Increasing the Oil and Gas Setback Requirement to 2,500-feet in Colorado

The Economic and Fiscal Impacts of 2018 Proposition 112

AUTHORS

CHRIS BROWN / ZHAO CHANG

JULY 2018 / CONDUCTED BY

COMMON SENSE Policy Roundtable

COLORADO CONCERN

DENVERSOUTH ECONOMIC DEVELOPMENT PARTNERSHIP

COLORADO THE BANKERS ASSOCIATION

colorado association of REALTORS®

ABOUT THE REMI PARTNERSHIP

A partnership of public and private organizations announced in July 2013 the formation of a collaboration to provide Colorado lawmakers, policy makers, business leaders, and citizens, with greater insight into the economic impact of public policy decisions that face the state and surrounding regions. The parties involved include the Colorado Association of REALTORS®, the Colorado Bankers Association, Colorado Concern, Common Sense Policy Roundtable and Denver South Economic Development Partnership. This consortium meets monthly to discuss pressing economic issues impacting the state and to prioritize and manage its independent research efforts.

SPECIAL THANKS

Special thanks to Dr. Ian Lange and Dr. Braeton Smith, with the Colorado School of Mines, Mineral and Energy Economics Program, for their work to review the economic impact methodology and findings portions of the report. Their insights and feedback were incredibly valuable in ensuring the study appropriately estimated the economic impacts of this critical issue.

CONTENTS

ABSTRACT

This study evaluates the economic and fiscal impacts of the proposed Ballot Proposition 112 - Setback Requirement for Oil and Gas Development. If successful, the initiative would increase the setback requirement for new oil and gas activity on non-federal land, from 500-ft to 2,500-ft from designated structures and vulnerable areas.

Mapping of surface land by the Colorado Oil and Gas Conservation Commission (COGCC) (Colorado Oil and Gas Conservation Commission, 2018) demonstrates that the increase in the setback to 2,500-ft would make an estimated 54% of Colorado's entire land surface off-limits to new oil and gas production. However, by mapping this surface restriction to historic data on new wells, 89.42% of new oil production and 87.3% of new gas production, has occurred within the proposed 2,500-ft increased setback area.

A projection of future oil and gas production, based on price forecasts and rig counts, shows strong continued growth in the oil and gas sector, of which 52.8% is projected to occur within the expanded setback area. It is uncertain if the amount of production that would be lost within the setback area could occur outside the setback area in the future, therefore this study models two scenarios to account for a range of 10% displacement and 30% displacement. These two scenarios show that between 17% and 22% of the total projected production in the first year is lost, and by 2030 the entire production value would be reduced by 54% to 70%, as the loss in annual new production is combined with the future year's lost production based on expected decline curves. Between 2019 and 2030, the estimated dollar amount of lost oil and gas production ranges from $110 Billion to $141 Billion. (Fixed 2018$)

The results of the economic simulation, using the Colorado Tax-PI model developed by REMI are as follows. The lost value of production would reduce employment in the first year by around 33,500 to 43,000 jobs, and around 115,000 to 147,800 jobs by year 2030. The direct loss in state and local tax revenue from new oil and gas activity, including from severance taxes, property taxes, income taxes, and sales and use taxes, would range from between $201 Million and $258 Million in the first year, growing to between $825 Million and $1.1 Billion by 2030.

TABLE 1: SUMMARY RESULTS TABLE

Economic and Fiscal Impacts of Proposition 112 Summary Results Table			
10% Displacement	**2019**	**2030**	**2019-2030**
% of New Production Loss	-80%	-80%	80%
% of All Production Loss	-22%	-70%	57%
Employment (Units)	-43,000	-147,800	-109,500
GDP (Billion 2018$)	-$6.216	-$26.312	-$217.926
Tax Revenue (Million 2018$)	-$258.47	-$1,060.55	-$9,020.31
30% Displacement	**2019**	**2030**	**2019 - 2030**
% of New Production Loss	-62%	-62%	62%
% of All Production Loss	-17%	-54%	44%
Employment (Units)	-33,500	-115,000	-85,200
GDP (Billion 2018$)	-$4.836	-$20.462	-$169.486
Tax Revenue (Million 2018$)	-$201.03	-$824.87	-$7,015.80

OVERVIEW

INTRODUCTION

From education to infrastructure to energy, the REMI Partnership examines the economic impacts of policies, initiatives, and proposed laws by employing dynamic modeling and thorough policy analysis that measures the impact of each measure on the Colorado economy.

This study is meant to give voters and policymakers in the state of Colorado sound economic and policy information regarding Ballot Proposition 112, which, if passed, would heavily impact the state economy. The REMI Partnership strives to provide policymakers, community leaders and citizens of Colorado the facts and figures on free enterprise issues that impact their lives.

OVERVIEW AND HISTORY

The proposed Proposition 112 would increase the required setback distance for new oil and gas drilling to 2,500 ft. It also modifies and expands the definition of occupied structures and vulnerable areas that are subject to the setback requirement.

The definition of "occupied structure" includes any building or structure that requires a certificate of occupancy or building or structure intended for human occupancy, such as, homes, schools and hospitals.

"Vulnerable areas" includes playgrounds, permanent sports fields, amphitheaters, public parks, public open space, public and community drinking water sources, irrigation canals, reservoirs, lakes, rivers, perennial or intermittent streams, and creeks and any additional vulnerable areas designated by the state or a local government.

The proponents of Proposition 112, Colorado Rising, state that the proximity to oil and gas development, including the use of hydraulic fracturing or fracking, has detrimental impacts on public health, safety and welfare, and the environment overall.

Proposition 112 further states that such detrimental impacts could be reduced if oil and gas developments are located 2,500 feet away from occupied structures and vulnerable areas.

Many questions surround the impacts of Proposition 112:

- This new language of ballot Proposition 112 would effectively take out the application and hearing process; an effective tool used between private exploration and production companies and local governments and communities and relegate wells and production units automatically to abide by the 2,500-foot setback rule.
- It is unclear what effect the change in language from "High Occupancy Building Unit" and "Occupied Structure" would have on the issuance of new drilling permits.
- However, it is likely that "Occupied Structure" would encompass far more buildings than "High Occupancy" thus increasing not only the distance of new oil and gas activity from structures but also increasing the number of structures subject to setback.

- Additionally, giving local governments the power to decide which areas meet the "vulnerable areas" standard would effectively preempt the state constitution as it stands now as local governments do not have the power to decide whether to ban new oil and gas developments within their city limits.
- Any area designated as "vulnerable" by a local government in the future, would only further decrease the available land for future oil and gas activity.
- The extent to which the increase in the required setback would benefit public health. A 2017 study released by the Colorado Department of Public Health and the Environment (Colorado Department of Public Health and Environment, 2017) concluded that results from exposure and health effect studies do not indicate the need for immediate public health action as there was no substantial or moderate evidence of health effects of communities living near oil and gas operations.

CURRENT REGULATORY REQUIREMENTS

The most current language to be passed regarding setbacks was last adopted as of August 2013. Colorado law now dictates that, "No Well or Production facility shall be located five hundred feet or less from a Building Unit." Additionally, "No Well or Production facility shall be located one thousand feet or less from a High Occupancy Building Unit without Commission approval following Application and Hearing."

Along with the existing setback requirements, there are various other areas of regulation imposed on the oil and gas industry in Colorado (Amundson, 2018). These regulations were updated and strengthened on a near annual basis and numerous times throughout the last decade during the recent administrations of Democratic Governors Bill Ritter and John Hickenlooper.

Existing oil and gas regulation covers all aspects of oil and gas operations from initial exploration to transportation and clean-up. For more information on these regulations, see the Colorado Oil and Gas Conservation Commission website (https://cogcc.state.co.us/reg.html#/overview) as well as the Colorado Department of Public Health and Environment website (https://www.colorado.gov/pacific/cdphe/aqcc-regs).

Here is a timeline of some of the previous initiatives related to oil and gas development activities;

- In 2013, five Colorado communities passed local initiatives to pass moratoriums on fracking. These communities include Boulder, Broomfield, Fort Collins, Longmont and Brighton.
- In 2016, the Colorado Supreme Court struck down the local prohibitions on fracking, stating that the moratoriums were invalid due to the pre-emption of state law.
- In 2016, the State Legislature prepared an initiative mirroring the language of Proposition 112 that ultimately failed to make it onto the state-wide ballot for voting.
- In 2016, there was a Colorado Ballot Proposal that would ban the use of hydraulic fracturing altogether in the state of Colorado, which also failed.
- In 2016, a Ballot Initiative was cancelled which would have given local governments control over how to plan and regulate land use, including the authority to regulate land use to limit any detrimental impact on their community, including oil and gas use as it relates to public health and safety.

PREVIOUS ECONOMIC IMPACT RESEARCH

In 2014, conducted by the REMI Partnership, the Business Research Division of the Leeds School of Business at the University of Colorado analyzed price and policy impacts on the oil and gas industry, including analyzing a failed ballot measure that would have increased the set-back as it currently stands from to 2,000 feet in the state of Colorado. (Business Research Division, Leeds School of Business, 2014)

According to this study, "a 2,000-foot setback would curtail drilling locations by 25% to 50%."

Additionally, "Given a 25% reduction…the economic consequence would result in a lower GDP by an average of $3 billion and 18,000 fewer jobs in the first five years, and a lower GDP by an average of $3.2 billion and 24,400 fewer jobs between 2015 and 2040."

"Given a 50% reduction in new production…the economic consequence would result in a lower GDP by an average of $4.4 billion and 36,000 fewer jobs in the first five years, and a lower GDP by an average of $6.4 billion and 49,000 fewer jobs between 2015 and 2040."

In 2016, the University of Colorado analyzed price and policy impacts on oil and gas developments in the state of Colorado by analyzing a failed ballot measure that would have increased the setback to 2,500 feet (Business Research Division, Leeds School of Business, 2016).

According to this study, "a 2,500-foot setback would curtail accessible [surface] drilling locations by 90.2%."

Furthermore, "Assuming a 90.2% reduction in new production in 2017, the compounding economic consequence would result in a lower real GDP by an average of $7.1 billion and 54,000 jobs in the first five years, and a lower GDP by an average of $14.5 billion and 104,000 fewer jobs between 2017 and 2031."

FINDINGS

METHODOLOGY

The economic impacts presented in this report were developed using the dynamic forecasting and economic simulation model Tax-PI, developed and calibrated by Regional Economic Models Incorporated or REMI (a private company separate from the REMI Partnership) exclusively for the state of Colorado. The direct impacts to future oil and gas production were estimated using historical production data and GIS maps of the 2,500-foot setback area produced by the Colorado Oil and Gas Conservation Commission (COGCC). The average percentage of new oil and gas production from 2015 to 2017 that has occurred on land that would be off-limits due to the large setback was applied to a baseline forecast of new oil and gas production.

There are two scenarios for the economic impact simulations. Scenario 1 assumes that 10% of the new oil and gas activity expected to occur within the setback area will still be able to occur on land outside the setback area. Scenario 2 assumes that 30% of the new oil and gas activity expected to occur within the setback area will now occur on land outside the setback area. This assumption was not included in previous research, as there is no strong evidence to suggest exactly how much lost production can occur from outside the setback area. There are several reasons why it is expected to be challenging to continue to access those resources by drilling horizontally underneath the surface setback area.

- As larger setback zones run into each other, the eventual drilling distance will be much longer than 2,500-ft or what is possible to access with current technology.
- It is not as likely that companies could get access to drill from beyond the setback area to access resources underneath the new setback areas. Getting the surface permits would be more challenging for several reasons including the fact that to access the mineral rights would require drilling through areas that the company may not have the rights to drill through.
- The cost to access any resource that is both technologically and legally possible would be significantly more expensive. This would make it far more likely for oil and gas companies to invest their extraction resources elsewhere.

For reference, here is a map of the surface area in Weld County restricted under the current 500-ft setback requirement, compared to the 2,500-ft setback area.

FIGURE 1: 2018 SURFACE SETBACK AREA AT CURRENT 500 FEET

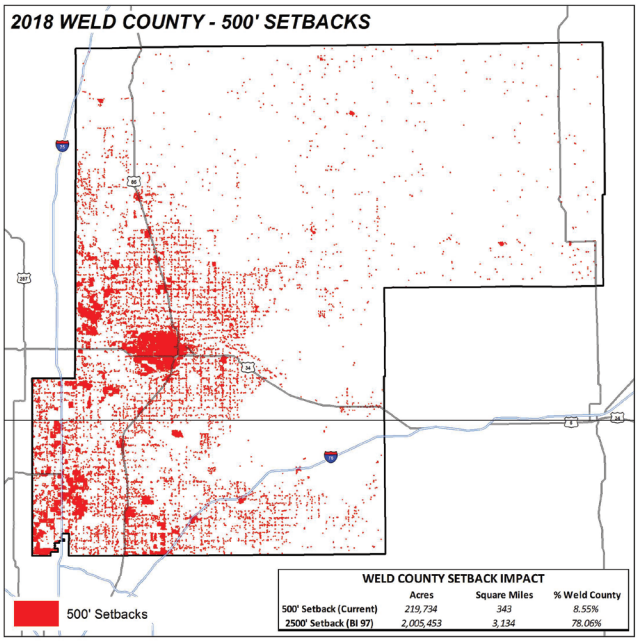


FIGURE 2: 2018 SURFACE SETBACK AREA AT PROPOSED 2,500-FEET

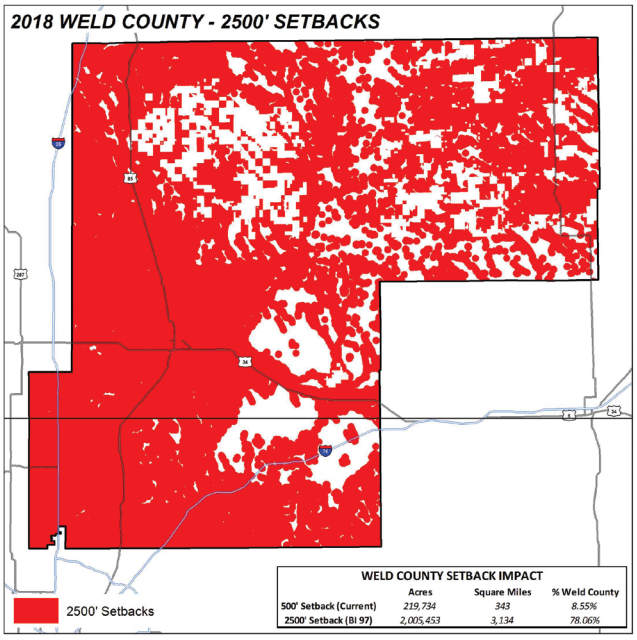


TABLE 2: FORECASTED DOLLAR VALUE AND PERCENT OF OIL AND GAS PRODUCTION INSIDE VS OUTSIDE THE PROPOSED 2,500-FT SETBACK AREA, 2019-2030

Total (New + Existing) Oil and Gas Production 2019-2030
Forecasted dollar value and percent of state total

	OIL		GAS	
	Amount (Billion 2018$)	% of Statewide Total	Amount (Billion 2018 $)	% of Statewide Total
INSIDE 2,500 FT SETBACK AREA				
DJ Basin	$106.45	69.1%	$34.04	35.9%
Rest of Colorado	$1.86	1.2%	$14.25	15.0%
Subtotal	$108.31	70.3%	$48.29	51.0%
OUTSIDE SETBACK AREA				
DJ Basin	$42.80	27.8%	$17.67	18.7%
Rest of Colorado	$2.89	1.9%	$28.77	30.4%
Subtotal	$45.69	29.9%	$46.44	49.0%
STATE TOTAL				
DJ Basin	$149.25	96.9%	$51.72	54.6%
Rest of Colorado	$4.75	3.1%	$43.02	45.4%
State Total	$154.00	100.00%	$94.73	100.00%

RESULTS

The results are presented for both the direct impacts and the statewide macroeconomic impacts. The direct impacts represent the estimated loss in new oil and gas production if Proposition 112 were to pass.

The direct impacts in Table 3 are displayed across several different dimensions:

- DJ Basin vs Rest of the State
- Oil vs Gas vs Total
- Dollar value of production
- Percentage loss of new production vs percentage loss of total production

The dynamic statewide impacts represent the economic loss to other industry sectors and individuals as the direct losses in oil and gas extraction would ripple throughout the rest of the state's economy. The Tax-PI model captures several distinct economic linkages including the disruption to the industry supply chain, the loss of consumer demand from fewer jobs and lower income, and in lower investment in non-residential and residential capital and equipment. The model captures the economy-wide impacts on such categories as employment, income, and value-added.

DIRECT IMPACTS

TABLE 3: DOLLAR VALUE AND PERCENTAGE OF ESTIMATED LOST OIL AND GAS PRODUCTION

Annual Dollar Value and Percentage Loss of Oil and Gas Production (Billion $)						
YEAR	10% DISPLACEMENT			30% DISPLACEMENT		
	Dollar Value Loss in the Setback Area	% of New Production Loss	% of All Production Loss	Dollar Value Loss in the Setback Area	% of New Production Loss	% of All Production Loss
DJ BASIN						
2019	-$3.76	-81.0%	-26.0%	-$2.93	-63.0%	-20.3%
2020	-$6.64	-81.2%	-46.7%	-$5.16	-63.1%	-36.3%
2021	-$7.92	-81.3%	-54.4%	-$6.16	-63.2%	-42.3%
2022	-$8.88	-81.3%	-59.1%	-$6.91	-63.2%	-46.0%
2023	-$9.76	-81.3%	-62.5%	-$7.59	-63.3%	-48.6%
2024	-$10.56	-81.4%	-65.0%	-$8.22	-63.3%	-50.5%
2025	-$11.36	-81.4%	-67.0%	-$8.84	-63.3%	-52.1%
2026	-$12.14	-81.4%	-68.6%	-$9.44	-63.3%	-53.3%
2027	-$12.94	-81.4%	-69.9%	-$10.07	-63.3%	-54.4%
2028	-$13.60	-81.5%	-71.1%	-$10.58	-63.4%	-55.3%
2029	-$14.18	-81.5%	-74.6%	-$11.03	-63.4%	-58.0%
2030	-$14.70	-81.5%	-75.3%	-$11.44	-63.4%	-58.5%

YEAR	10% DISPLACEMENT			30% DISPLACEMENT		
	Dollar Value Loss in the Setback Area	% of New Production Loss	% of All Production Loss	Dollar Value Loss in the Setback Area	% of New Production Loss	% of All Production Loss
REST OF COLORADO						
2019	-$0.27	-69.2%	-7.0%	-$0.21	-53.8%	-5.4%
2020	-$0.60	-69.1%	-15.7%	-$0.47	-53.8%	-12.2%
2021	-$0.79	-69.1%	-20.7%	-$0.61	-53.8%	-16.1%
2022	-$0.93	-69.1%	-24.6%	-$0.73	-53.8%	-19.1%
2023	-$1.07	-69.1%	-27.9%	-$0.83	-53.8%	-21.7%
2024	-$1.20	-69.1%	-30.7%	-$0.93	-53.8%	-23.9%
2025	-$1.33	-69.1%	-33.3%	-$1.03	-53.8%	-25.9%
2026	-$1.44	-69.1%	-35.8%	-$1.12	-53.7%	-27.8%
2027	-$1.56	-69.1%	-38.1%	-$1.21	-53.7%	-29.6%
2028	-$1.67	-69.1%	-40.2%	-$1.30	-53.7%	-31.3%
2029	-$1.77	-69.1%	-42.2%	-$1.38	-53.7%	-32.8%
2030	-$1.87	-69.1%	-44.1%	-$1.45	-53.7%	-34.3%
STATE TOTAL						
2019	-$4.04	-80.1%	-22.0%	-$3.14	-62.3%	-17.1%
2020	-$7.24	-80.0%	-40.1%	-$5.63	-62.2%	-31.2%
2021	-$8.70	-80.0%	-47.4%	-$6.77	-62.2%	-36.9%
2022	-$9.81	-80.0%	-52.2%	-$7.63	-62.2%	-40.6%
2023	-$10.83	-79.9%	-55.6%	-$8.42	-62.2%	-43.3%
2024	-$11.76	-79.9%	-58.3%	-$9.15	-62.2%	-45.3%
2025	-$12.69	-79.9%	-60.6%	-$9.87	-62.2%	-47.1%
2026	-$13.58	-79.9%	-62.5%	-$10.56	-62.1%	-48.6%
2027	-$14.50	-79.9%	-64.2%	-$11.28	-62.1%	-49.9%
2028	-$15.26	-79.9%	-65.6%	-$11.87	-62.1%	-51.0%
2029	-$15.95	-79.9%	-68.8%	-$12.41	-62.1%	-53.5%
2030	-$16.57	-79.9%	-69.7%	-$12.89	-62.1%	-54.2%

TABLE 4: IMPACTS ON STATE AND LOCAL TAX REVENUE

Reduction in State and Local Oil and Gas Tax Revenue (Million $)		
YEAR	**10% DISPLACEMENT SCENARIO**	**30% DISPLACEMENT SCENARIO**
2019	-$258.47	-$201.03
2020	-$463.40	-$360.42
2021	-$556.89	-$433.14
2022	-$628.03	-$488.47
2023	-$693.04	-$539.03
2024	-$752.96	-$585.64
2025	-$812.09	-$631.62
2026	-$869.02	-$675.91
2027	-$927.86	-$721.67
2028	-$976.89	-$759.81
2029	-$1,021.11	-$794.20
2030	-$1,060.55	-$824.87
Sum	-$9,020.31	-$7,015.80

DYNAMIC STATEWIDE IMPACTS

The macroeconomic impacts represent the total change relative to the baseline for each forecasted year. For instance, with only 10% anticipated displacement, in 2019 the estimated impact on jobs is - 43,000 which grows to -147,800 by 2030. This means that there are estimated to be 43,000 fewer jobs in 2019 and 147,800 fewer jobs in 2030 than were projected in the current policy REMI baseline as a result of the direct losses in new oil and gas production. Because the same job may continue from year-to-year, multiple years of job loss are represented as an annual average loss rather than a cumulative loss. For Gross State Product and personal income, the multiple year losses are summed together as each year the value of each category starts again at $0.

TABLE 5: EMPLOYMENT IMPACTS

Impact on Employment (Units)							
2019		**2025**		**2030**		**2019-2030 AVERAGE**	
10% displacement	30% displacement	10% displacement	30% displacement	10% displacement	30% displacement	10% displacement	30% displacement
-43,000	-33,500	-117,300	-91,200	-147,800	-115,000	-109,500	-85,200
-1.15%	-0.90%	-3.22%	-2.50%	-4.07%	-3.16%		

TABLE 6: GROSS STATE PRODUCT (GSP) IMPACTS

Impact on Gross State Product (GSP) (Billion 2018$)							
2019		**2025**		**2030**		**2019-2030 SUM**	
10% displacement	30% displacement	10% displacement	30% displacement	10% displacement	30% displacement	10% displacement	30% displacement
-$6.216	-$4.836	-$19.386	-$15.077	-$26.312	-$20.462	-$217.926	-$169.486
-1.75%	-1.36%	-5.03%	-3.91%	-6.29%	-4.89%		

TABLE 7: PERSONAL INCOME IMPACTS

Impact on Personal Income (Billion 2018$)							
2019		**2025**		**2030**		**2019-2030 SUM**	
10% displacement	30% displacement	10% displacement	30% displacement	10% displacement	30% displacement	10% displacement	30% displacement
-$3.983	-$3.098	-$13.114	-$10.201	-$18.492	-$14.386	-$147.636	-$114.845
-1.22%	-0.97%	-3.54%	-2.82%	-4.50%	-3.60%		

Table 8 and 9 show the impacts on employment and Value-added by the most impacted sectors as a percent of the total. 57% of all value-added lost between 2019 and 2030 comes from industries outside of oil and gas, while 77% of all jobs lost are outside of the oil and gas extraction industry.

TABLE 8: IMPACTS BY INDUSTRY AS PERCENT OF TOTAL VALUE-ADDED IMPACTS

Value Added Impact by Industry as a Percent of Total	
INDUSTRY	**PERCENTAGE OF TOTAL**
Oil and gas extraction	54%
Professional, scientific, and technical services	7%
Retail trade	5%
Real estate	5%
Construction	4%
Wholesale trade	3%
State and Local Government	3%
Ambulatory health care services	2%
Telecommunications	1%
Administrative and support services	1%
Food services and drinking places	1%
All other Industries	14%

TABLE 9: IMPACTS BY INDUSTRY AS PERCENT OF TOTAL EMPLOYMENT IMPACTS

Employment Impact by Industry as a Percent of Total	
INDUSTRY	**PERCENTAGE OF TOTAL**
Oil and gas extraction	23%
Retail trade	11%
Professional, scientific, and technical services	10%
Health care and social assistance	8%
Construction	7%
Accommodation and food services	6%
State and Local Government	6%
Other services (except public administration)	5%
Administrative, support, waste management, and remediation services	4%
Real estate and rental and leasing	4%
All other Industries	17%

CONCLUSION

Colorado's oil and gas industry supports hundreds of thousands of jobs in the state across nearly all sectors of the economy. In addition, the industry operates within some of the nation's strictest regulations regarding safety, water monitoring and air quality.

A change from the existing 500-foot setback requirement to a 2,500-foot requirement would eliminate between 62% and 80% of annual new oil and gas development in the state. By 2030, it would reduce the total value of production in the state by between 54% and 70%. The state and local tax revenue lost from the reductions in the oil and gas industry alone would range from -$201M to -$258M in the first year, to between -$825M and -$1.1B annually by 2030. And by 2030 there would be roughly 115,000 to 147,800 fewer jobs through all sectors of the economy.

APPENDIX A - METHODOLOGY

The goal of this research is to determine the economic impacts of a 2,500-foot oil and gas setback in Colorado compared to a current policy baseline. The methodology to get to the ultimate economic impacts is outlined in several different phases. The process can be broadly thought of as an effort to determine the direct economic shocks of the policy and running the economic simulation model to determine the cascading dynamic economic impacts.

1. Development of current policy baseline
2. Direct economic impacts
3. Statewide economic impacts

I. Development of current policy baseline

To determine the impacts of Proposition 112, there must first be a baseline to measure against. While the Tax-PI Model developed by Regional Economic Models Inc, or REMI, contains a macroeconomic baseline, it is also necessary to estimate a current baseline for the estimated future production and economic activity of the oil and gas industry. The initial step consists of overlaying the publicly released COGCC GIS map files released on July 2, 2018, that outline the surface land available for new oil and gas development with historic location specific production data. A GIS Analyst with Noble Energy performed the mapping overlay and produced annual historic estimates on the amount of new oil and gas production that has occurred inside or outside of the proposed setback area across several dimensions.

a. Within the DJ Basin vs Rest of Colorado
b. On federal land
c. Within municipal boundaries

Baseline production forecast

The estimate of future production from new wells was then produced for the area that under current policy would occur within the 2,500-setback area and for what would likely occur outside of the 2,500-foot setback area. The future production forecast combines new annual production dictated by rig counts and forecasted prices combined with each new wells future production based on anticipated decline curves (i.e. First year production from new wells + future annual production of those wells).

A strong correlation is observed between historic oil and gas prices and rig counts. The correlation coefficient between the WTI Spot Price from EIA and the Baker Hughes US Rig Count (Baker Hughes , 2018), lagged by 3-months, is 0.96. Due to this close relationship, a forecast of future rig counts is generated based on external pricing forecasts. The regression equation is determined as following with a significant critical (all p-values < .05) value:

$$\textit{Rigs in 3 Months} = -7.47678915 + 0.747902679 \times \textit{Current Oil Price}$$

The monthly forecast price of both oil and gas is the average of two separate sources; Moody's Analytics and CME Group (CME Group). The difference from the historic Colorado price and national price, as reported by EIA (U.S. Energy Information Administration, Last Updated July 19, 2018), was removed from the national average. The price projections from CME Group are available for each future month from 2018 to 2027. The last price in year 2027 is assumed to remain constant until year 2030. The forecasted statewide future rig counts are then shared out into projections of rigs in DJ basin and in the rest of Colorado based on historic averages.

Annual average production per rig is calculated by dividing the last three years of oil and gas production by the rig counts in that year. Overall, extraction technology in the oil and gas industry in the past 3 years remained relatively static after making significant leaps after 2014. Therefore, future production of oil and gas from new wells in their first calendar year is determined by multiplying the forecasted future rig counts in each region by the three-year average annual production per rig constant.

The annual rate of production decline for each future year was estimated by a Stimulation Advisor at Noble Energy using RS Energy Group software. The total production that occurred in the first calendar year from new wells was estimated to decline in future years based on that estimated decline curve. The total estimated loss in production is then estimated as the sum of future new wells forecasted production from 2019 through 2030.

II. Direct impacts of a 2,500-ft setback policy

To model the dynamic economic and fiscal impacts of a 2,500-foot setback, the starting point is determining the direct model inputs. The direct inputs or direct impacts represent the impacts occurring as an immediate result of the policy change. The direct impacts are then used as inputs to the economic simulation model, Tax-PI, developed by REMI, to estimate the ripple effects. For this research, the direct impacts are the estimated loss in new oil and gas production described in the section above. The total amount of production expected to occur inside of a potential setback area, was multiplied by the projected future price to determine the total dollar value. The estimated annual lost value of production was then divided by the total production value in the current policy baseline and entered in the model as a percentage loss in output in Oil and gas extraction. (NAICS 211)

NAICS 211 – Oil and Gas Extraction Definition

"Industries in the Oil and Gas Extraction subsector operate and/or develop oil and gas field properties. Such activities may include exploration for crude petroleum and natural gas; drilling, completing, and equipping wells; operating separators, emulsion breakers, desilting equipment, and field gathering lines for crude petroleum and natural gas; and all other activities in the preparation of oil and gas up to the point of shipment from the producing property. This subsector includes the production of crude petroleum, the mining and extraction of oil from oil shale and oil sands, the production of natural gas, sulfur recovery from natural gas, and recovery of hydrocarbon liquids.

Establishments in this subsector include those that operate oil and gas wells on their own account or for others on a contract or fee basis. Establishments primarily engaged in providing support services, on a contract or fee basis, required for the drilling or operation of oil and gas wells (except geophysical surveying and mapping, mine site preparation, and construction of oil/gas pipelines) are classified in Subsector 213, Support Activities for Mining."

Within the framework of the calculations described in Section I, two scenarios were created to account for the uncertainty surrounding the extent to which projected production expected to occur within the setback areas could still be accessed from outside the new 2,500-foot setback zone.

Economic Impact Scenarios

Scenario 1 – Assume 10% of lost production can occur from outside setback area

Scenario 2 – Assume 30% of lost production can occur from outside setback area

These scenarios have the effect of dampening the economic impacts of the setback by assuming that some amount of forecasted production will be displaced to areas outside of the setback zone. The ability for this displacement to occur is highly unlikely in most cases as numerous barriers and economic challenges exist.

a. Even though horizontal drilling has the capacity to access resources at a distance beyond 2,500-ft, as setback "buffer zone" collides against other "buffer zones," the actual distance to reach most resources goes well beyond the horizontal drilling capability. Please see figure 1 and figure 2 for a map of Weld county setback areas under current 500-ft compared to 2,500-ft.

b. It is not as likely that companies could get access to drill from beyond the setback area to access resources underneath the new setback areas. Getting the surface permits would be more challenging for several reasons including the fact that to access the mineral rights would require drilling through areas that the company may not have the rights to drill through.

c. If each of the above challenges can be met, the cost of extracting the resources will be much higher relative to more easily accessed reserves. As such, unless the price climbs significantly, it is not likely that reserves that are now under a 2,500ft setback would be immediately drilled in the same timeframe as current baseline, further emphasizing the overall percent decline.

No direct assumptions were made about additional direct losses or changes because of Proposition 112, beyond the percentage reduction in output of the oil and gas extraction industry. There was no strong basis for direct inputs to be formulated that quantified any offsetting positive impacts to health or land or property values that could be used as model inputs.

A 2017 report put forward by the Colorado Department of Public Health and Environment, entitled "Assessment of Potential Public Health Effects from Oil and Gas Operations in Colorado (Colorado Department of Public Health and Environment, 2017)," concluded the risk of harmful health effects is low for residents living near oil and gas operations, and that at this time the research and monitoring do not indicate the need for immediate public health action.

Given the uncertainty around the ability for oil and gas companies to continue to be able to access resources underneath setback areas, the simulation model was run with two scenarios.

III. Statewide economic impacts of 2,500 ft setback policy

Under current policy, it is assumed that oil and gas development and production will occur on available land based upon historic production and decline rates and projected future prices. Through GIS mapping and data compiled by COGCC, an estimate of the amount of historical oil

and gas activity that would have occurred inside and outside of the expanded setback region can be created. Then the projected production from existing wells is combined with the future drilling activity and production of future wells. This provides a comprehensive projection of all oil and gas activity contained within and outside of the projected 2,500 ft setback area between 2019 and 2030.

For purpose of the economic impact scenario, the new oil and gas drilling and production activity that is projected to occur within the 2,500 ft setback area is removed from the dynamic economic simulation model Tax-PI, developed by REMI, to produce the statewide economic and fiscal impacts across all sectors and parts of the economy.

The statewide macroeconomic impacts included the changes in jobs, gross state product and personal income. The impacts in each year should be interpreted as representing the impacts relative to the baseline for that year.

Following the direct inputs, several adjustments were made within the Tax-PI model to reflect the unique aspects of the oil and gas industry and the model's default responses.

> Adjustment 1 – Residence Adjustment – 10% of all compensation lost directly by the oil and gas extraction industry was put back into the economy. This is to adjust for oil and gas workers who were working in Colorado but living elsewhere, and therefore would not have their lost compensation impact the Colorado economy. Relative to other oil and gas producing states, a lower percentage of oil and gas workers work in Colorado but live somewhere else, but it is still reasonable to assume it is still a higher percentage than the average of all industries.

TABLE 10: RESIDENCE ADJUSTMENT CALCULATIONS

REMI Tax-PI Model Residence Adjustment					
YEAR	*Average Annual Compensation Rate (Current $)	10% DISPLACEMENT		30% DISPLACEMENT	
		10% of Lost Jobs in Oil and Gas Extraction	Million $ Increase in Residence Adjustment	10% of Lost Jobs in Oil and Gas Extraction	Million $ Increase in Residence Adjustment
2019	$53,346	-933	-$49.79	-726	-$38.72
2020	$56,230	-1722	-$96.82	-1339	-$75.30
2021	$58,970	-2059	-$121.44	-1601	-$94.42
2022	$61,760	-2279	-$140.74	-1772	-$109.42
2023	$64,590	-2447	-$158.08	-1903	-$122.88
2024	$67,387	-2597	-$175.02	-2019	-$136.03
2025	$70,331	-2727	-$191.80	-2119	-$149.05
2026	$73,384	-2841	-$208.51	-2208	-$162.01
2027	$76,539	-2963	-$226.82	-2302	-$176.22
2028	$79,807	-3068	-$244.82	-2383	-$190.18
2029	$82,455	-3279	-$270.35	-2547	-$209.99
2030	$85,173	-3386	-$288.40	-2630	-$223.97

*COMPENSATION PROJECTIONS TAKEN FROM TAX-PI BASELINE CONTROL

Adjustment 2 – Alternative Investment Response – The alternative investment response was turned on instead of the REMI's current default response, because of the dynamic impacts expected within the construction sector. With the default investment response, the loss in the NAICS industry Oil and Gas Extraction was generating a very high response in non-residential and residential spending which triggered significant losses in the construction industry. While we expect to have a strong response in certain construction sectors, particularly heavy and civil engineering construction, we expect some of the lost demand for construction workers to be made up by demand from other parts of the economy due to the current tight labor market. Therefore, a lower investment response impacting non-residential construction was appropriate.

Adjustment 3 - Alternative Government Spending Response – The government spending response to changes in GDP was turned off due to expectation that some revenue losses to local governments would be partially offset by spending from other parts of the state budget. With the adjustment, the relative impacts on state and local government are more in-line with previous findings in relation to the impacts on the government sector including employment and spending.

STATE AND LOCAL TAX REVENUE IMPACT

The fiscal impact results represent the direct impact on state and local tax revenue generated from the activity of the oil and gas industry. According to a memo released by the Legislative Council (Silbaugh, January 12, 2018) in January of 2018, the effective tax rate of all state and local taxes for oil and natural gas producers was 6.4% in FY 2016-2017. This includes the categories of production tax, property taxes, income taxes and sales and use taxes. The projected direct revenue is derived by using the above effective tax rate multiplied by the annual value of lost oil and gas production.

APPENDIX B - MODEL FRAMEWORK – WWW.REMI.COM

PI+, Tax-PI and TranSight are structural economic forecasting and policy analysis models. The following core framework applies to all REMI model builds. More information about Tax-PI can be found at www.remi.com. The model integrates input-output, computable general equilibrium, econometric and economic geography methodologies. The model is dynamic, with forecasts and simulations generated on an annual basis and behavioral responses to compensation, price, and other economic factors.

The model consists of thousands of simultaneous equations with a structure that is relatively straightforward. The exact number of equations used varies depending on the extent of industry, demographic, demand, and other detail in the specific model being used. The overall structure of the model can be summarized in five major blocks: (1) Output and Demand, (2) Labor and Capital Demand, (3) Population and Labor Supply, (4) Compensation, Prices, and Costs, and (5) Market Shares. The blocks and their key interactions are shown in Figures 1 and 2.

FIGURE 1: REMI MODEL LINKAGES

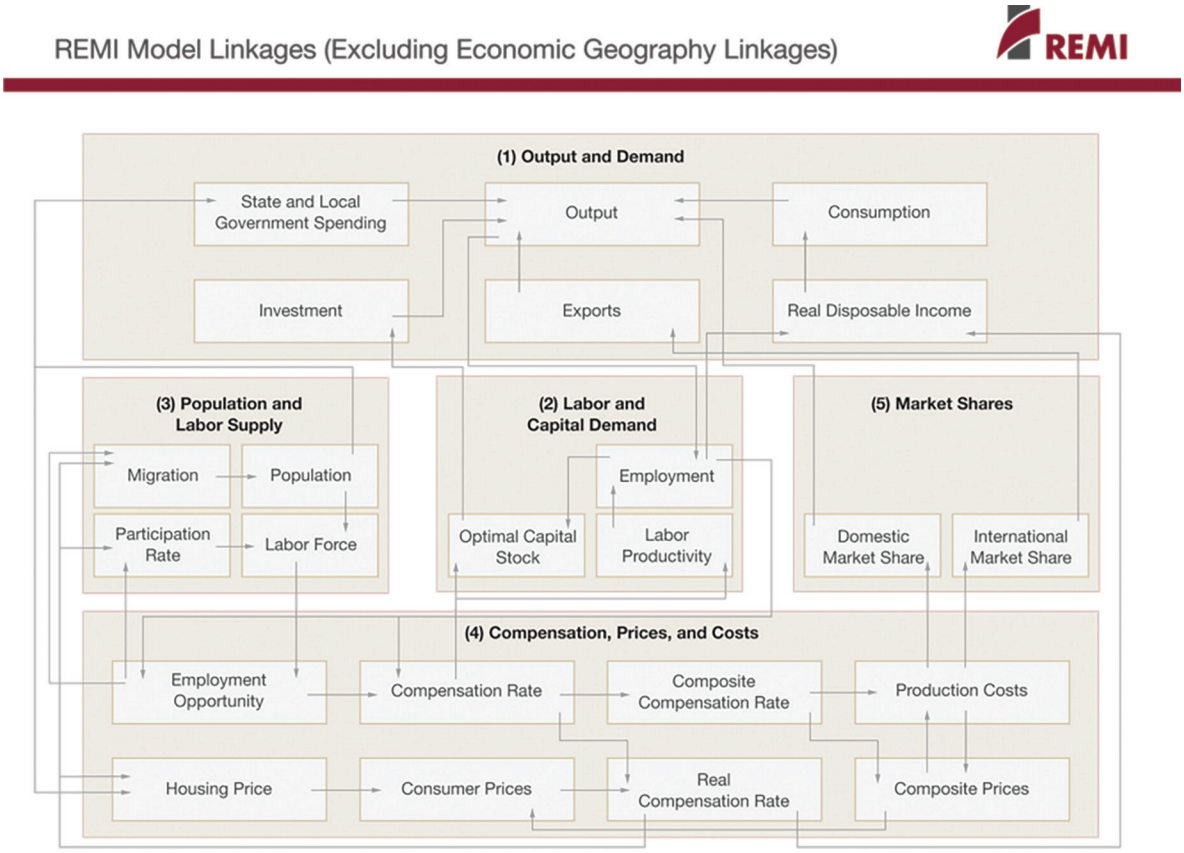
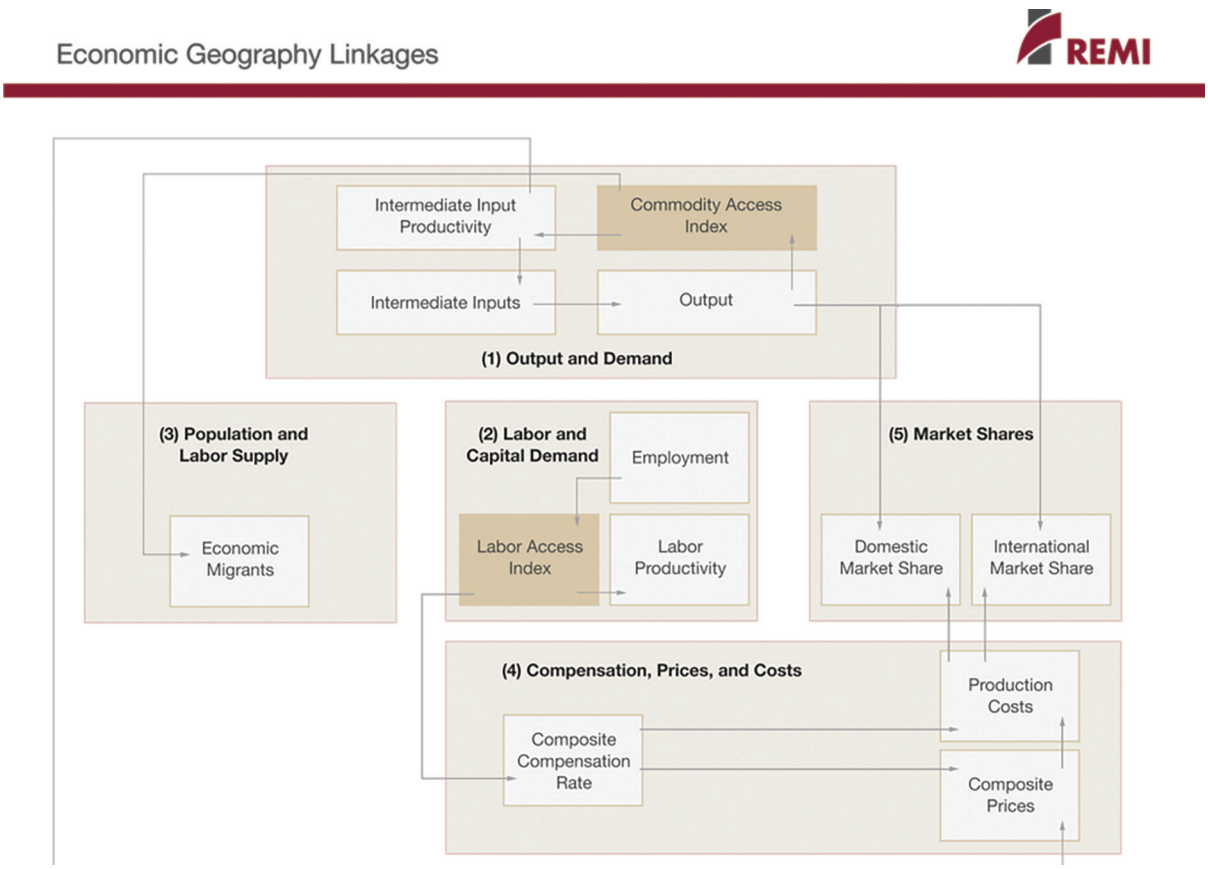


FIGURE 2: ECONOMIC GEOGRAPHY LINKAGES



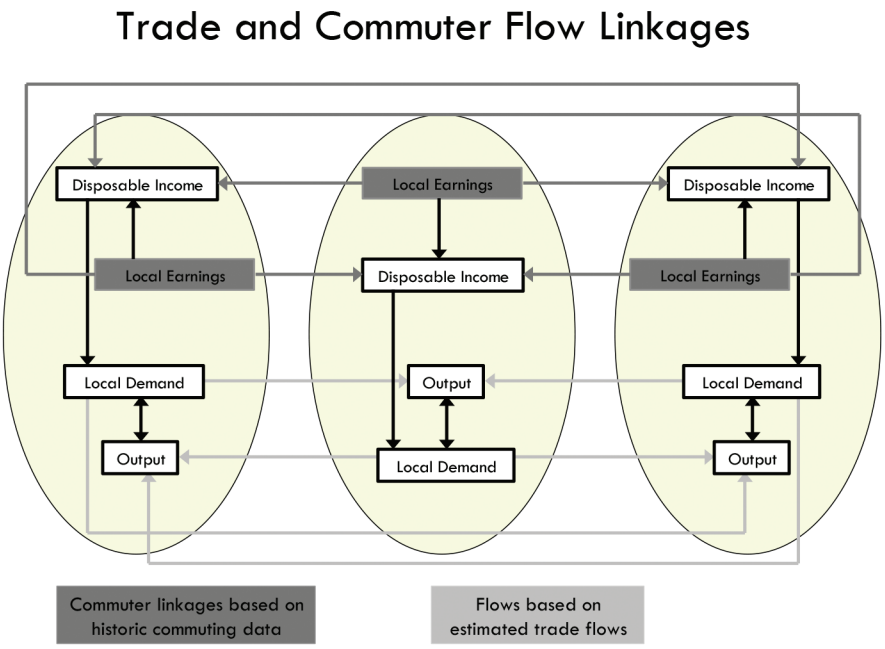
The Output and Demand block consists of output, demand, consumption, investment, government spending, exports, and imports, as well as feedback from output change due to the change in the productivity of intermediate inputs. The Labor and Capital Demand block includes labor intensity and productivity as well as demand for labor and capital. Labor force participation rate and migration equations are in the Population and Labor Supply block. The Compensation, Prices, and Costs block includes composite prices, determinants of production costs, the consumption price deflator, housing prices, and the compensation equations. The proportion of local, inter-regional, and export markets captured by each region is included in the Market Shares block.

Models can be built as single region, multi-region, or multi-region national models. A region is defined broadly as a sub-national area, and could consist of a state, province, county, or city, or any combination of sub-national areas.

Single-region models consist of an individual region, called the home region. The rest of the nation is also represented in the model. However, since the home region is only a small part of the total nation, the changes in the region do not have an endogenous effect on the variables in the rest of the nation.

Multi-regional models have interactions among regions, such as trade and commuting flows. These interactions include trade flows from each region to each of the other regions. These flows are illustrated for a three-region model in Figure 3.

FIGURE 3: TRADE AND COMMUTER FLOW LINKAGES



Multi-regional national models also include a central bank monetary response that constrains labor markets. Models that only encompass a relatively small portion of a nation are not endogenously constrained by changes in exchange rates or monetary responses.

Block 1. Output and Demand

This block includes output, demand, consumption, investment, government spending, import, commodity access, and export concepts. Output for each industry in the home region is determined by industry demand in all regions in the nation, the home region's share of each market, and international exports from the region.

For each industry, demand is determined by the amount of output, consumption, investment, and capital demand on that industry. Consumption depends on real disposable income per capita, relative prices, differential income elasticities, and population. Input productivity depends on access to inputs because a larger choice set of inputs means it is more likely that the input with the specific characteristics required for the job will be found. In the capital stock adjustment process, investment occurs to fill the difference between optimal and actual capital stock for residential, non-residential, and equipment investment. Government spending changes are determined by changes in the population.

Block 2. Labor and Capital Demand

The Labor and Capital Demand block includes the determination of labor productivity, labor intensity, and the optimal capital stocks. Industry-specific labor productivity depends on the availability of workers with differentiated skills for the occupations used in each industry. The occupational labor supply and commuting costs determine firms' access to a specialized labor force.

Labor intensity is determined by the cost of labor relative to the other factor inputs, capital and fuel. Demand for capital is driven by the optimal capital stock equation for both non-residential capital and equipment. Optimal capital stock for each industry depends on the relative cost of labor and capital, and the employment weighted by capital use for each industry. Employment in private industries is determined by the value added and employment per unit of value added in each industry.

Block 3. Population and Labor Supply

The Population and Labor Supply block includes detailed demographic information about the region. Population data is given for age, gender, and race, with birth and survival rates for each group. The size and labor force participation rate of each group determines the labor supply. These participation rates respond to changes in employment relative to the potential labor force and to changes in the real after-tax compensation rate. Migration includes retirement, military, international, and economic migration. Economic migration is determined by the relative real after-tax compensation rate, relative employment opportunity, and consumer access to variety.

Block 4. Compensation, Prices and Costs

This block includes delivered prices, production costs, equipment cost, the consumption deflator, consumer prices, the price of housing, and the compensation equation. Economic geography concepts account for the productivity and price effects of access to specialized labor, goods, and services.

These prices measure the price of the industry output, taking into account the access to production locations. This access is important due to the specialization of production that takes place within each industry, and because transportation and transaction costs of distance are significant. Composite prices for each industry are then calculated based on the production costs of supplying regions, the effective distance to these regions, and the index of access to the variety of outputs in the industry relative to the access by other uses of the product.

The cost of production for each industry is determined by the cost of labor, capital, fuel, and intermediate inputs. Labor costs reflect a productivity adjustment to account for access to specialized labor, as well as underlying compensation rates. Capital costs include costs of non-residential structures and equipment, while fuel costs incorporate electricity, natural gas, and residual fuels.

The consumption deflator converts industry prices to prices for consumption commodities. For potential migrants, the consumer price is additionally calculated to include housing prices. Housing prices change from their initial level depending on changes in income and population density.

Compensation changes are due to changes in labor demand and supply conditions and changes in the national compensation rate. Changes in employment opportunities relative to the labor force and occupational demand change determine compensation rates by industry.

Block 5. Market Shares

The market shares equations measure the proportion of local and export markets that are captured by each industry. These depend on relative production costs, the estimated price elasticity of demand, and the effective distance between the home region and each of the other regions. The change in share of a specific area in any region depends on changes in its delivered price and the quantity it produces compared with the same factors for competitors in that market. The share of local and external markets then drives the exports from and imports to the home economy.

REFERENCES

Baker Hughes . (2018, July). Retrieved from http://phx.corporate-ir.net/phoenix.zhtml?c=79687&p=irol-reportsother

Business Research Division, Leeds School of Business. (2014). Colorado Oil and Gas Industry Updated Economic Assessment of Colorado Oil and Gas Ballot Initiatives in 2014.

Business Research Division, Leeds School of Business. (2016). Colorado Oil and Gas Industry Economic Assessment of 2,500-Foot Oil and Gas Setback Proposal.

CME Group. (n.d.). Crude Oil Futures Quotes. Retrieved from https://www.cmegroup.com/trading/energy/crude-oil/light-sweet-crude_quotes_globex.html

Colorado Department of Public Health and Environment. (2017). Assessment of Potential Public Health Effects from Oil and Gas Operations in Colorado. Colorado Department of Public Health and the Environment.

Colorado Oil and Gas Conservation Commission. (2018). Colorado Ballot Initiative #97 2500' Setback Requirement for Oil and Gas Development GIS-Based Impact Assessment.

Silbaugh, L. (January 12, 2018). Memorandum; Effective Severance Tax Rates on Oil and Gas. Retrieved from https://leg.colorado.gov/sites/default/files/interested_persons_memo_on_severance_taxes.pdf

U.S. Energy Information Administration. (Last Updated July 19, 2018). Colorado State Profile and Energy Estimates.