 Health & Social Services	0	0	6	6
71 Arts, Entertainment & Recreation	0	2	11	13
72 Accommodation & Food Services	0	26	44	70
81 Other Services	0	27	49	76
92 Government	0	6	14	19
Total	3,843.6	1,096.1	785.4	5,725.1

Appendix Table D16. Value-added Activity, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Development, Oil and Gas Industry, North Dakota, 2019

NAICS Code and Economic Sector	Direct	Indirect	Induced	Total
	----- 000s \$ -----			
11 Ag, Forestry, Fishing & Hunting	0	145	975	1,120
21 Mining	1,582,712	8,341	166	1,591,218
22 Utilities	0	5,740	8,308	14,048
23 Construction	0	21,615	3,797	25,413
31-33 Manufacturing	0	6,235	1,689	7,924
42 Wholesale Trade	0	84,191	21,491	105,682
44-45 Retail trade	0	4,891	44,527	49,418
48-49 Transportation & Warehousing	0	23,773	13,329	37,103
51 Information	0	15,859	14,486	30,345
52 Finance & insurance	0	98,556	40,264	138,820
53 Real Estate & Rental	0	107,365	100,008	207,373
54 Professional, Scientific & Tech Services	0	126,247	11,668	137,915
55 Management of Companies	0	20,517	3,355	23,872
56 Administrative & Waste Services	0	32,110	8,119	40,229
61 Educational Services	0	2	96,026	96,028
62 Health & Social Services	0	85	3,308	3,393
71 Arts, Entertainment & Recreation	0	611	4,798	5,409
72 Accommodation & Food Services	0	12,791	22,532	35,323
81 Other Services	0	16,670	27,964	44,634
92 Government	0	-19,626	1,161	-18,465
Total	1,582,712	566,120	427,969	2,576,801

Appendix Table D17. Employment, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Production, Oil and Gas Industry, North Dakota, 2019

NAICS Code and Economic Sector	Direct	Indirect	Induced	Total
11 Ag, Forestry, Fishing & Hunting	0	4	37	40
21 Mining	11,626	20	2	11,647
22 Utilities	0	133	38	171
23 Construction	0	218	66	284
31-33 Manufacturing	0	62	34	96
42 Wholesale Trade	0	607	233	840
44-45 Retail trade	0	97	1,852	1,949
48-49 Transportation & Warehousing	0	896	353	1,250
51 Information	0	159	141	300
52 Finance & insurance	0	1,272	713	1,985
53 Real Estate & Rental	0	612	450	1,062
54 Professional, Scientific & Tech Services	0	2,488	266	2,754
55 Management of Companies	0	787	49	837
56 Administrative & Waste Services	0	936	309	1,246
61 Educational Services	0	0	2,412	2,412
62 Health & Social Services	0	4	202	206
71 Arts, Entertainment & Recreation	0	61	317	378
72 Accommodation & Food Services	0	354	1,266	1,620
81 Other Services	0	221	1,047	1,269
92 Government	0	189	91	279
Total	11,626	9,120	9,879	30,625

Appendix Table D18. Employment Compensation, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Production, Oil and Gas Industry, North Dakota, 2019

NAICS Code and Economic Sector	Direct	Indirect	Induced	Total
11 Ag, Forestry, Fishing & Hunting	0	36	427	462
21 Mining	1,376,058	1,621	166	1,377,844
22 Utilities	0	19,749	5,782	25,530
23 Construction	0	11,659	3,422	15,081
31-33 Manufacturing	0	4,167	1,847	6,013
42 Wholesale Trade	0	51,083	18,868	69,950
44-45 Retail trade	0	3,678	51,980	55,658
48-49 Transportation & Warehousing	0	99,513	16,060	115,573
51 Information	0	10,561	10,654	21,215
52 Finance & insurance	0	74,638	41,717	116,355
53 Real Estate & Rental	0	21,602	5,544	27,145
54 Professional, Scientific & Tech Services	0	166,372	15,415	181,787
55 Management of Companies	0	89,504	5,616	95,120
56 Administrative & Waste Services	0	32,690	10,720	43,409
61 Educational Services	0	2	149,235	149,237
62 Health & Social Services	0	88	5,145	5,234
71 Arts, Entertainment & Recreation	0	554	4,722	5,276
72 Accommodation & Food Services	0	7,484	26,772	34,256
81 Other Services	0	10,338	34,490	44,828
92 Government	0	14,314	6,542	20,856
Total	1,376,058	619,649	415,121	2,410,828

Appendix Table D19. Business Volume, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Production, Oil and Gas Industry, North Dakota, 2019

NAICS Code and Economic Sector	Direct	Indirect	Induced	Total
	----- millions \$ -----			
11 Ag, Forestry, Fishing & Hunting	0	0	3	3
21 Mining	27,430	10	0	27,441
22 Utilities	0	138	27	165
23 Construction	0	50	9	59
31-33 Manufacturing	0	26	7	33
42 Wholesale Trade	0	191	46	236
44-45 Retail trade	0	10	98	108
48-49 Transportation & Warehousing	0	240	27	267
51 Information	0	58	31	89
52 Finance & insurance	0	349	120	469
53 Real Estate & Rental	0	200	161	361
54 Professional, Scientific & Tech Services	0	345	23	368
55 Management of Companies	0	170	7	177
56 Administrative & Waste Services	0	86	17	103
61 Educational Services	0	0	189	189
62 Health & Social Services	0	0	7	7
71 Arts, Entertainment & Recreation	0	3	12	16
72 Accommodation & Food Services	0	23	51	74
81 Other Services	0	26	57	83
92 Government	0	52	16	68
Total	27,430.3	1,978.8	907.5	30,316.5

Appendix Table D20. Value-added Activity, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Production, Oil and Gas Industry, North Dakota, 2019

NAICS Code and Economic Sector	Direct	Indirect	Induced	Total
	----- 000s \$ -----			
11 Ag, Forestry, Fishing & Hunting	0	127	1,789	1,916
21 Mining	19,667,024	5,453	304	19,672,780
22 Utilities	0	50,698	15,251	65,949
23 Construction	0	24,452	6,967	31,418
31-33 Manufacturing	0	8,596	3,100	11,696
42 Wholesale Trade	0	111,941	39,442	151,384
44-45 Retail trade	0	6,396	81,717	88,114
48-49 Transportation & Warehousing	0	171,057	24,451	195,508
51 Information	0	26,929	26,591	53,520
52 Finance & insurance	0	138,079	73,846	211,925
53 Real Estate & Rental	0	134,443	183,483	317,926
54 Professional, Scientific & Tech Services	0	212,343	21,397	233,740
55 Management of Companies	0	98,097	6,155	104,251
56 Administrative & Waste Services	0	47,502	14,889	62,391
61 Educational Services	0	2	176,135	176,138
62 Health & Social Services	0	116	6,048	6,164
71 Arts, Entertainment & Recreation	0	996	8,801	9,797
72 Accommodation & Food Services	0	11,545	41,337	52,882
81 Other Services	0	16,057	51,280	67,337
92 Government	0	7,350	2,156	9,506
Total	19,667,024	1,072,178	785,138	21,524,340

Appendix Table D21. Employment, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Processing and Transportation, Oil and Gas Industry, North Dakota, 2019

NAICS Code and Economic Sector	Direct	Indirect	Induced	Total
11 Ag, Forestry, Fishing & Hunting	0	1	7	8
21 Mining	853	15	0	868
22 Utilities	0	60	7	67
23 Construction	0	255	12	267
31-33 Manufacturing	386	13	6	405
42 Wholesale Trade	114	39	43	196
44-45 Retail trade	0	73	338	411
48-49 Transportation & Warehousing	644	407	64	1,116
51 Information	0	25	26	51
52 Finance & insurance	0	100	130	230
53 Real Estate & Rental	0	71	82	153
54 Professional, Scientific & Tech Services	0	177	49	225
55 Management of Companies	0	70	9	79
56 Administrative & Waste Services	0	236	56	293
61 Educational Services	0	0	440	440
62 Health & Social Services	0	2	37	39
71 Arts, Entertainment & Recreation	0	8	58	66
72 Accommodation & Food Services	0	92	231	323
81 Other Services	0	122	191	313
92 Government	0	24	17	40
Total	1,997	1,790	1,803	5,589

Appendix Table D22. Employment Compensation, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Processing and Transportation, Oil and Gas Industry, North Dakota, 2019

NAICS Code and Economic Sector	Direct	Indirect	Induced	Total
11 Ag, Forestry, Fishing & Hunting	0	14	78	92
21 Mining	54,314	1,314	30	55,658
22 Utilities	0	7,618	1,054	8,672
23 Construction	0	11,770	624	12,394
31-33 Manufacturing	31,417	763	337	32,517
42 Wholesale Trade	5,170	2,802	3,441	11,413
44-45 Retail trade	0	1,928	9,481	11,409
48-49 Transportation & Warehousing	63,216	34,007	2,930	100,152
51 Information	0	1,494	1,943	3,437
52 Finance & insurance	0	4,985	7,613	12,598
53 Real Estate & Rental	0	1,714	1,011	2,725
54 Professional, Scientific & Tech Services	0	10,284	2,813	13,097
55 Management of Companies	0	6,902	1,025	7,927
56 Administrative & Waste Services	0	7,043	1,956	8,999
61 Educational Services	0	1	27,230	27,230
62 Health & Social Services	0	40	941	981
71 Arts, Entertainment & Recreation	0	60	862	922
72 Accommodation & Food Services	0	1,690	4,884	6,574
81 Other Services	0	5,092	6,294	11,386
92 Government	0	1,576	1,193	2,769
Total	154,117	101,095	75,741	330,953

Appendix Table D23. Business Volume, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Processing and Transportation, Oil and Gas Industry, North Dakota, 2019

NAICS Code and Economic Sector	Direct	Indirect	Induced	Total
	----- millions \$ -----			
11 Ag, Forestry, Fishing & Hunting	0	0	1	1
21 Mining	79	5	0	84
22 Utilities	0	59	8	66
23 Construction	0	50	3	52
31-33 Manufacturing	2,646	4	2	2,653
42 Wholesale Trade	47	11	13	71
44-45 Retail trade	0	7	28	35
48-49 Transportation & Warehousing	118	79	8	205
51 Information	0	8	9	17
52 Finance & insurance	0	21	35	56
53 Real Estate & Rental	0	17	47	63
54 Professional, Scientific & Tech Services	0	24	7	30
55 Management of Companies	0	13	2	15
56 Administrative & Waste Services	0	17	5	22
61 Educational Services	0	0	55	55
62 Health & Social Services	0	0	2	2
71 Arts, Entertainment & Recreation	0	0	4	4
72 Accommodation & Food Services	0	5	15	20
81 Other Services	0	11	17	28
92 Government	0	6	5	10
Total	2,890.3	335.4	262.9	3,488.6

Appendix Table D24. Value-added Activity, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Processing and Transportation, Oil and Gas Industry, North Dakota, 2019

NAICS Code and Economic Sector	Direct	Indirect	Induced	Total
	----- 000s \$ -----			
11 Ag, Forestry, Fishing & Hunting	0	48	326	374
21 Mining	84,985	2,764	55	87,805
22 Utilities	0	23,233	2,781	26,015
23 Construction	0	27,469	1,271	28,740
31-33 Manufacturing	292,452	1,627	565	294,644
42 Wholesale Trade	50,117	7,252	7,194	64,562
44-45 Retail trade	0	4,258	14,905	19,163
48-49 Transportation & Warehousing	124,554	61,573	4,461	190,588
51 Information	0	4,579	4,850	9,428
52 Finance & insurance	0	9,562	13,475	23,037
53 Real Estate & Rental	0	11,804	33,474	45,278
54 Professional, Scientific & Tech Services	0	15,539	3,905	19,443
55 Management of Companies	0	8,415	1,123	9,537
56 Administrative & Waste Services	0	10,682	2,717	13,399
61 Educational Services	0	1	32,138	32,139
62 Health & Social Services	0	62	1,106	1,168
71 Arts, Entertainment & Recreation	0	130	1,606	1,736
72 Accommodation & Food Services	0	2,888	7,542	10,429
81 Other Services	0	8,236	9,358	17,594
92 Government	0	1,553	390	1,944
Total	552,107	201,674	143,243	897,024

Appendix Table D25. Employment, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Development, Oil and Gas Industry, North Dakota, 2017

NAICS Code and Economic Sector	Direct	Indirect	Induced	Total
11 Ag, Forestry, Fishing & Hunting	0	4	7	11
21 Mining	6,031	28	1	6,060
22 Utilities	0	13	10	23
23 Construction	0	225	29	254
31-33 Manufacturing	0	22	12	34
42 Wholesale Trade	0	255	97	352
44-45 Retail trade	0	42	621	664
48-49 Transportation & Warehousing	0	98	88	186
51 Information	0	71	44	115
52 Finance & insurance	0	609	233	842
53 Real Estate & Rental	0	207	151	358
54 Professional, Scientific & Tech Services	0	863	101	964
55 Management of Companies	0	192	19	211
56 Administrative & Waste Services	0	451	119	570
61 Educational Services	0	0	82	83
62 Health & Social Services	0	0	710	710
71 Arts, Entertainment & Recreation	0	26	82	107
72 Accommodation & Food Services	0	495	402	897
81 Other Services	0	103	361	464
92 Government	0	15	32	48
Totals	6,031	3,720	3,200	12,951

Appendix Table D26. Employment Compensation, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Development, Oil and Gas Industry, North Dakota, 2017

NAICS Code and Economic Sector	Direct	Indirect	Induced	Total
11 Ag, Forestry, Fishing & Hunting	0	39	109	147
21 Mining	709,978	2,299	66	712,344
22 Utilities	0	1,825	1,315	3,139
23 Construction	0	11,355	1,470	12,825
31-33 Manufacturing	0	1,302	687	1,989
42 Wholesale Trade	0	18,592	7,086	25,678
44-45 Retail trade	0	1,414	17,875	19,289
48-49 Transportation & Warehousing	0	5,486	4,459	9,945
51 Information	0	4,522	3,011	7,533
52 Finance & insurance	0	26,184	12,284	38,468
53 Real Estate & Rental	0	8,607	1,400	10,007
54 Professional, Scientific & Tech Services	0	65,790	4,990	70,780
55 Management of Companies	0	18,122	1,822	19,945
56 Administrative & Waste Services	0	16,162	3,856	20,018
61 Educational Services	0	7	1,859	1,866
62 Health & Social Services	0	1	40,841	40,842
71 Arts, Entertainment & Recreation	0	210	1,211	1,421
72 Accommodation & Food Services	0	9,564	8,081	17,645
81 Other Services	0	4,667	9,925	14,592
92 Government	0	872	2,039	2,911
Total	709,978	197,018	124,386	1,031,382

Appendix Table D27. Business Volume, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Development, Oil and Gas Industry, North Dakota, 2017

NAICS Code and Economic Sector	Direct	Indirect	Induced	Total
----- 000s \$ -----				
11 Ag, Forestry, Fishing & Hunting	0	266	1,171	1,437
21 Mining	3,381,445	7,973	296	3,389,713
22 Utilities	0	16,060	11,493	27,553
23 Construction	0	39,431	5,141	44,572
31-33 Manufacturing	0	8,382	4,890	13,273
42 Wholesale Trade	0	65,665	25,026	90,692
44-45 Retail trade	0	3,963	55,748	59,711
48-49 Transportation & Warehousing	0	14,981	12,528	27,508
51 Information	0	23,193	14,769	37,962
52 Finance & insurance	0	117,128	51,775	168,903
53 Real Estate & Rental	0	84,739	80,871	165,610
54 Professional, Scientific & Tech Services	0	126,132	11,907	138,039
55 Management of Companies	0	39,906	4,013	43,919
56 Administrative & Waste Services	0	35,823	9,378	45,202
61 Educational Services	0	17	3,652	3,669
62 Health & Social Services	0	2	77,217	77,219
71 Arts, Entertainment & Recreation	0	1,057	5,549	6,605
72 Accommodation & Food Services	0	38,995	23,390	62,385
81 Other Services	0	14,076	24,775	38,851
92 Government	0	2,577	7,638	10,215
Total	3,381,445	640,366	431,227	4,453,037

Appendix Table D28. Value-added Activity, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Development, Oil and Gas Industry, North Dakota, 2017

NAICS Code and Economic Sector	Direct	Indirect	Induced	Total
----- 000s \$ -----				
11 Ag, Forestry, Fishing & Hunting	0	138	639	777
21 Mining	1,875,816	6,799	159	1,882,774
22 Utilities	0	5,940	4,314	10,254
23 Construction	0	21,338	2,665	24,002
31-33 Manufacturing	0	2,642	1,259	3,901
42 Wholesale Trade	0	46,207	17,610	63,817
44-45 Retail trade	0	2,466	33,144	35,609
48-49 Transportation & Warehousing	0	9,146	7,333	16,479
51 Information	0	10,295	7,167	17,462
52 Finance & insurance	0	45,559	22,790	68,350
53 Real Estate & Rental	0	64,556	54,580	119,136
54 Professional, Scientific & Tech Services	0	76,030	7,329	83,359
55 Management of Companies	0	20,968	2,108	23,076
56 Administrative & Waste Services	0	25,367	5,984	31,351
61 Educational Services	0	8	1,876	1,884
62 Health & Social Services	0	1	47,636	47,637
71 Arts, Entertainment & Recreation	0	334	2,273	2,606
72 Accommodation & Food Services	0	22,024	12,710	34,734
81 Other Services	0	10,185	16,541	26,725
92 Government	0	-5,973	-1,364	-7,337
Total	1,875,816	364,028	246,753	2,486,596

Appendix Table D29. Employment, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Production, Oil and Gas Industry, North Dakota, 2017

NAICS Code and Economic Sector	Direct	Indirect	Induced	Total
11 Ag, Forestry, Fishing & Hunting	0	3	30	33
21 Mining	10,286	17	3	10,306
22 Utilities	0	47	39	85
23 Construction	0	878	115	993
31-33 Manufacturing	0	33	47	79
42 Wholesale Trade	0	297	391	688
44-45 Retail trade	0	127	2,513	2,640
48-49 Transportation & Warehousing	0	439	358	796
51 Information	0	95	177	271
52 Finance & insurance	0	440	925	1,365
53 Real Estate & Rental	0	288	599	886
54 Professional, Scientific & Tech Services	0	801	409	1,210
55 Management of Companies	0	742	78	820
56 Administrative & Waste Services	0	357	484	841
61 Educational Services	0	1	352	352
62 Health & Social Services	0	0	2,864	2,864
71 Arts, Entertainment & Recreation	0	36	336	372
72 Accommodation & Food Services	0	291	1,626	1,917
81 Other Services	0	84	1,447	1,531
92 Government	0	57	128	185
Total	10,286	5,031	12,919	28,236

Appendix Table D30. Employment Compensation, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Production, Oil and Gas Industry, North Dakota, 2017

NAICS Code and Economic Sector	Direct	Indirect	Induced	Total
11 Ag, Forestry, Fishing & Hunting	0	35	440	475
21 Mining	1,273,783	1,398	268	1,275,449
22 Utilities	0	6,076	5,252	11,328
23 Construction	0	44,690	6,000	50,690
31-33 Manufacturing	0	1,962	2,788	4,750
42 Wholesale Trade	0	21,891	28,812	50,703
44-45 Retail trade	0	3,959	72,969	76,929
48-49 Transportation & Warehousing	0	51,944	18,239	70,182
51 Information	0	5,935	12,155	18,091
52 Finance & insurance	0	21,956	49,420	71,376
53 Real Estate & Rental	0	12,203	5,613	17,815
54 Professional, Scientific & Tech Services	0	57,187	20,479	77,666
55 Management of Companies	0	70,888	7,403	78,291
56 Administrative & Waste Services	0	13,869	15,814	29,684
61 Educational Services	0	10	8,027	8,037
62 Health & Social Services	0	1	164,553	164,554
71 Arts, Entertainment & Recreation	0	322	5,020	5,342
72 Accommodation & Food Services	0	5,732	32,955	38,687
81 Other Services	0	3,763	40,000	43,764
92 Government	0	3,831	8,159	11,990
Total	1,273,783	327,652	504,366	2,105,801

Appendix Table D31. Business Volume, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Production, Oil and Gas Industry, North Dakota, 2017

NAICS Code and Economic Sector	Direct	Indirect	Induced	Total
	----- 000s \$ -----			
11 Ag, Forestry, Fishing & Hunting	0	266	3,322	3,588
21 Mining	22,214,571	5,300	834	22,220,705
22 Utilities	0	52,510	31,774	84,284
23 Construction	0	155,895	14,658	170,553
31-33 Manufacturing	0	11,029	13,744	24,773
42 Wholesale Trade	0	76,948	70,393	147,340
44-45 Retail trade	0	11,110	157,328	168,437
48-49 Transportation & Warehousing	0	117,101	35,665	152,766
51 Information	0	28,524	40,998	69,522
52 Finance & insurance	0	88,158	144,042	232,200
53 Real Estate & Rental	0	124,033	230,453	354,486
54 Professional, Scientific & Tech Services	0	111,400	33,995	145,395
55 Management of Companies	0	155,590	11,294	166,884
56 Administrative & Waste Services	0	33,183	26,798	59,981
61 Educational Services	0	27	11,009	11,035
62 Health & Social Services	0	2	216,463	216,466
71 Arts, Entertainment & Recreation	0	1,627	15,873	17,500
72 Accommodation & Food Services	0	21,944	66,317	88,261
81 Other Services	0	11,330	69,542	80,873
92 Government	0	14,243	21,163	35,407
Total	22,214,571	1,020,219	1,215,664	24,450,455

Appendix Table D32. Value-added Activity, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Production, Oil and Gas Industry, North Dakota, 2017

NAICS Code and Economic Sector	Direct	Indirect	Induced	Total
	----- 000s \$ -----			
11 Ag, Forestry, Fishing & Hunting	0	136	2,605	2,741
21 Mining	18,383,825	3,974	641	18,388,439
22 Utilities	0	20,093	17,234	37,327
23 Construction	0	83,984	10,874	94,858
31-33 Manufacturing	0	3,588	5,105	8,692
42 Wholesale Trade	0	54,406	71,606	126,012
44-45 Retail trade	0	6,749	135,291	142,040
48-49 Transportation & Warehousing	0	83,689	30,037	113,725
51 Information	0	12,569	28,852	41,421
52 Finance & insurance	0	37,964	91,780	129,744
53 Real Estate & Rental	0	93,257	223,623	316,880
54 Professional, Scientific & Tech Services	0	67,841	30,091	97,932
55 Management of Companies	0	82,018	8,565	90,584
56 Administrative & Waste Services	0	21,156	24,555	45,711
61 Educational Services	0	12	8,082	8,094
62 Health & Social Services	0	1	192,318	192,319
71 Arts, Entertainment & Recreation	0	514	9,329	9,843
72 Accommodation & Food Services	0	12,309	51,829	64,137
81 Other Services	0	8,239	66,860	75,099
92 Government	0	1,600	-5,722	-4,121
Total	18,383,825	594,097	1,003,555	19,981,477

Appendix Table D33. Employment, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Processing and Transportation, Oil and Gas Industry, North Dakota, 2017

NAICS Code and Economic Sector	Direct	Indirect	Induced	Total
11 Ag, Forestry, Fishing & Hunting	0	0	4	4
21 Mining	0	1	0	1
22 Utilities	735	7	5	746
23 Construction	0	168	14	182
31-33 Manufacturing	288	7	6	300
42 Wholesale Trade	99	251	46	396
44-45 Retail trade	0	31	295	327
48-49 Transportation & Warehousing	644	335	42	1,021
51 Information	0	23	21	44
52 Finance & insurance	0	133	111	244
53 Real Estate & Rental	0	58	72	130
54 Professional, Scientific & Tech Services	0	221	48	269
55 Management of Companies	0	42	9	51
56 Administrative & Waste Services	0	157	57	214
61 Educational Services	0	1	39	40
62 Health & Social Services	0	0	338	338
71 Arts, Entertainment & Recreation	0	14	39	53
72 Accommodation & Food Services	0	63	191	254
81 Other Services	0	58	172	230
92 Government	0	11	15	26
Total	1,766	1,583	1,522	4,871

Appendix Table D34. Employment Compensation, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Processing and Transportation, Oil and Gas Industry, North Dakota, 2017

NAICS Code and Economic Sector	Direct	Indirect	Induced	Total
11 Ag, Forestry, Fishing & Hunting	0	5	50	55
21 Mining	0	95	31	125
22 Utilities	97,500	867	606	98,973
23 Construction	0	7,835	675	8,509
31-33 Manufacturing	57,701	333	316	58,349
42 Wholesale Trade	7,229	16,934	3,256	27,419
44-45 Retail trade	0	886	8,208	9,094
48-49 Transportation & Warehousing	91,452	29,289	2,047	122,787
51 Information	0	1,232	1,385	2,618
52 Finance & insurance	0	7,974	5,654	13,627
53 Real Estate & Rental	0	600	645	1,244
54 Professional, Scientific & Tech Services	0	11,071	2,289	13,361
55 Management of Companies	0	3,675	837	4,512
56 Administrative & Waste Services	0	4,617	1,769	6,387
61 Educational Services	0	30	846	875
62 Health & Social Services	0	0	18,792	18,792
71 Arts, Entertainment & Recreation	0	108	555	662
72 Accommodation & Food Services	0	1,186	3,711	4,897
81 Other Services	0	2,010	4,567	6,576
92 Government	0	655	939	1,594
Total	253,881	89,401	57,175	400,457

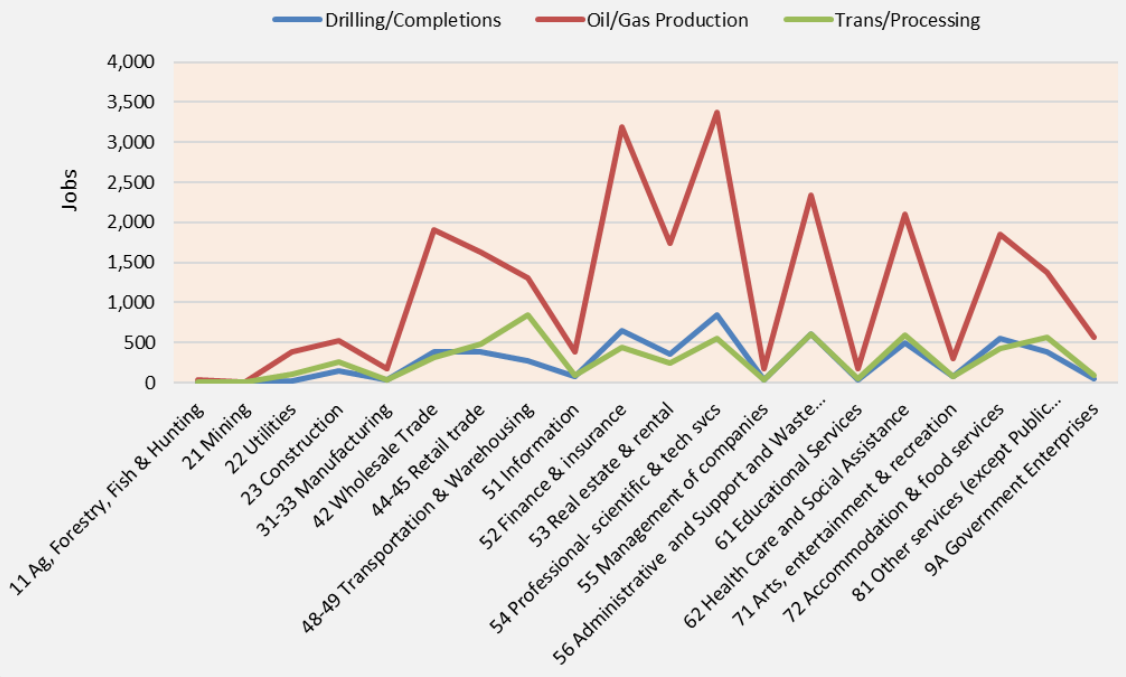
Appendix Table D35. Business Volume, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Processing and Transportation, Oil and Gas Industry, North Dakota, 2017

NAICS Code and Economic Sector	Direct	Indirect	Induced	Total
	----- 000s \$ -----			
11 Ag, Forestry, Fishing & Hunting	0	67	658	725
21 Mining	0	529	167	696
22 Utilities	348,748	9,170	6,476	364,394
23 Construction	0	32,713	2,887	35,600
31-33 Manufacturing	1,701,729	1,906	2,749	1,706,384
42 Wholesale Trade	25,533	71,915	14,062	111,510
44-45 Retail trade	0	3,004	31,306	34,310
48-49 Transportation & Warehousing	194,749	84,614	7,030	286,393
51 Information	0	6,736	8,314	15,050
52 Finance & insurance	0	32,615	29,150	61,765
53 Real Estate & Rental	0	14,219	45,381	59,600
54 Professional, Scientific & Tech Services	0	27,346	6,681	34,027
55 Management of Companies	0	9,729	2,255	11,984
56 Administrative & Waste Services	0	13,533	5,258	18,791
61 Educational Services	0	86	2,034	2,120
62 Health & Social Services	0	1	43,446	43,448
71 Arts, Entertainment & Recreation	0	611	3,112	3,723
72 Accommodation & Food Services	0	4,047	13,137	17,184
81 Other Services	0	7,880	13,936	21,816
92 Government	0	2,994	4,304	7,297
Total	2,270,758	323,715	242,343	2,836,816

Appendix Table D36. Value-added Activity, Direct, Indirect, and Induced Economic Effects, by Economic Sector, Oil and Gas Processing and Transportation, Oil and Gas Industry, North Dakota, 2017

NAICS Code and Economic Sector	Direct	Indirect	Induced	Total
	----- 000s \$ -----			
11 Ag, Forestry, Fishing & Hunting	0	33	339	372
21 Mining	0	272	85	357
22 Utilities	132,008	3,224	2,296	137,528
23 Construction	0	16,789	1,414	18,203
31-33 Manufacturing	281,667	585	669	282,921
42 Wholesale Trade	17,967	47,995	9,348	75,310
44-45 Retail trade	0	1,716	17,583	19,299
48-49 Transportation & Warehousing	145,195	53,981	3,888	203,064
51 Information	0	2,742	3,811	6,552
52 Finance & insurance	0	15,666	12,116	27,782
53 Real Estate & Rental	0	9,481	28,938	38,418
54 Professional, Scientific & Tech Services	0	16,509	3,885	20,394
55 Management of Companies	0	4,848	1,119	5,968
56 Administrative & Waste Services	0	8,265	3,172	11,437
61 Educational Services	0	38	986	1,024
62 Health & Social Services	0	1	25,316	25,316
71 Arts, Entertainment & Recreation	0	190	1,205	1,394
72 Accommodation & Food Services	0	2,071	6,744	8,815
81 Other Services	0	5,432	8,789	14,221
92 Government	0	143	-720	-577
Total	576,836	189,980	130,980	897,796

Appendix Figure D1. Gross Business Volume, Indirect and Induced Activity, by 2-digit NAICS, North Dakota, 2021



Appendix Figure D2. Employment, Indirect and Induced Activity, by 2-digit NAICS, North Dakota, 2021

