The Economic, Demographic, Fiscal, and Emissions Implications of a Carbon Fee in Arkansas

Prepared By
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Prepared For
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CCL volunteers and others advocating for carbon fee & dividend in Arkansas

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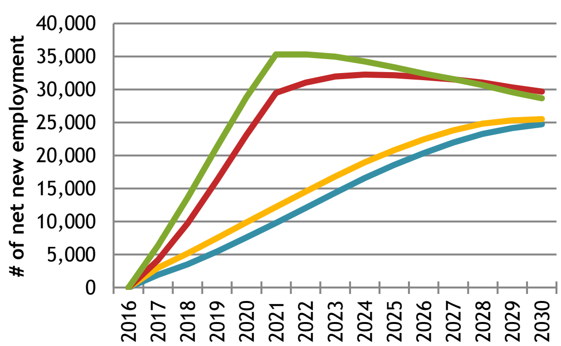
Table of Contents

Executive Summary

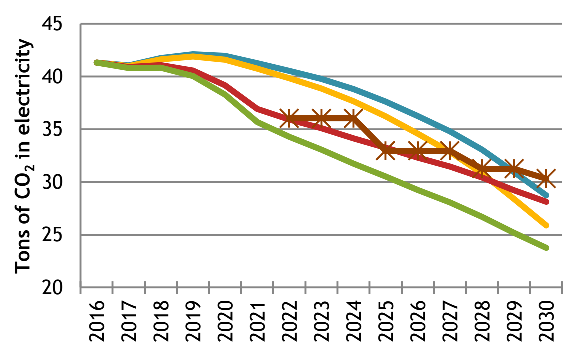
This study examines the potential economic, demographic, fiscal, and emissions impact of a fee on carbon dioxide in Arkansas. The Arkansas chapter of Citizens Climate Lobby (CCL) engaged with Regional Economic Models, Inc. (REMI) in Washington, DC to perform this work. REMI used two primary tools to perform this analysis: PI+, a proprietary though peer-reviewed model of the economics and demographics of subnational units of the United States' economy and the Carbon Tax Analysis Model (CTAM), customized to Arkansas by REMI, an open-source model of carbon dioxide emissions used in numerous previous analyses at the regional and the national level. The REMI PI+ model already sees use in Arkansas by the University of Arkansas-Little Rock (UALR) Institute for Economic Advancement. It was also the model at the center of the economic impact analysis of the Big River steel mill in 2013.[2] REMI PI+ is a choice model in most states for analyzing the impact of policy and has experience with carbon fee-and-dividend studies in Massachusetts, Washington, California, Vermont, Rhode Island, and with the United States overall and countless other policies across the country.

REMI developed eight scenarios with CCL based on three dimensions with two policy designs under each (2x2x2=8). One choice was to include only electricity in the fee towards compliance with the requirements of the Clean Power Plan (CPP) in the state or also to include liquid and gaseous fuels in the fee. The second was regarding tax rates, where one gradually escalated from $15 per metric ton of carbon dioxide in 2017 upwards $10 per year and the other rapidly rose to $150 per metric ton in 2021. The last choice involved the disbursement of the revenues from the carbon fee—the simulations here examined a dividend system to households and employers as well as a second choice to send 25% of the funds to energy efficiency programs in the early years to help with CPP compliance. **All cases increase the total number of jobs and the size of the economy in Arkansas—mostly by reducing imported fossil fuels and through the encouragement of a more labor-intensive industry mixture and added income to households.** The carbon fee also reduces emissions by discouraging the consumption of fossil fuels. All scenarios under examination comply with the goals of the CPP by 2030 and one of them, **below in lime green**, manages all the intermediate goals.

Additional employment in Arkansas from carbon fee and rebates while only charging the fee on electricity consumers in the state



Carbon dioxide in Arkansas implied by demand in millions of short tons, where the brown is the requirements of CPP rules



[2] Lee Hogan, "Lawmakers discuss Big River steel project," *Arkansas Online*, March 25, 2013, <http://www.arkansasonline.com/news/2013/mar/25/lawmakers-discuss-big-river-steel-project/>

"Just the Facts, Ma'am"

Economic
- 20,000 to 30,000 additional jobs over the baseline scenario
- Increased GSP and real disposable personal income (RDPI)

Emissions
- Reduction of 20 to 30 million metric tons per year total
- Power sector emissions are at or below the CPP requirements

Budgetary
- $500 million to $1 billion in the first year, $4 billion long-term
- Monthly rebate to households and employers over $200 per month

Demographic
- The long-term population of the state increases with fee
- Attracted by stronger labor market and the system of dividends

- A strong economy and environmental quality are not mutually exclusive functions
  - In fact, when understood as "mundane" fiscal policy, environmental measures might have some positive effects across the economy
    - **Reduced fossil fuel imports**
    - **Encouragement of localized, labor-intensive industries**
- These results do not depend on a motivation for "why" to put a fee on carbon dioxide
  - Climate "feedbacks" are not an effect in the modeling performed here

Word Cloud


State
Arkansas
Carbon
Industry
Fee
Model
Remi
Figure
Product
Economic
One
New
Energy
Such
Live
Pp
Cost
Job
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Between
Process
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Spend
Rdpi
General
Come
Fall
Up
Two
Liquid
Note
Typical
Cover
Arctam

Introduction

This study examines the various implications and interactions of a fee on carbon dioxide in the state of Arkansas. It includes potential impacts on the Arkansas economy, its demographics, the emissions of carbon dioxide from power generation, plus liquid and gaseous fuels, and the fiscal effects on the state budget. It also considers how a carbon fee in the Natural State would help it comply with the strictures of the EPA's Clean Power Plan (CPP) to reduce the carbon dioxide emitted from existing power plants.[3] The consideration of a carbon fee as a means for Arkansas to comply with the CPP will be a special focus of this report. According to one summary, the EPA specifically included carbon pricing as a compliance mechanism:

> *"The final rule has explicitly allowed a carbon fee as a means of complying with the Clean Power Plan.[4] If states do decide to adopt a carbon fee as their compliance mechanism… A carbon fee could match or even exceed the EPA's emission reduction targets as supported by data from the Energy Information Administration."*[5,6]

This report will focus on a carbon fee to do just that—reduce power emissions in Arkansas—as well as an element of energy efficiency. The revenues from the fee could go to upgrade the state's infrastructure, appliances, housing stock, commercial space, and industrial equipment to use less electricity during operations and for financing of energy efficiency.

Stepping back to provide a synopsis of the policy, a carbon fee is a price placed on energy at some point in the fossil energy supply chain. The price derives from the eventual or implicit carbon dioxide emissions from the use of that of the energy. For an example of this pricing process, imagine a single gallon of gasoline. It weighs around six pounds and when combined with the oxygen in the atmosphere during combustion, it creates around nineteen pounds of carbon dioxide.[7] The nineteen pounds becomes the basis for the carbon fee,[8] and the process is similar with different fuel types. Carbon fees have two objectives: (1) incentivize a reduction in the emissions of carbon dioxide and (2) generating revenues to put towards other policy goals. The former relies on what economists call "price elasticity of demand" or, more simply, the idea that making a good or service more expensive reduces the consumption of the same. This logic derives from the work of Arthur Cecil Pigou, an economist of the early Twentieth Century, the namesake of such "Pigouvian" measures.[9] These dollars can have a large influence on a state's economy on their own, which makes this a further focus of the study. Accounting for both of these effects requires the modeling of regional economic outcomes.

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[3] For EPA's summary webpage on the CPP and a link to the final rule, please see, <http://www2.epa.gov/cleanpowerplan/clean-power-plan-existing-power-plants>
[4] (citation not in original text) Please see ***Table 1*** on, <http://www.c2es.org/federal/executive/epa/q-a-regulation-greenhouse-gases-existing-power>, *Center for Climate and Energy Solutions (C2ES)*, for a compilation of potential compliance avenues for the Clean Power Plan in states
[5] Kate Colwell, "EPA includes carbon tax in final power plant rule," *Friends of the Earth*, August 4, 2015, <http://www.foe.org/news/news-releases/2015-08-epa-includes-carbon-tax-in-final-power-plant-rule>
[6] <http://www.gpo.gov/fdsys/pkg/FR-2015-10-23/pdf/2015-22842.pdf>
[7] Clark Gordon, "How many pounds of carbon dioxide (CO2) does a gallon of gas produce," *The EPIC Energy Blog*, May 24, 2013, <http://epicenergyblog.com/2013/05/24/how-many-pounds-of-carbon-dioxide-co2-does-a-gallon-of-gasoline-produce/>
[8] 1 gallon = 19 pounds = 8.61 kilograms = 0.009 metric tons
[9] For more information on Pigou, please see, <http://www.econlib.org/library/Enc/bios/Pigou.html>

This research takes a different avenue from numerous studies in the field (though certainly not all of them) in analyzing an Arkansas carbon fee as a matter of fiscal and economic development regardless of the climate. **This study does not argue for or against the threats of higher concentrations of carbon dioxide. It does not examine motivations for Arkansas, the United States, or the world for wishing to reduce said emissions (save for the requirements of the CPP).** Climate science has three chief layers of evidence regarding the veracity and immediacy of its claims: (1) the climate is undergoing rapid change, (2) the change is primarily anthropogenic in nature, and (3) its results are a net harm for human wellbeing. However, no system of assumptions or beliefs about these issues has relevance to the results of this study, which looks at a carbon fee in Arkansas purely as a matter of "mundane" budget and tax policy. In essence, what one thinks about climate science and global warming is irrelevant to the economic and fiscal impact study here. It uses the typical tools of the trade for the same, as well, which include price elasticity/static tax and regional modeling.

The Arkansas subdivision of Citizens' Climate Lobby (CCL) engaged with Regional Economic Models, Inc. (REMI) to perform this analysis. It relies on two tools: the Carbon Tax Analysis Model (CTAM)[10] and REMI PI+. CTAM, customized here into "ARCTAM" for Arkansas by REMI, has had widespread adaptation across the United States for carbon pricing issues, including its original version for Washington,[11] Oregon,[12] and numerous states in New England in other REMI carbon pricing studies.[13] CTAM draws most of its underlying data and assumptions from the Annual Energy Outlook (AEO)[14] produced by the Energy Information Administration, which are themselves products of a model called NEMS (the National Energy Modeling System).[15] NEMS is really a series of models that handles the "upstream" of the energy supply chain, including resource endowments, extraction, the pipeline network, electricity generation, and the power distribution system. CTAM adapts the AEO data from NEMS to show changes in the end-use consumption of energy when final users see different prices. This data integrates with PI+, an economic and demographic model of subnational units of the United States' economy, which shows macroeconomic changes such as job creation or economic growth.

The remainder of this report covers several sections on the policy design, simulations, and the methodologies of the models. Prior to digging into the core of the carbon fee simulations with the linkage of the ARCTAM and Arkansas PI+ models, we will discuss the "economic base" of the Arkansas economy and its current nature in terms of employment and industry mixture. The policy design section after that discusses the exact policies modeled here for the state economy and towards compliance or noncompliance with the CPP. The final, appendix section looks at the workings of PI+, the variables chosen to run these simulations, and provides more data on the linkages and initial sources for the ARCTAM model used here.

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[10] For a template in Microsoft Excel, please see, <http://daily.sightline.org/files/2011/08/Washington-State-Carbon-Tax-Analysis-Model.xls>

[11] <http://www.commerce.wa.gov/Programs/Energy/Office/Topics/Pages/Carbon-Tax.aspx>

[12] Jenny Liu and Jeff Renfro, "Carbon Tax and Shift: How to Make It Work for Oregon's Economy," *Portland State University – Northwest Economic Research Council (NERC)*, March 1, 2013, <https://www.pdx.edu/nerc/sites/www.pdx.edu.nerc/files/carbontax2013.pdf>

[13] <https://www.dropbox.com/s/x1n8tlczls5ya03/REMI%20Carbon%20Tax%20Literature.zip?dl=0>

[14] Available online, please see, <http://www.eia.gov/forecasts/aeo/>

[15] For a summary, please see, <http://www.eia.gov/oiaf/aeo/overview/>

Arkansas Economy (2013)[16]

Category	Data
Population	2.96 million
Labor Force	1.33 million
Total Employment (# of jobs)	1.58 million
Private Nonfarm Employment (# of jobs)	1.29 million
Gross State Product (GSP)	$122.2 billion
Real Disposable Personal Income (RDPI)	$102.2 billion
RDPI per capita	$34,500 per capita

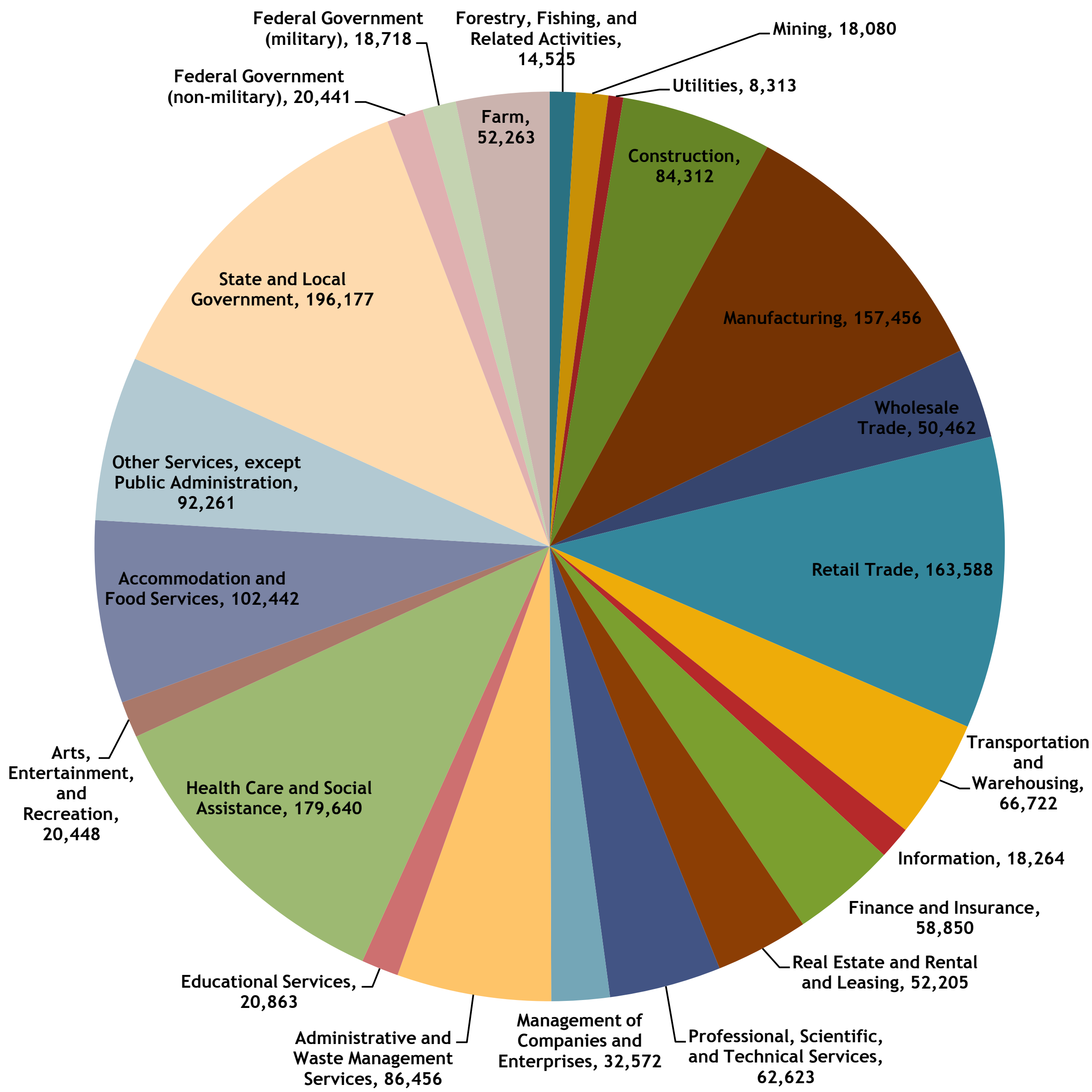
The figures above describe the current, actual Arkansas economy and its demographics from historical data. These concepts will be central towards the understanding of the results of this study and putting them in context of the Natural State as it is. Defining each of them with some commentary on their interactions in the REMI model will come before an examination of the industry and employment mixture of the state on the following pages:

- **Population** – Population is the total number of persons living in Arkansas. The nature of the underlying demographics has a strong influence on the development of any state, and it changes over time due to natural change (the net of births and deaths) and the mobility of labor within the United States.
- **Labor Force** – The labor force of a state is its number of young adults or adults with a job or currently seeking one. The growth of the labor force determines the number of available workers to hold jobs, pay taxes, and undertake new enterprises in the region. The labor force is how the population interacts with the economy and can change in a drastic manner from migratory activity between the states.
- **Total Employment** – In REMI PI+, this is the number of jobs in the economy. This is different from the number of individuals holding a job. The former concept relates to the Bureau of Labor Statistics' (BLS) definition of employment and their monthly releases for the number of jobs created.[17] The latter definition of employment, the number of jobs instead of the number of people holding a job, is from the Bureau of Economic Analysis (BEA) and is the one in the REMI model. This number counts labor units, such as one person holding multiple jobs, as many jobs rather than one person.[18]
- **Private Nonfarm Employment** – These are the jobs from the previous category subtracted from the government and farm jobs. In Arkansas, over 85% of the workforce is in the private sector save 235,000 government workers.
- **Gross State Product (GSP)** – The equivalent to gross domestic product (GDP) only for the state, GSP is the sum of all new economic activity in a year.
- **Real disposable personal income (RDPI)** – RDPI is REMI's calculation of the consumer income, minus taxes, and adjusted for the cost of living.

[16] All figures and data from 2013, the last history year (LHYR) available at the regional configuration
[17] For the most recent release, please see, <http://www.bls.gov/news.release/laus.nr0.htm>
[18] For more detail, please see, <http://www.bea.gov/faq/index.cfm?faq_id=104>

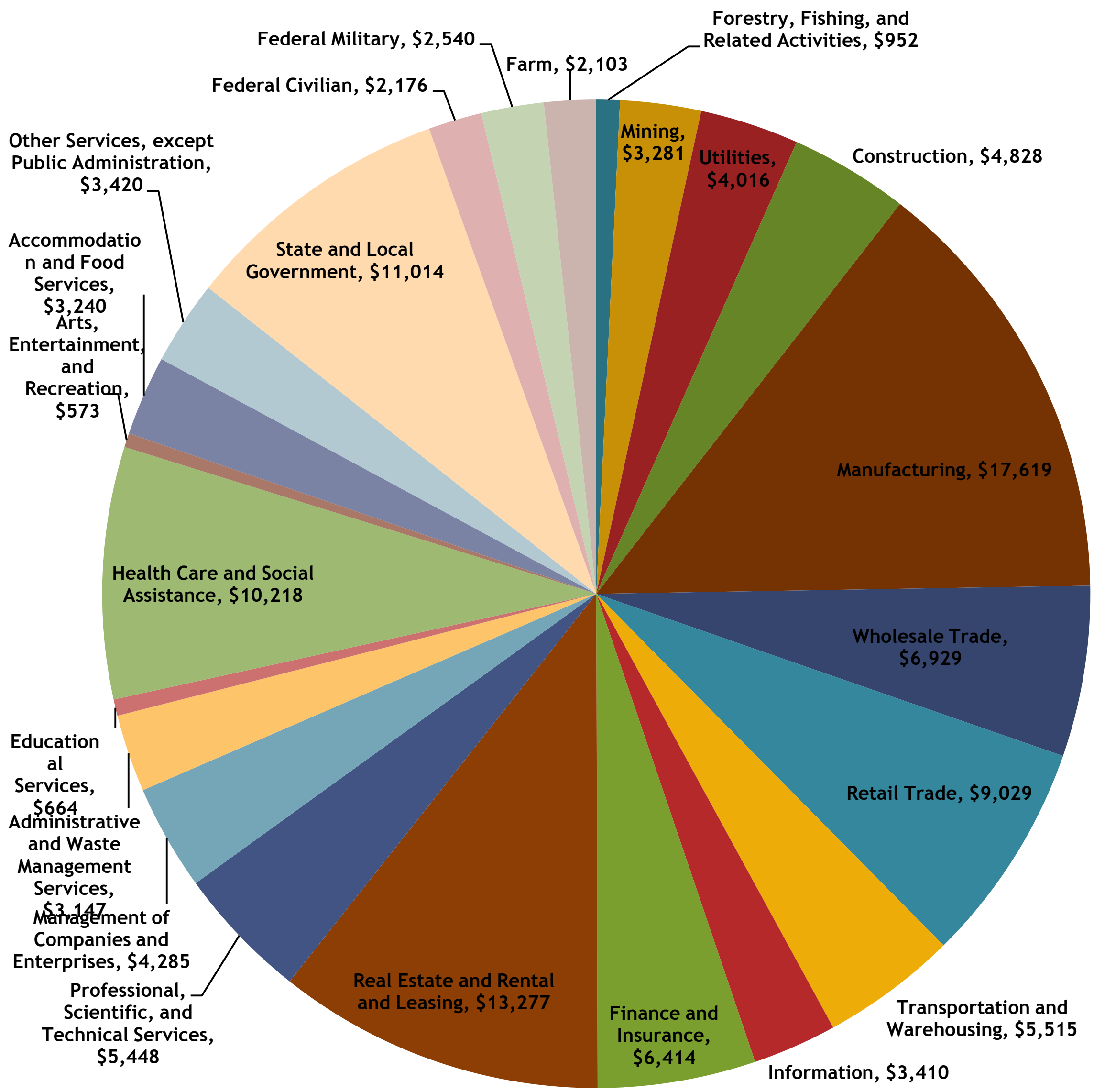
Arkansas Employment Mixture (# of jobs)

The below shares and figures describe the distribution of the 1.58 million jobs in Arkansas amid major economic sectors. The largest sector is the state and local governments, though healthcare is a close second with manufacturing industries, retail trade, accommodation/food services, and construction not far behind. **One thing to note, particularly relative to the data in the following pages, is the relatively small part in the Arkansas labor market played by the mining (18,000) and utilities sectors (8,300).** Also, note the domination of the labor market by commercial and service sectors, where 79% of workers in the state have jobs in the sectors clockwise from wholesale trade through to the government sectors. This is in contrast to the data on GSP by industry in Arkansas, which invites a conversation on labor productivity on the reading of the herein carbon fee and CPPC results section.



Arkansas Industry Mixture (millions of 2015 dollars in GSP)

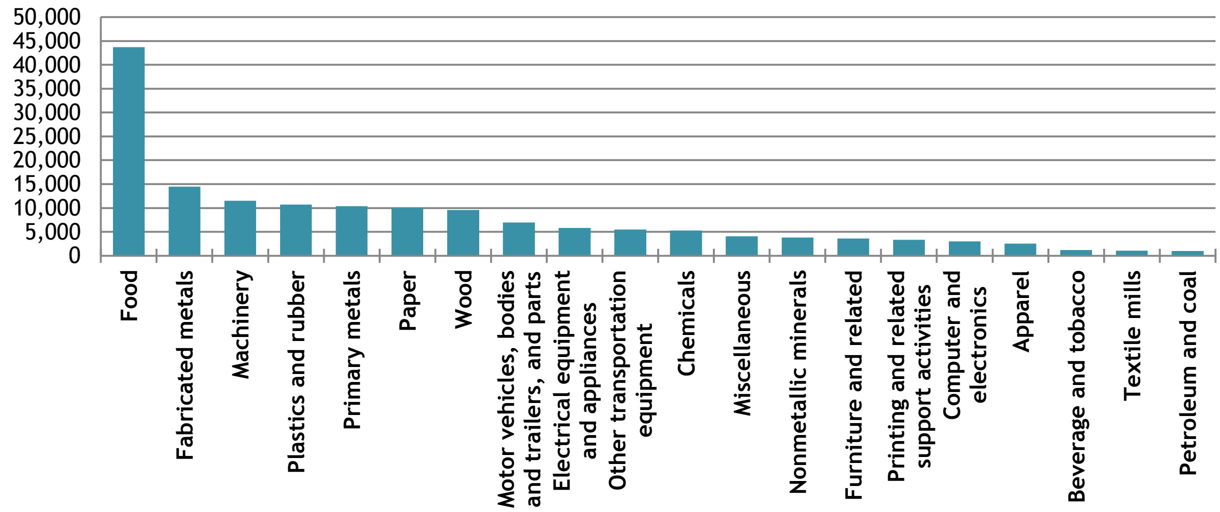
GSP by industry presents a different picture. Several industries with a relatively small number for employment generate a large output because of their higher productivity. Manufacturing or real estate rentals are prime examples of these sorts of industries. The larger share of the pie for the "industrial" sectors (as opposed to commercial) from farm clockwise to manufacturing is because of their technology and production processes. Modern manufacturing involves a high degree of automation where capital inputs—machines, equipment, software—do most of the work while humans design and maintain their functioning. Healthcare and government, on the other hand, require more human hands and minds for day-to-day instruction activities or for diagnosis and treatment. The difference in labor productivity between sectors will greatly inform the results to employment and GSP in the results section of this report.



Arkansas Manufacturing Industry

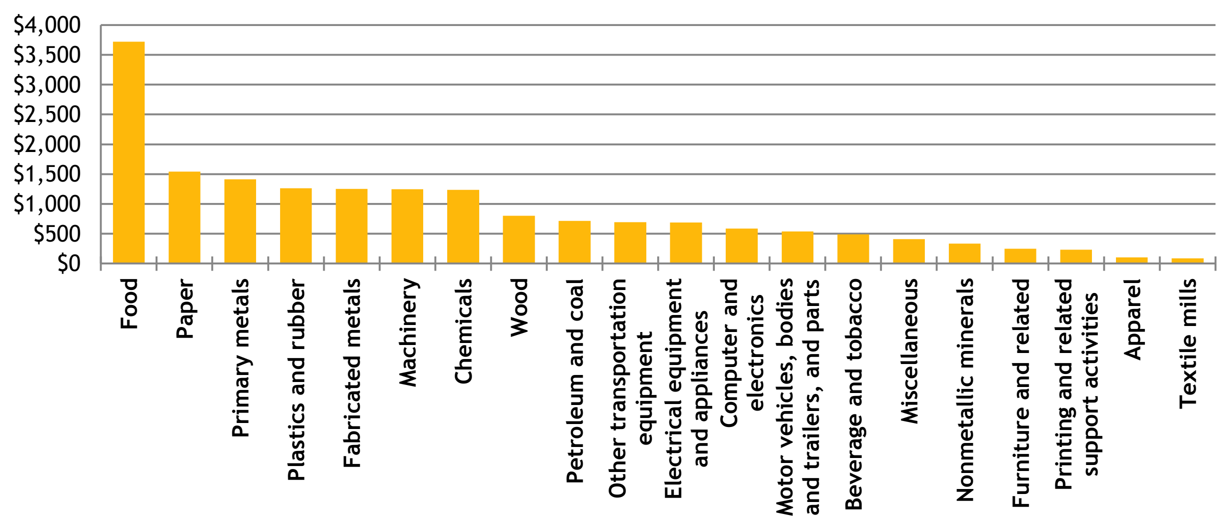
Employment (# of jobs)

Industries in REMI PI+ and the government data are hierarchical—as with a set of Faberge eggs, the largest "egg" on the outside contains subdivisions within it. The below breakouts are for the general manufacturing sector down into its component parts. Speaking of eggs, the largest of the manufacturing sectors in Arkansas in terms of employment is food, which includes pet foods, milling, processed foods, preserving, dairy products, meatpacking, and baking. Food products dwarf even the next few largest categories in the state such as metal goods.



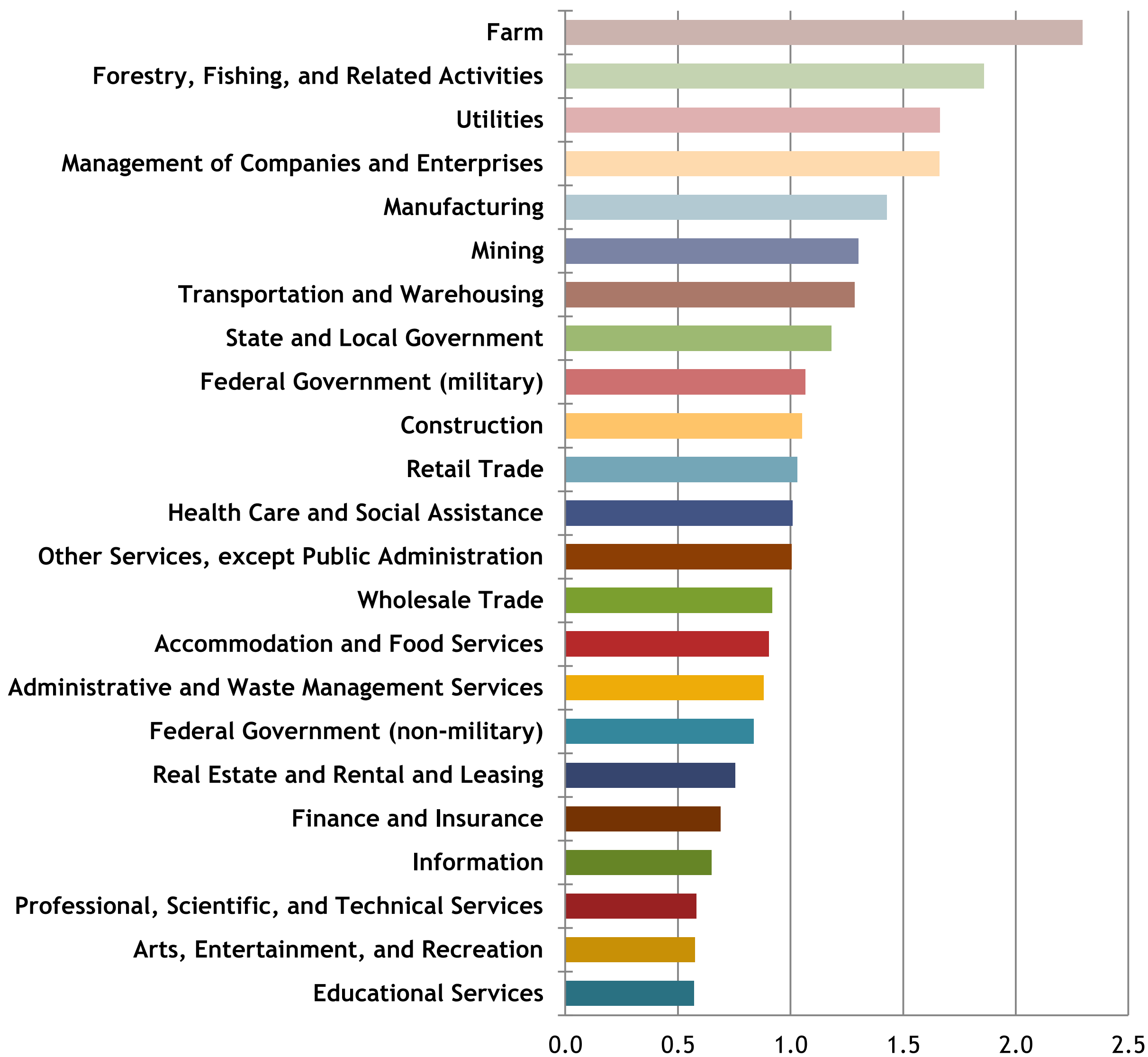
GSP by Industry (millions of 2015 dollars)

The GSP by manufacturing industry shows a similar but different story. Food manufacturing is still the largest subsector; however, food processing is a relatively labor-intensive industry for manufacturing, which means its lead is far less than last time. Petroleum and coal product goes from dead last to the middle of the pack for its high productivity.



Arkansas Location Quotients

The figure below describes the location quotients (LQs) for Arkansas' industry mixture. An LQ is the ratio of how important an industry is in a regional economy relative to how important it is in the United States overall. The LQ of 2.0 implies an area has twice as much of an industry for its size than the United States has relative to its $17 trillion GDP. Farms, forestry, utilities, and then management of companies and enterprises have large "concentrations" in Arkansas relative to their size at the national level, though they are all still relatively small industries in terms of the state's total employment and GSP contributions. Regarding management, Arkansas is the home base of six Fortune 500 firms (a large number for a state this size): Dillard's, J.B. Hunt (the trucking company), Murphy Oil, Tyson Foods, Wal-Mart, and Windstream.[19] The size and scale of the industry mixture and LQ data matches up with this list, though only manufacturing has a high concentration in the state while remaining a relatively large industry.



[19] Please see, <https://www.buyandhold.com/bh/en/research/states/AR.html>

Policy Design

There are several dimensions of comparison to this study and its policies. This is to quantify the sensitivity of the Arkansas economy to various measures and the complex series of interactions between the economy, demographics, taxation, energy, regulation, and the environment behind these issues. Each of these may react differently to varying stimuli such as the rate of the carbon fee under consideration or the "recycling" of the revenues back into the state economy or within the state budget. The main dimensions of analysis include the following:

- **The fee rate** – The fee rate is the actual charge on actual or implicit carbon dioxide emission in the state. This directly influences the price response to the fee as well as the expected revenues into a state fund for other applications.
- **The revenue recycling** – Once the money comes into the state, it has to go towards some other fiscal or policy priority. Unlike a federal study, the revenues cannot cover "deficit reduction" as Arkansas has a constitutional obligation to maintain a balanced budget—a requirement it will continue to have with or without a carbon fee.[20] Hence, all collected funds must return, or "recycle," into the state economy with a combination of marginal rate cuts, rebates, expanded tax exemptions or expenditures, or using the monies for some new appropriation from the state budget. These will all have a strong influence on the eventual economic outcome for the Natural State.
- **The fee's coverage** – The coverage involves what carbon dioxide (or equivalent) is a part of the fee. This might include which sectors of the economy to cover (the residential sector versus businesses and industry, or the public and the private sectors), which types of energy to involve (electricity and including or not including liquid and gaseous fuels for heating and transportation), and if to involve gases besides carbon dioxide alone. Within this white paper, we confine things to CO_2 alone—there is no "CO_2-equivalent" concept added to the fee. Some states may wish to concentrate only on certain sectors, such as New England states leaving electricity out of its carbon fee because of potential interference with the Regional Greenhouse Gas Initiative (RGGI).[21]
- **Relationship to the Clean Power Plan (CPP)** – This aspect of the policy design is not so much an explicit, legislative requirement of certain fee rate or a set of revenue recycling options so much as a consideration of how PI+ and ARCTAM's results relate to the requirements of the CPP. The CPP includes the option for energy efficiency, which the EPA describes as, "reducing demands on power plants is a proven, low-cost way to reduce emissions, which will save consumers and businesses money and mean less carbon pollution."[22] Energy efficiency is a route to compliance with the mass-based goal of the CPP for Arkansas. This research endeavors for the carbon fee to comply with energy efficiency in two regards: (1) the price reducing the demand for electricity, and

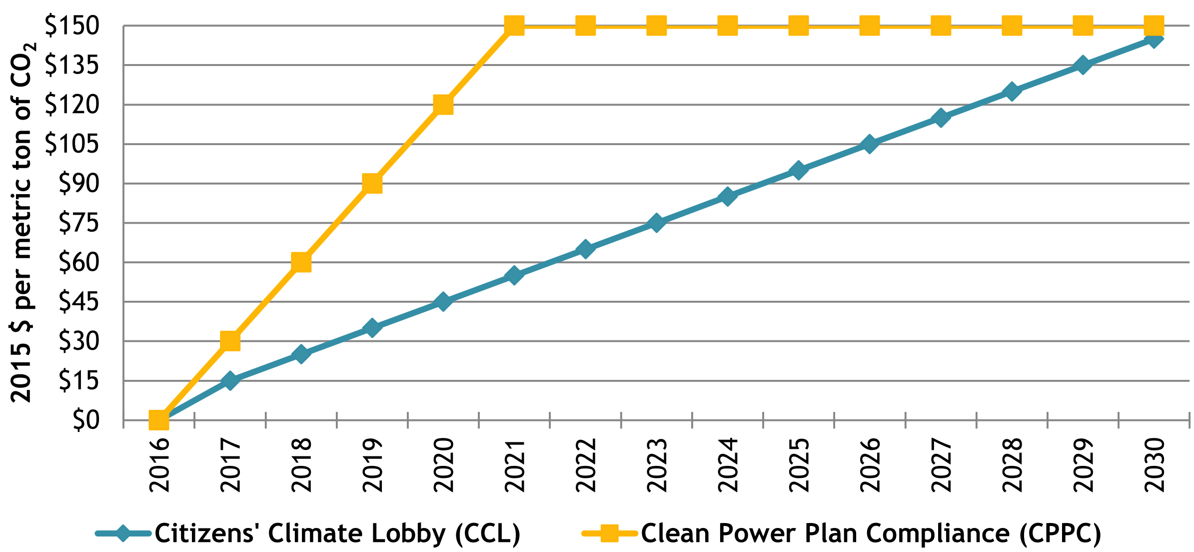
[20] 49/50 states (save Vermont) have a constitutional requirement to balance their budget, which means this study does not need to examine deficit relief as an aspect of this policy as the baseline for Arkansas' future will already contain a balanced budget, please see, <http://www.ncsl.org/research/fiscal-policy/state-constitutional-and-statutory-requirements-fo.aspx>

[21] Such as in a similar REMI study regarding a carbon fee in Rhode Island, please see, <http://www.rifuture.org/study-shows-carbon-tax-would-bring-2000-jobs-to-ri.html>

[22] Formerly known as a "building block," now more general, "EPA Factsheet: Clean Power Plan," <http://www2.epa.gov/sites/production/files/2014-05/documents/20140602fs-setting-goals.pdf>

thereby reducing power emissions, and (2) providing revenues the state might devote towards more programs. Such programs might include weatherization or upgrading old cooling equipment, for instance. Hence, this sidesteps the potential for a rate-based goal for the mass-based goal only. For the purposes of this carbon fee, this is because of the CPP's requirement for state-by-state compliance with its rules. States are administrative and political boundaries, but they, with a few major exceptions,[23] do not reflect the engineering fundamentals of the electrical grid and its transmission between power generation and end-use consumers. This makes a carbon fee placed on generators in only a small section of a transmission union (with Arkansas in the Midcontinent Independent Operator System, MISO)[24] have potential to cause "leakage" of emissions from Arkansas to neighboring state's plants in Oklahoma or Louisiana.[25] EPA would not allow the leakage of emissions into other states to comply with the CPP, so this study looks at the carbon fee as a means to cause efficiency from consumers' natural price response and programs. Looking at a rate-based way to comply with CPP in Arkansas would be an important topic for future modeling of that sector.

Fee Rate



In order to perform a sensitivity analysis and cap the theoretically unlimited number of rates and scenarios, we have focused on two rate algorithms. The first is the rates favored by CCL in their proposed national legislation. The rate begins at $15 per metric ton of carbon dioxide in

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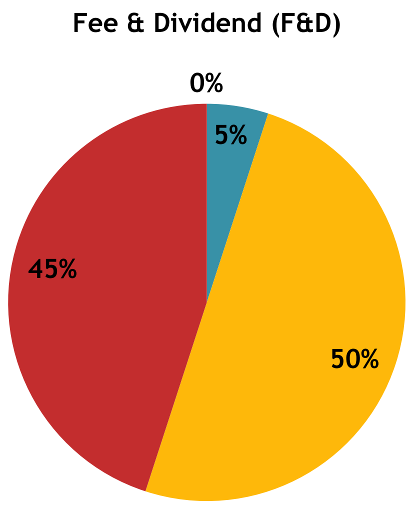
[23] California, New York, and Texas being the most likely exceptions

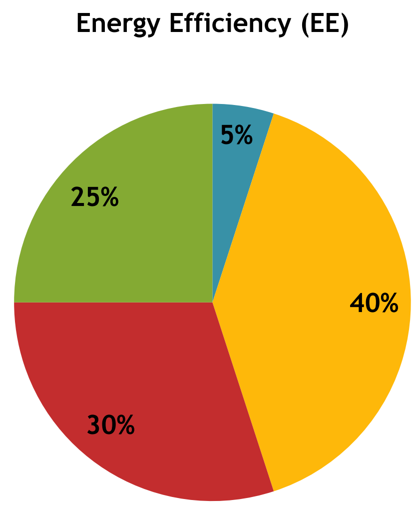
[24] See map and description by Mike Jacobs, "Electricity Grid Progress since August 2003 Blackout," *Union of Concerned Scientists (UCS)*, August 12, 2013, <http://blog.ucsusa.org/electricity-grid-progress-since-the-august-2003-blackout-202> and <http://blog.ucsusa.org/wp-content/uploads/2013/08/ISOs-of-US-map.png> for Arkansas' placement in both MISO and Southwest Power Pool (SPP)

[25] For a fuller description of this problem for Massachusetts within the New England Independent Operator System (NEISO), please see Marc Breslow, Sonia Hamel, Patrick Luckow, and Scott Nystrom, "Analysis of a Carbon Fee or Tax as a Mechanism to Reduce GHG Emissions in Massachusetts," prepared for the Massachusetts Department of Energy Resources (MA DOER), December 31, 2014, pp. 30-42, <http://www.mass.gov/eea/docs/doer/fuels/mass-carbon-tax-study.pdf>

the first year followed by a gradual escalation of $10 per year through at least the 2030s.[26] It culminates at $145 per metric ton in 2030 here (the sunset of this analysis). The second line is for a rapid escalation of the carbon fee, starting at $30 per ton and increasing $30 per year, until it plateaus at $150 per ton in 2021. Its figures derive from internal testing on what rates of consumer carbon fees in the electricity sector would lead to full compliance with the CPP in the state of Arkansas. Both sets of rates "phase in" to allow consumers and businesses some time to adjust to the new prices, and both cases include indexing to prevent inflation from eroding the real value of the fee in the future (as with the federal excise tax on motor gasoline).[27] These two options then combine with two further options on revenues.

Revenue Recycling





- **Administration and Overhead** – An assumed 5% cost to the state for the collection of the fee and the redistribution of the funds back into the state economy
- **Rebates to Households** – Monthly checks or direct deposits to individuals and households in Arkansas to rebate revenues back to the public
- **Rebates to Employers** – Similar to the rebate to households though paid to employers in the state (either public sector or private sector, nonprofit and for profit alike) either as a monthly rebate check or through the state tax system
- **Energy Efficiency Programs** – Funds appropriated by the state towards various energy efficiency programs to further reduce energy demand and emissions

The F&D case always follows the distribution on the left. The EE case follows the distribution of the funds on the right from **2017 to 2021 before transitioning into the distribution** from the F&D case from 2022 forward—four total of 2x2 (rates, recycling).

[26] For the draft, please see, <https://citizensclimatelobby.org/wp-content/uploads/2014/10/Carbon-Fee-and-Dividend-July-2015.pdf>

[27] Last raised in 1993 to $0.184 per gallon and since losing 40% of its real purchasing power to inflation, please see Elia J. Peterson, "Inflation Indexing the Federal Gas Tax," *Tax Foundation*, October 24, 2013, <http://taxfoundation.org/blog/inflation-indexing-federal-gas-tax>

Motivations and Implementation

While this study is not an explicit discussion of the implementation of a carbon fee in Arkansas (or in any state), some description of the same should help the reader imagine such a policy "on the ground." We assumed a 5% overhead cost for the collection, administration, and remittance of the carbon fee. This number may be high;[28] however, we felt a conservative estimate on the administrative costs was best. The rebates to households are, again, an idea taken from the CCL national proposal.[29] This would return money to households in order to help them pay for higher energy costs or spend the money on their other wants and needs. A rebate on a monthly basis has the added feature of rising and falling with seasonal energy demand. When energy demand is the highest (and, consequently, revenues) in the summer with air conditioning and winter with indoor heat, the rebate checks are the largest and their smallest during the relatively low demand spring and autumn. This design prefers a rebate to a cut in marginal rates because of the former's ability to reach those without a job (such as the young, unemployed, or retirees) and for increased rebates proportional to family size (1 share to adults, ½ share to children under 18). The rebate to employers returns money to firms and groups in the state based on their share of employment adjusted for full-time equivalency (FTE). If a business employs 158 FTEs of the 1.58 million jobs in the state, they receive 0.01% this rebate. Relying on rebates to groups and organizations with employees allows this recycling option to cover nonprofits and the public sector, which do not have tax liability and do not benefit from a change in the rates of the corporate tax system. The efficiency programs go towards the construction and renovation industries, which will have their own macroeconomic effects.

Fee Coverage

	F&D	EE
CCL	Case (1)	Case (2)
CPPC	Case (3)	Case (4)

The rates (on the y-axis, row headers) and revenue recycling options (on the x-axis, column headers) combined create four cases. Their numbers are 1, 2, 3, and 4 above, and the colors (from blue to green) stay consistent through the report. On top of this 2x2 flat, 2D matrix of cases, **we then add a third dimension on the coverage of the fee.**

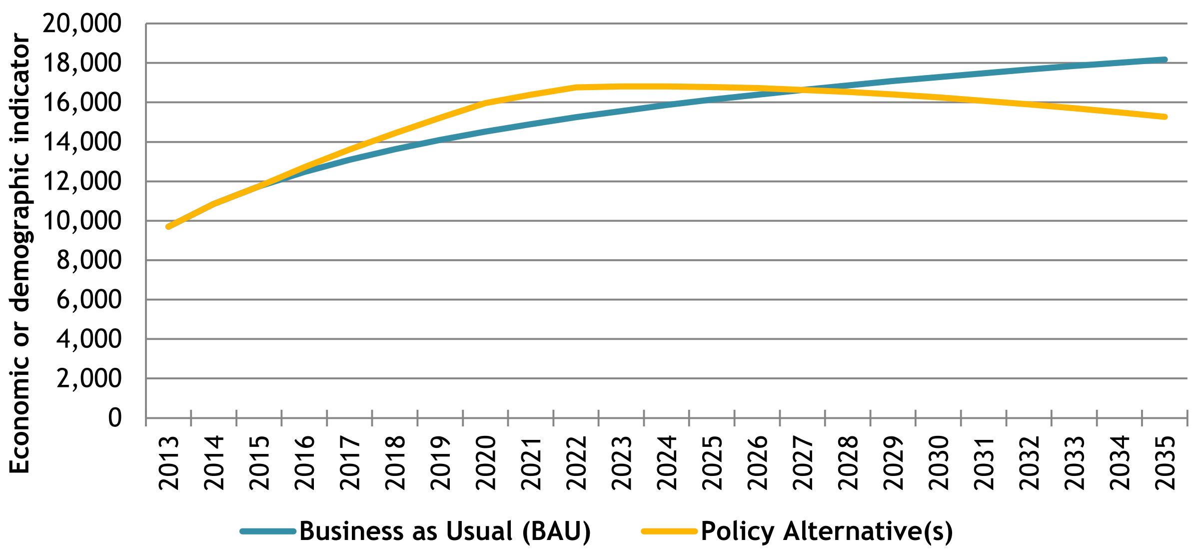
The first part of the results section will concentrate on CPPC and look only at a fee affecting the consumption of electricity. It will not include a fee on liquid or gaseous fuels such as natural gas or various petroleum products. After that, the second part of the results section will examine a more "generalized" carbon fee that includes electricity, natural gas, and petroleum products with the same fee rates. This creates a 2x2x2 cube with eight sets of results, though only four of them will see particular discussion at any one time in this white paper.

[28] For instance, the budget of the Internal Revenue Service (IRS) is $12 billion, which performs the complicated task of administering the individual and corporate income tax codes and processing hundreds of millions of tax returns to bring in $2.4 trillion in revenues—or 0.5% overhead
[29] Also similar to the Alaska Permanent Fund, <https://pfd.alaska.gov/>

The Clean Power Plan

Another consideration of this modeling is the choice of a "baseline." The baseline comparison in an economic model is the "do-nothing" case (similar to a null hypothesis in statistical analysis). It describes the natural development of an economy given fundamentals such as demographics, productivity, industry clusters, and natural resources. The baseline situation in a model is the economy going forward, without external shocks, which then becomes a comparison within the simulation of a policy (such as a carbon fee or the CPP). For instance, the baseline of the REMI PI+ model anticipates a faster growth rate in Washington than in Massachusetts, despite their similar sizes and industry mixtures in Seattle and Boston, because Washington is a younger state, attracts more international and domestic migrants, and therefore has a faster growth rate in its labor force. Massachusetts is, comparatively, older and has a more stagnant labor force. That is the baseline. The purpose of the simulations in ARCTAM and PI+ are to see what might happen if the Commonwealth implemented policies to catch up to the Evergreen State. These might include items to make the Bay State more attractive to migrants, such as tax reform, more availability on the real estate market, or better transportation.

This shows the baseline versus the alternative concept, where the "impact" attributable to a policy in the model is the vertical difference between the two lines over time. This policy change is better (gold over blue) through 2028 though an inferior choice in the long-term.



For our simulations here, the do-nothing baseline is not the only possible alternative. A model with a do-nothing baseline absent the CPP is one possibility. Another option is "defaulting" to a carbon-credits trading program (one run by federal agencies) between states that comes about if a state does not issue its own implementation plan under the CPP. Development of a baseline that describes the second is tricky. The final CPP rule is out; however, it is unclear what each individual state will do towards compliance, the potential reactions of their general economies and power sectors, and how much coordination might come about in organizations such as RGGI. Despite this, a number of groups have modeled the impact of the CPP at the national level of the economy and electricity rates under various sets of assumptions. We developed our own "do-nothing with CPP" baseline by examining the rate impacts in other studies, averaging those more generous[30] and those most conservative,[31] and running our own simulation in REMI PI+ here. This updated the baseline for the United States, and Arkansas in particular, to have approximately 10% higher electricity costs than it would have otherwise. This creates a new baseline for comparison to the results of the carbon fee policies here. We will include these differences for comparison for major indicators, such as total employment or GSP, though not for all detailed results for the sake of reporting brevity.

Simulation Results

Economics

- Total employment, gross state product (GSP), and real personal income
- Details by industry, occupational category, and over time (by year)

Emissions

- Projected carbon dioxide released from economic activity and efficiency
- Relationship to and compliance options with the Clean Power Plan (CPP)

Budgetary

- Revenues from the carbon fee for recycling back into the state economy
- Size of rebates per person or rebates per employee from revenues

Demographics

- Long-term change in state population under various policy options
- Responding to labor market fundamentals and the quality of life

The results of the simulations from PI+ and ARCTAM cover the economy, emissions, the impact on the state budget, and demographic implications. **The models simulate the net impact of the implicitly higher end-use energy costs of the carbon fee versus the benefits of increased consumer spending (from the F&D), efficiency programs, and the rebate to employers and its influence on operating costs.** Thus, they account for both positive and negative aspects of these policies in terms of the incentives introduced into the economy of Arkansas and the long-term performance of its emissions, budget, and demographics. Within the model, the business as usual (BAU) "baseline" represents the general drift of the economy absent the policies described here or other internal shocks, and the potential positive or negative outcomes from the policy represent a *ceteris paribus* change against the "null hypothesis of the

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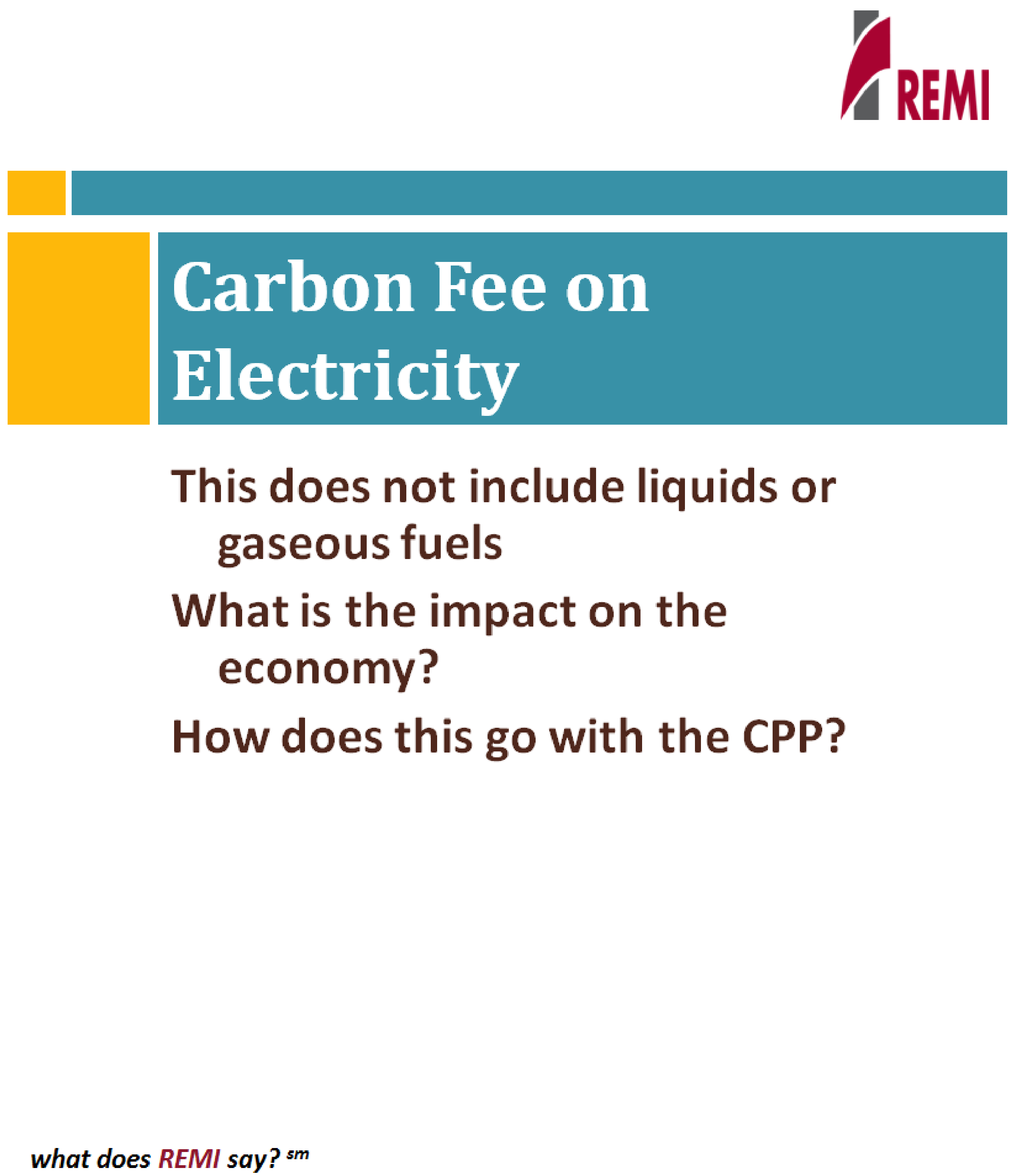
[30] "EPA projections also show that electricity bills will rise modestly by 2.4% to 2.7% in 2020, but then decline by 2.7% to 3.8% in 2025, and 7.0% to 7.7% in 2030," quoted in "How Much Will the Clean Power Plan Cost," *Union of Concerned Scientists (UCS)*, <http://www.ucsusa.org/global-warming/reduce-emissions/how-much-will-clean-power-plan-cost#.VkC_lb_tCPU>

[31] David Harrison, Anne Smith, Paul Bernstein, Scott Bloomberg, Andrew Foss, Andrew Stuntz, and Sugandha Tuladhar, "Potential Energy Impacts of the EPA Proposed Clean Power Plan," *National Economic Research Associates (NERA)*, October 2014, <http://americaspower.org/sites/default/files/NERA_CPP%20Report_Final_Oct%202014.pdf>

BAU baseline. Most of the results are against this baseline, though there are instances where a direct comparison between baseline and alternative is appropriate.



Carbon Fee on Electricity Only

Employment

Figure 1.1 *– All carbon fee cases (the blue down to green, not including brown) show a net increase in the number of jobs in the state. There are two main reasons for this, which we will discuss in the ensuing section in detail. The default 10% increase in electricity prices has a slightly negative influence on the Arkansas state economy, in comparison below.*

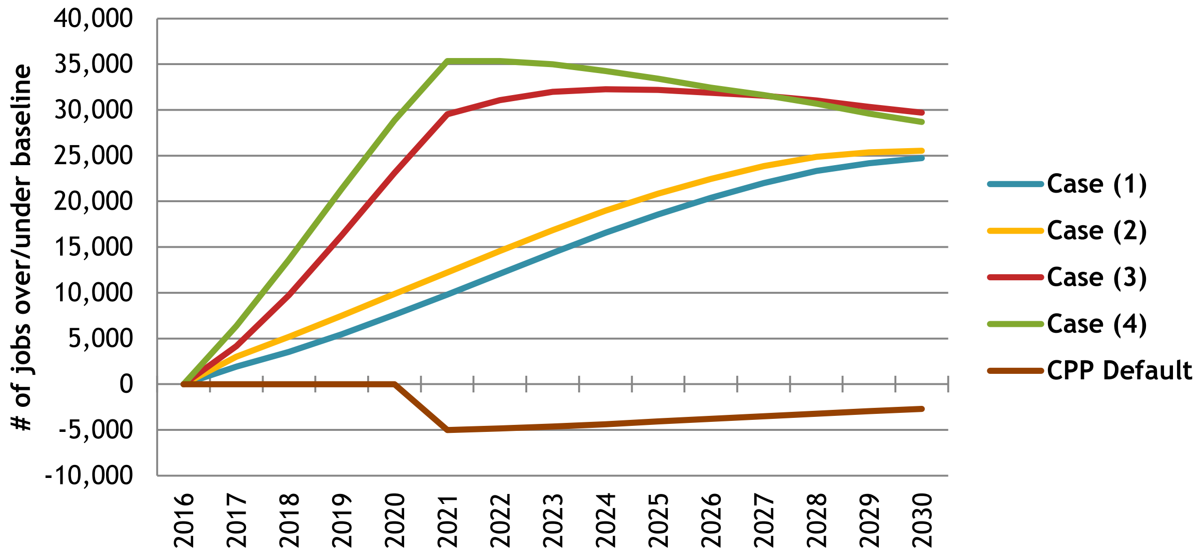
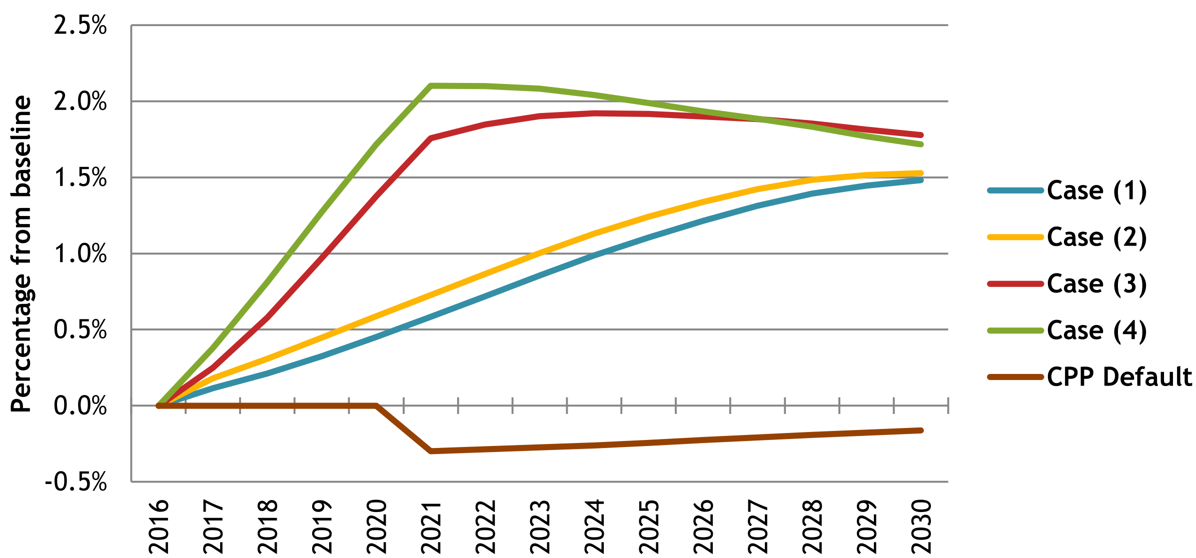


Figure 1.2 *– While the numbers below are sizeable, remember them in the context of the 3 million people within the Natural State and its 1.58 million jobs. Adding 30,000 jobs in that context, particularly over the course of twenty years, is only between a 1.5% and 2.0% change in the long-term. This is a relatively small change to the Arkansas economy overall.*



Gross State Product

Figure 1.3 *– This is the result for the size of the state economy as measured by GSP. The Arkansas economy is larger with the fee and rebates than in the baseline, increasing by as much as $1.5 billion per year in cases (3) and (4) or $1.0 billion per year for cases (1) and (2) around 2030. This is comparatively less than the impact on total employment.*

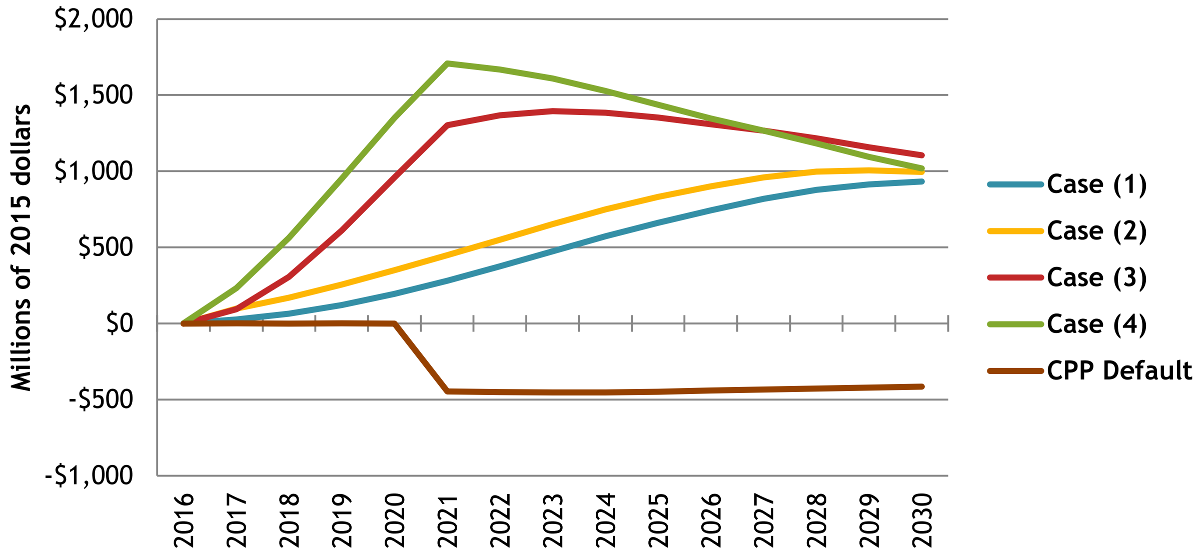
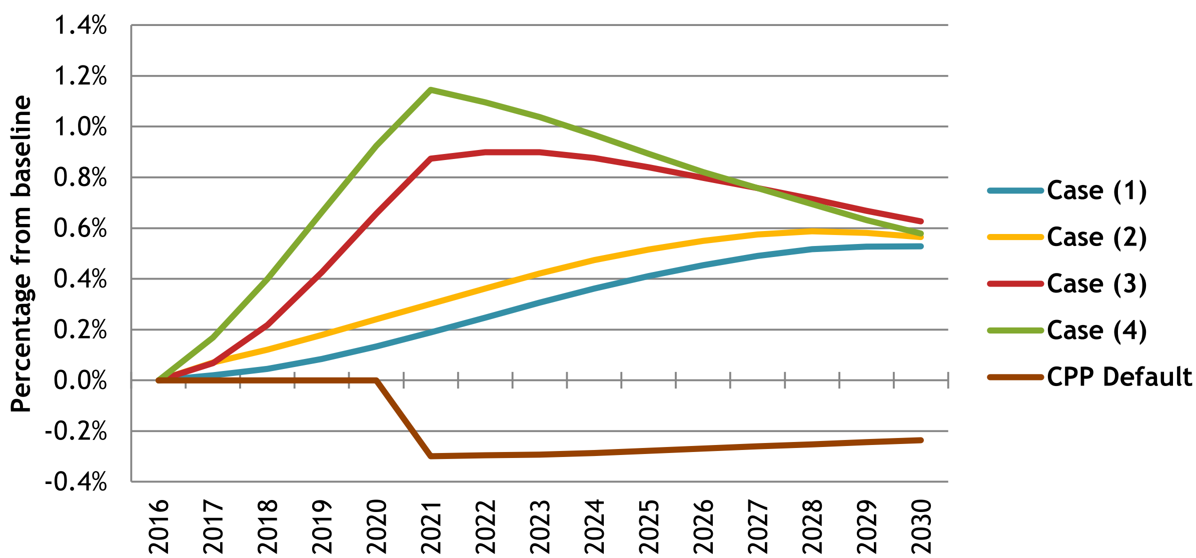


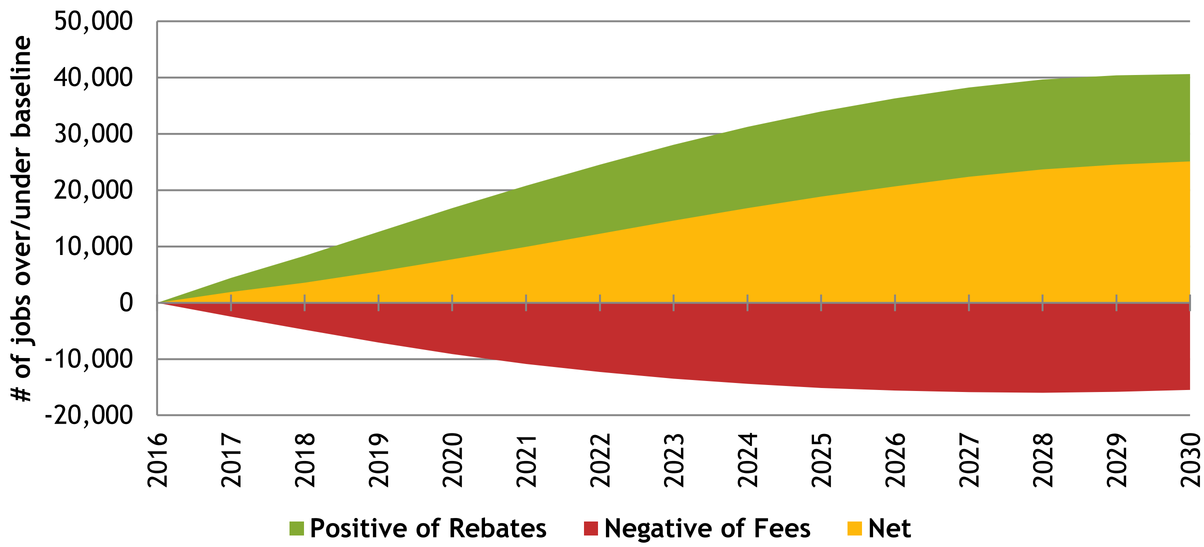
Figure 1.4 *– This is the same results as* ***Figure 1.3*** *relative to the baseline in percentages. The most notable facet of the results is, while employment increases by as much as 2.0%, the numbers struggle over 1.0% only in case (4) here. Therefore, the fee and rebate is having more of an effect on employment in the state than on its output. This comes down to the relatively low wages in Arkansas—compared to the United States overall and certain regions—and the labor-intensity of the industries influenced in a positive sense by the rebates. Before that, however, we can look into the relative magnitude of the positive and negative effects.*



"All my economists say, 'On the one hand, on the other.' Give me a one-handed economist!"
~President Harry S. Truman

To put the headline results—jobs and GSP—in context, **this next section simulates the economic harm of higher electricity prices (at retail from the carbon fee on any of the implicit emissions in Arkansas) versus the benefits to the state's economy from the revenues.** A model like PI+ can simulate different aspects of a policy to examine their relative magnitudes and directions. While one could replicate these simulations for all four cases under consideration here, **we will perform this exercise only with case (1) for interest of brevity. This will avoid repeating points.**

Total Employment (magnitude of effects)



These are the results for "all the good" (the green area) and "all the bad" (the red area, with the net of the two in yellow) run separately in PI+. The rebates, with 50% to households and 45% to employers in case (1), manage to create 40,000 jobs in the Arkansas economy by 2030. At the same time, however, the carbon fee in the wholesale or retail electricity market manages to cost the state around 15,000 jobs in the same timeframe. The net, the same figure as the blue line in ***Figure 1.1***, is around positive 25,000. First, examine the positive figure. According to EPA data, Arkansas emitted 35 million metric tons of carbon dioxide from power generation in 2013. To apply the carbon fee from 2021 here ($55 per metric ton), this implies revenues of around $1.9 billion to the state—**calculations later include a response to these higher prices, but this is a much simpler calculation here.** The 20,000 jobs for $1.9 billion revenues is just about $100,000 per job ($96,250 sans rounding there). That is, for every $100,000 in rebate dollars to households and employers and their ensuing spending, they managed to bring about one unit of employment. This number is nothing explicit in the PI+ model, but rather an implication of the results here. The relatively low wages in Arkansas, particularly in comparison to wealthy, coastal states, makes this number appropriate.

Arkansas has relatively low wages, which affects how its labor market reacts to rebate dollars. Arkansas also has a low cost of living overall, freer labor markets, and attractive amenities to make up the difference. That said, lower wages mean the same amount of dollars "go further" in Arkansas towards creating jobs than they do in other states, and, in particular, the affluent and coastal states in previous carbon fee analyses:

Highest wage states	Lowest wage states
1. Massachusetts	1. Montana
2. New York	2. South Dakota
3. New Jersey	3. Idaho
4. Connecticut	4. Mississippi
5. Illinois	5. Hawaii
6. Delaware	6. Maine
7. Pennsylvania	7. Wyoming
8. California	8. New Mexico
9. Texas	9. Vermont
10. Washington	10. Arkansas

In 2013, average annual compensation in Massachusetts was $55,000 per year while the same figure for Arkansas was $37,000. Hence, the same dollars go 50% further in Arkansas when it comes to jobs on the labor market simply due to these fundamentals. This explains the strong impact on employment relative to GDP in the results of the simulations.

The red section for "negative of fees" above as well as the ensuing section on the impacts on GSP and employment by industry depends on the market share responses in the REMI PI⁺ model. While there is more information on this in the technical appendix, a model with computable general equilibrium (CGE) aspects such as REMI usually includes a response to competitiveness because of price conditions. To provide an example, a state with generally low energy costs will have a competitive advantage over those with higher prices—typically, as of now, a state in the South or the Midwest relative to New England or the Mid-Atlantic. Such issues matter far more in industries where electricity and energy in general, like manufacturing sectors, are a huge part of their costs. Service industries (for instance, healthcare or food services) do use electricity, natural gas, and petroleum products as an input to their production, but not nearly to the degree that different industrial sectors need to. This difference, as well as a general response in the competitiveness of a state to prices, is inherently inside the REMI model.

Once competitiveness changes, total employment or GSP rises or falls in PI⁺. This might happen several "real world" ways, though the model treats them all monolithically. A firm in a state with higher costs may decide to relocate itself to one with cheaper prices plus favorable business conditions. Investors looking to provide seed money or entrepreneurs planning for a startup could find the environment more alluring in the low cost region than a neighboring region with higher prices. The lower cost firm might be able to undercut its competitors from elsewhere; therefore, they win more contracts, do more business, and are more likely to expand instead of a competitor somewhere else in the United States or the rest of the world. The REMI PI⁺ model includes all of these effects, even though it is in a net, "all of the above" manner, and that is where the red loss of jobs comes from on the previous page. Arkansas' firms do have a measure of lost competitiveness from the carbon fee, though rebates based on their employment figures and increased demand from households in the region makes the difference.

GSP by Industry (case (1), millions of 2015 dollars)

Figure 1.5 *– This is the change in the average annual contribution to GSP in the case (1) simulation. Case (1) covers the CCL tax rate with F&D revenue recycling; we will also examine case (4) with its CPPC rates and EE revenue recycling to provide a contrast. In general, most industries, on net, benefit from this policy after accounting for both higher electricity prices and the rebates in the state economy. In fact, much of the subtraction from GSP is within the electrical generation sector itself (utilities below), which falls to comply with the CPP.*

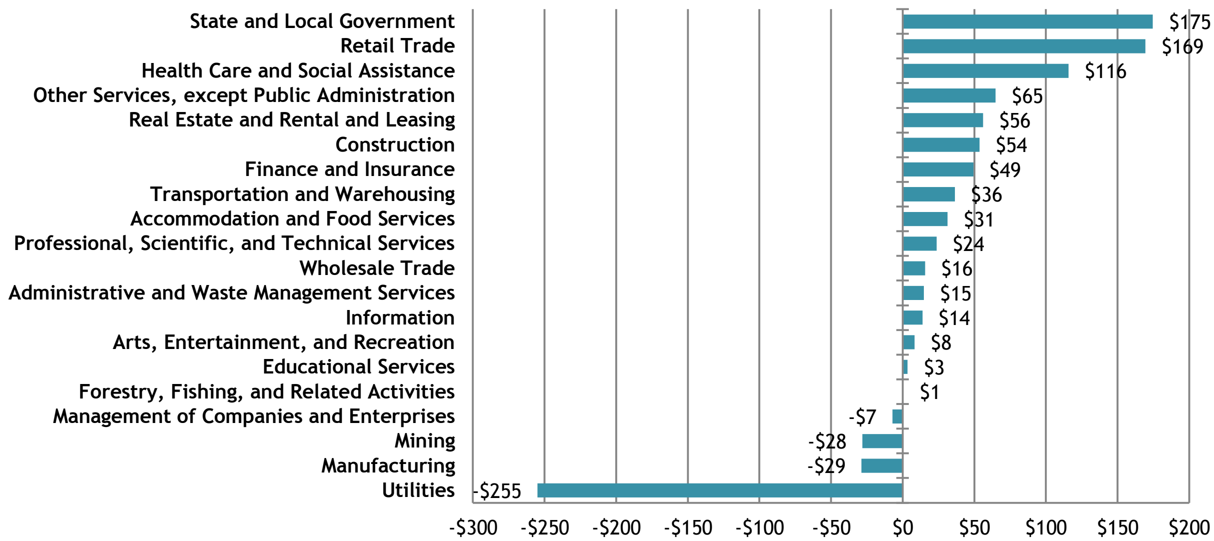
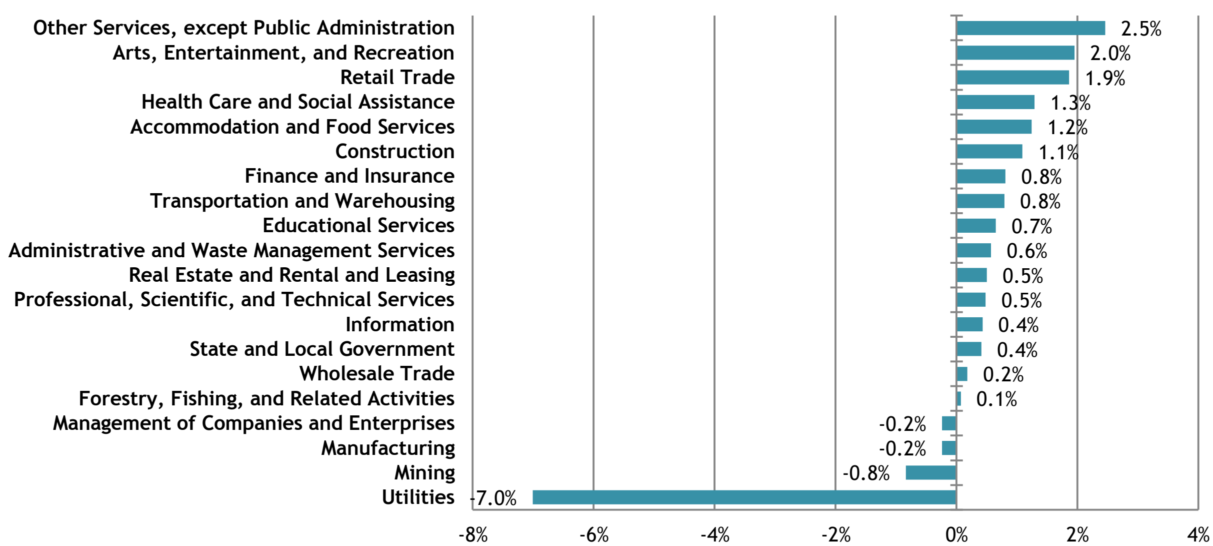


Figure 1.6 – These results show the percentage difference, from the baseline, for the GSP contribution of each major industry in 2030. *Overall, its patterns are similar to the results from the previous figure, but it does illustrate the magnitude of these changes of typically no more than 2% from the baseline. The exception is, again, utilities, which fall 7% overall (accounting for the small changes in natural gas and water and sewage).*



GSP by Industry (case (4), millions of 2015 dollars)

***Figure 1.7** – The results here are, again, the difference in the average annual contribution to GSP from the baseline. F&D devotes 95% of its revenues to rebates; EE vectors 25% of the dollars in the early years towards efficiency upgrades. These manifest themselves below in the construction industry, which handles many of those projects and employs workers in the infrastructure and retrofit trades. Besides the spike in construction here, the results between **Figure 1.5** and **Figure 1.7** are similar in their distribution amid the industries.*

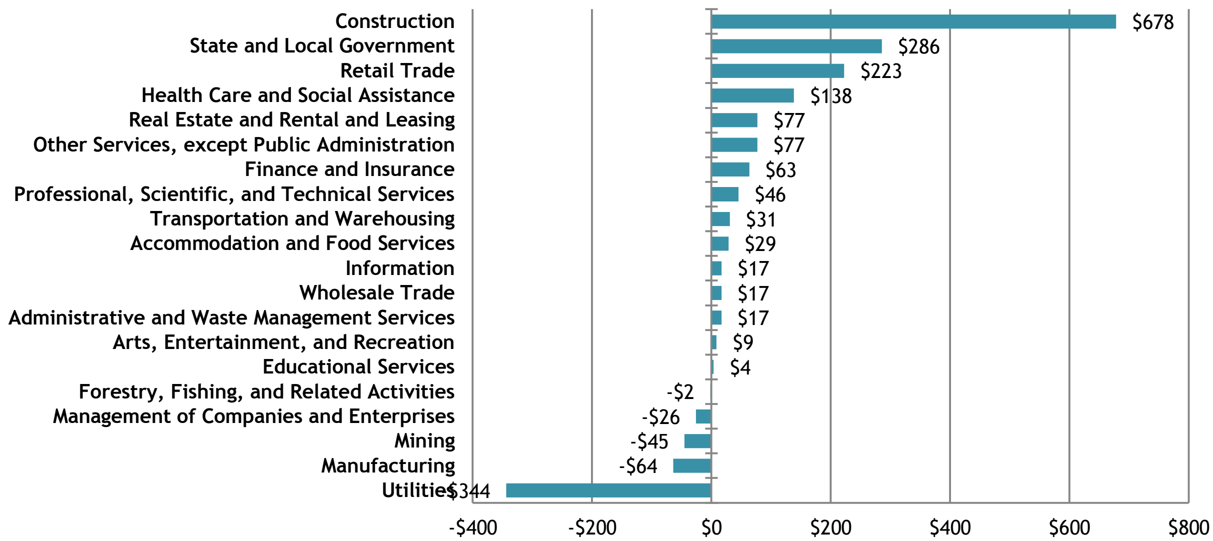


***Figure 1.8** – This chart describes the underlying final demand effects driving much of the macroeconomic impact. Electricity is more expensive; hence, consumers and businesses would buy less of it. The funds from that higher price go towards efficiency upgrades (construction) and other, general consumer spending and investments (out of the rebate), which shows up in the other industries inside of the state with a modest, though positive, influence.*

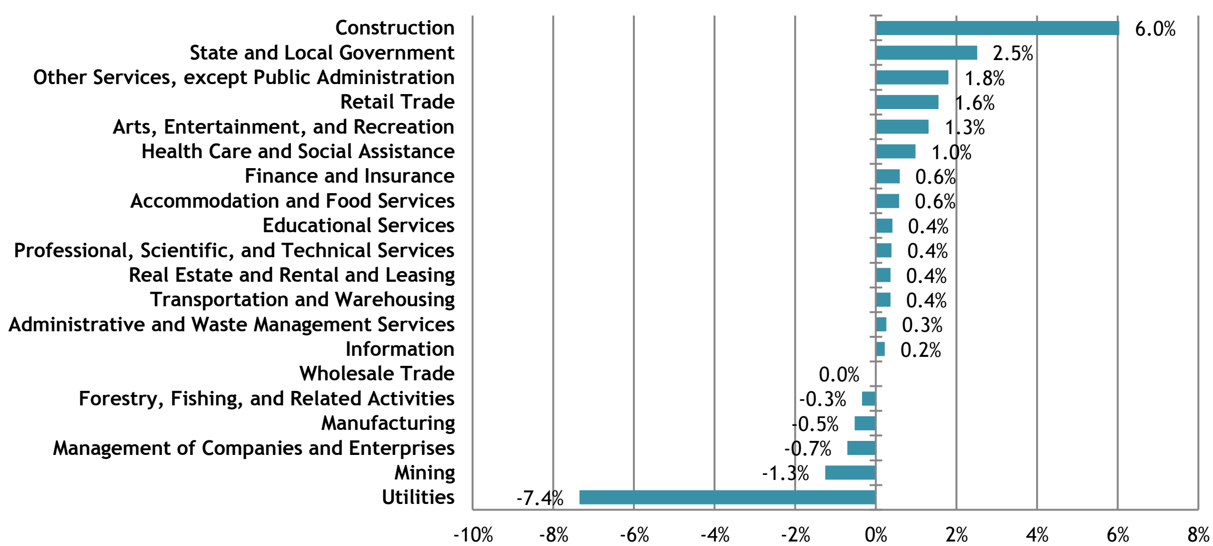
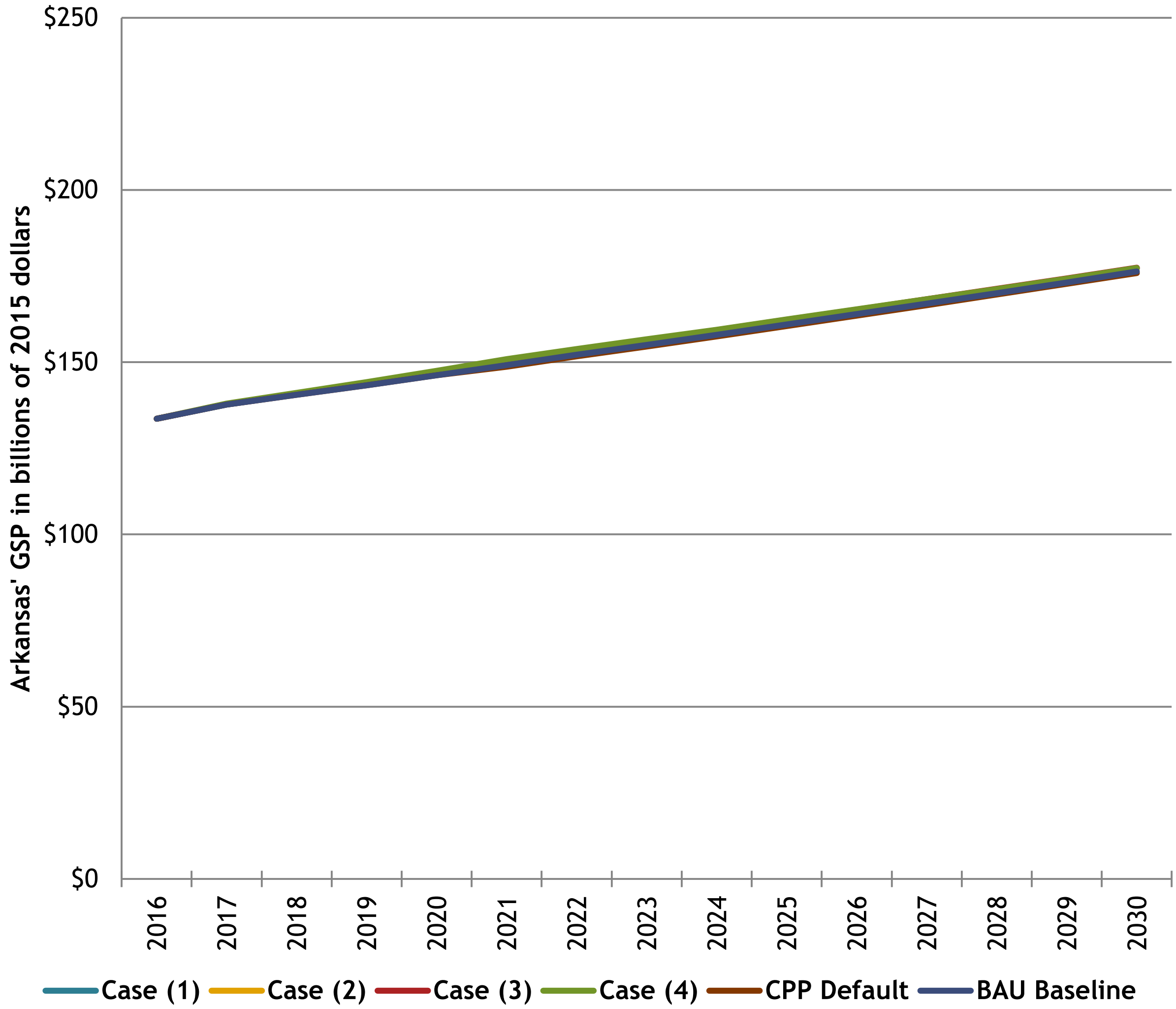


Figure 1.16 and ***Figure 1.18*** begin to discuss the changes to the Arkansas economy from these policies at the scale of the total economy. Seeing these changes at scale will help with the further understanding of this information. The chart below graphs the GSP forecast in the PI+ model for Arkansas under the various policy scenarios: the "do-nothing" baseline, the four sets of carbon fee options, and the national CPP of 10% higher utility prices. The colors in the figure are the same and, from present to 2030, here are the forecasted data trends:



At current, as measured by GSP, the Arkansas economy totals around $135 billion annually. In the REMI model, which accounts for national economic growth and technology change as well as regional competitiveness and demographics, this figure grows to around $175 billion in the state by 2030. The policies under consideration do change the forecast (and the exact changes are in ***Figure 1.3***). On the other hand, at scale, these changes are difficult to make out relative one another. This is not to say a carbon fee or the CPP will have zero influence on the economy of the Natural State or the United States overall, but that the economy changes and adapts to different conditions and continues to grow (albeit slightly differently). At scale, again and however, this registers as a marginal change in economic development.

GSP by Manufacturing Sector (case (1), millions of 2015 dollars)

Figure 1.9 *– This figure breaks down the manufacturing result from the previous section (always in blue) to the manufacturing sectors. All figures are the average annual difference in GSP contribution by manufacturing subsector. A small number of trades actually see a gain in GSP because of the rebates (tobacco and beverages, apparel, computers, and furniture). Conversely, a handful of capital-intensive industries, such as chemical products and paper manufacturing, experience a decline in their production throughout the study period.*

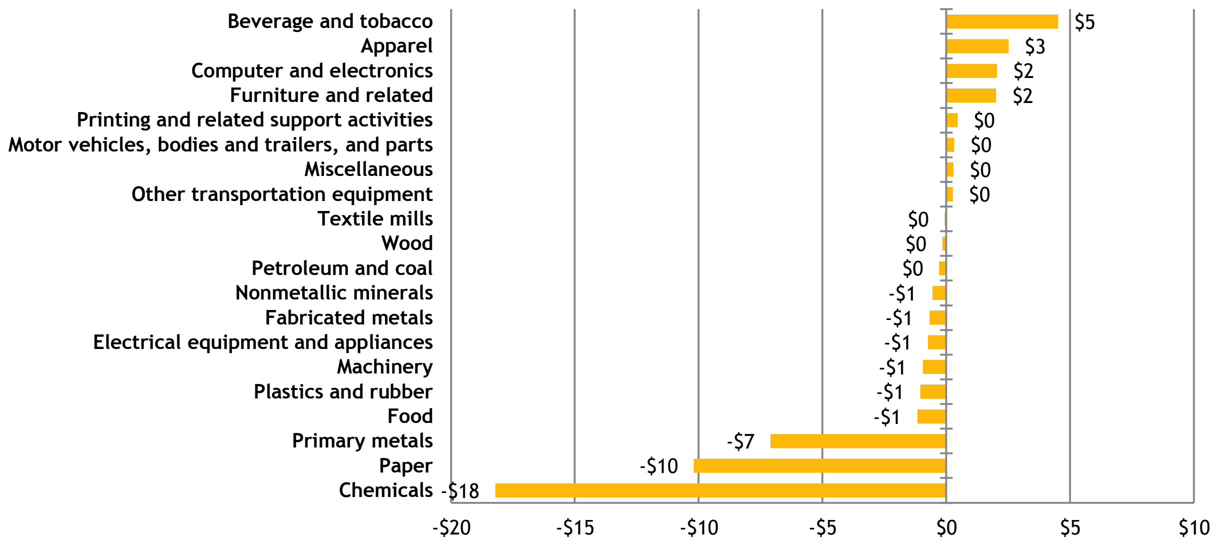
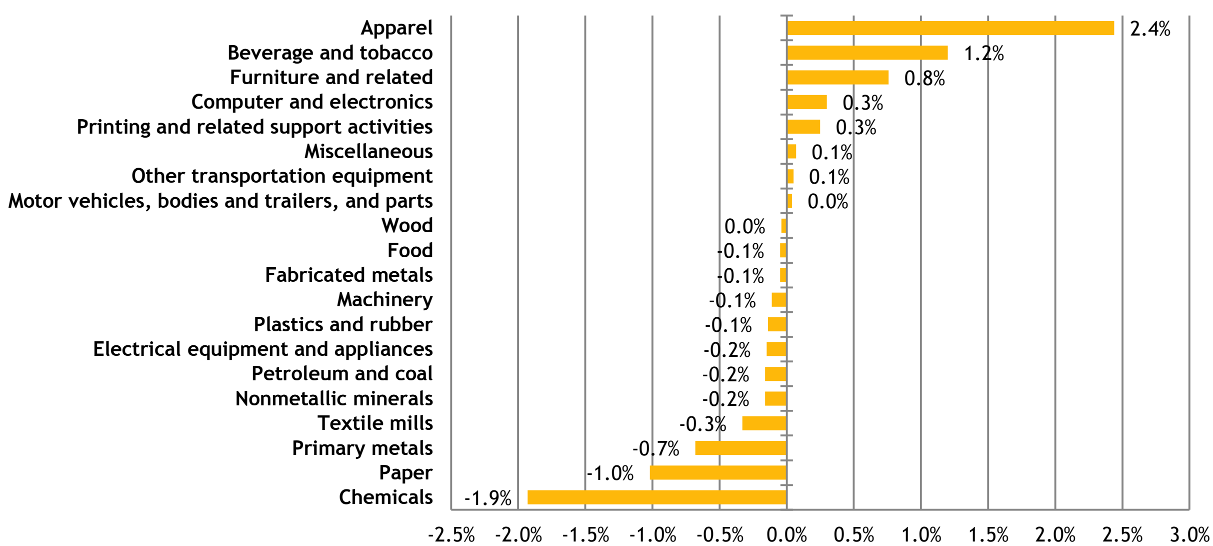


Figure 1.10 *– Recasting results in terms of the percentage difference from the baseline puts the results from **Figure 1.9** in context. While some industries do suffer a decline in their output, these are relatively small in comparison to the size of the overall industry in the model and in the Arkansas state economy. Chemicals, the most negative industry in both absolute and relative terms, only has a decline of around 2.0% by the study sunset in 2030 in case (4).*



GSP by Manufacturing Sector (case (4), millions of 2015 dollars)

***Figure 1.11** – The result for case (4) is generally similar to those from case (1). There is one major exception—computers and electronics manufacturing. Computer manufacturing, which is a high-volume, low-margin industry in competition with similar operations throughout the world, has a high degree of sensitivity to costs in the REMI model. Case (4) dedicates 25% of the dividend money to energy efficiency, which means 25% less in rebates for the industry. This is enough to switch its results from slightly positive before to slightly negative here.*

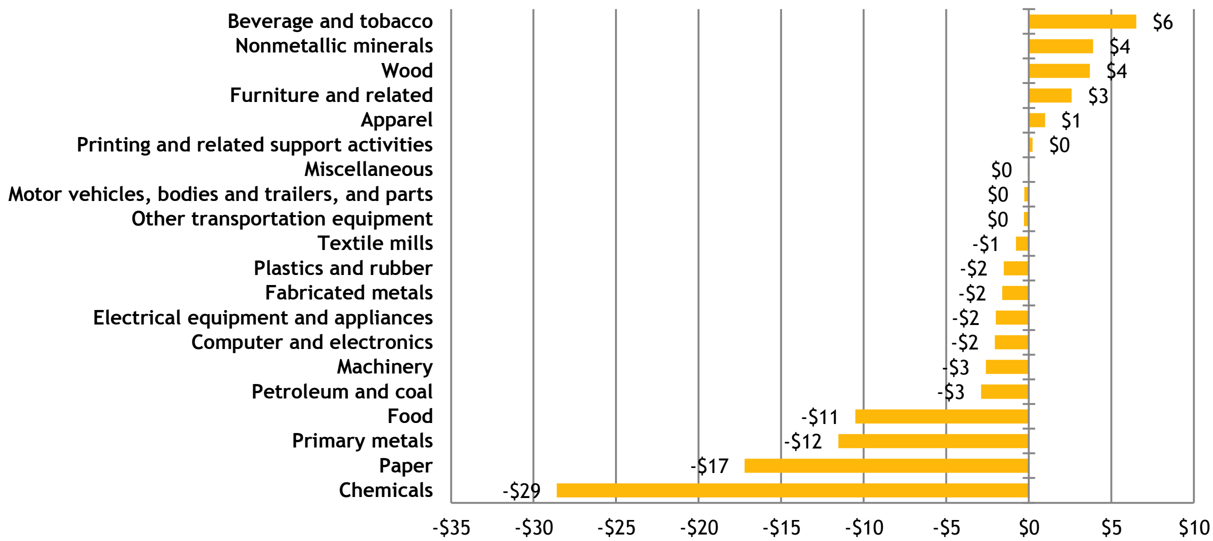
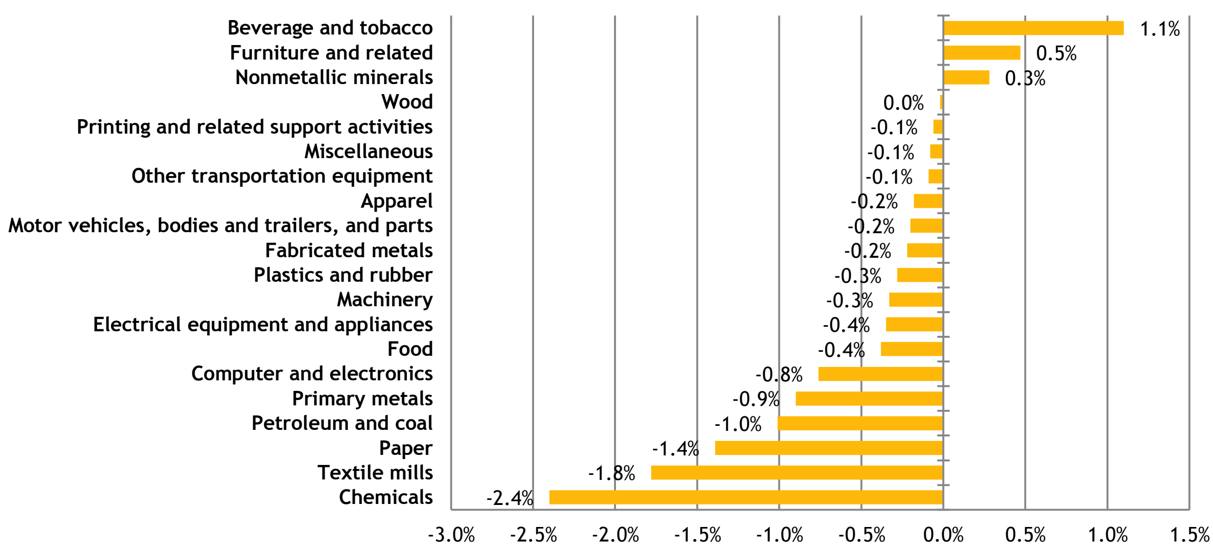


***Figure 1.12** – The proportional change for case (4) is slightly more to the negative direction for manufacturing than they were with case (1). As with **Figure 1.12**, the dedication of 25% of the revenues towards efficiency (mostly the construction industry) leaves other industries in Arkansas at a relatively slight disadvantage. This translates to a 2.5% reduction in the output of chemical manufacturing in 2030 while all other industries have less of an impact.*



Employment by Industry (case (1), # of jobs)

Figure 1.13 *– The change below is the difference from the BAU baseline for the different industries in the Arkansas economy as an annual average. Most of the employment growth comes in localized, labor-intensive industries sensitive to consumer spending and without competition from vendors outside the state. The only industry substantially in the negative was utilities, which includes power generation. Higher electricity prices at retail and wholesale would reduce demand for that sort of service and related employment.*

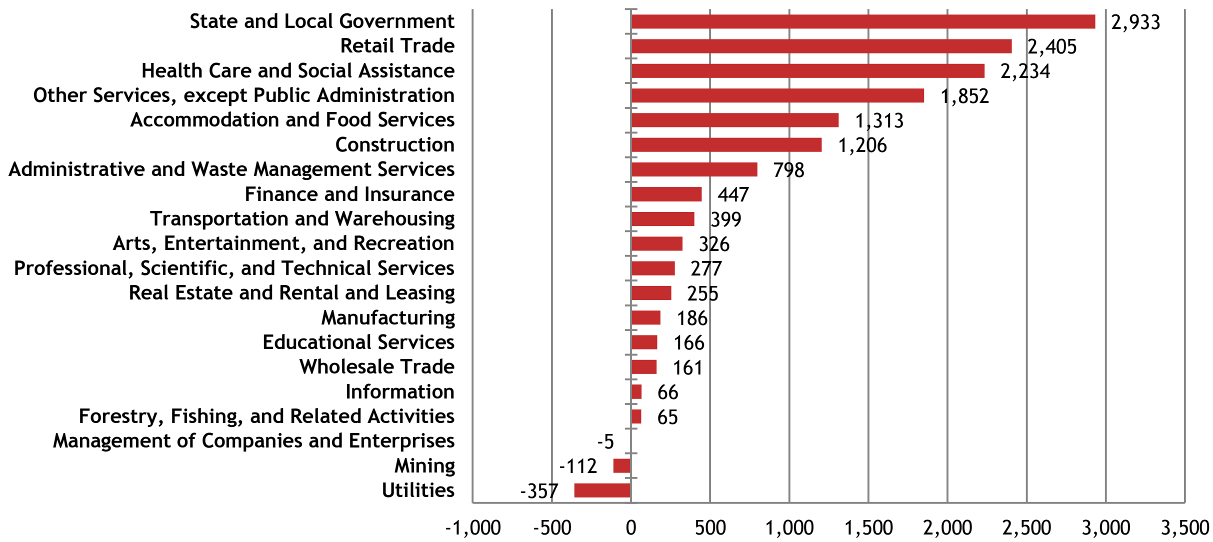
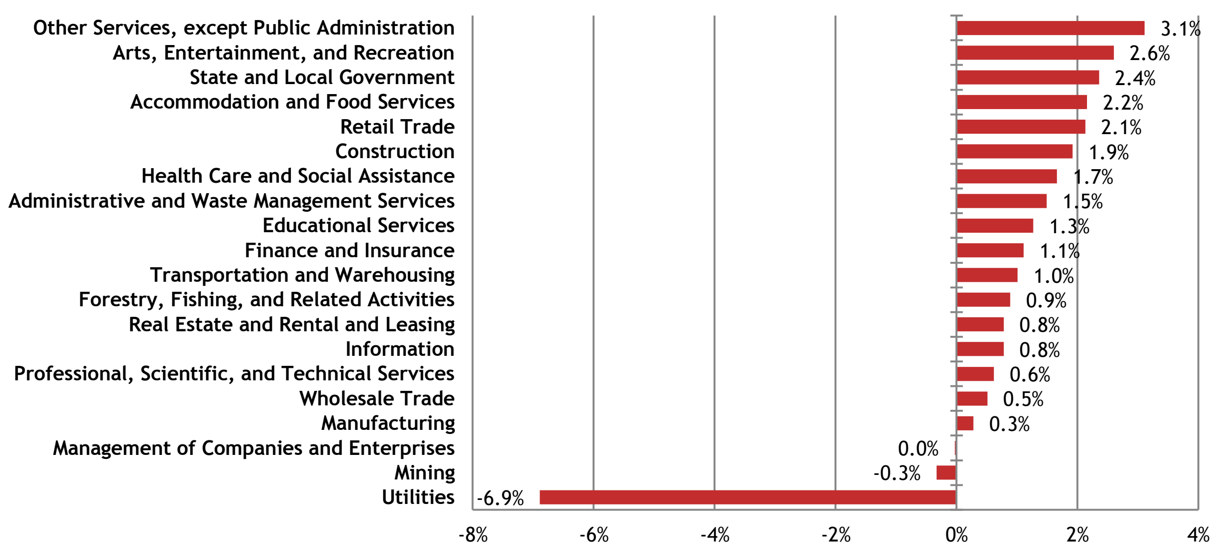


Figure 1.14 *– The proportional change here is similar to the ones for GSP overall and the GSP contribution of the manufacturing sectors. Most major economic clusters see a change in their employment of less than 3%. The exception is, again, utilities. The 7% decline is mostly in power generation, as opposed to water, sewage, and natural gas, which would see relatively little change in their employment numbers, easily made up for in other sectors.*



Employment by Industry (case (4), # of jobs)

Figure 1.15 *– Redirecting 25% of the revenues into energy efficiency in the earliest years of the policy changes the effect on the labor market. Now, instead of a general spread through the consumer-centric industries, the construction industry (related to renovation and retrofit of infrastructure, equipment, and appliances) has the largest impact of around 10,000 jobs. The remaining sectors have similar patterns, however, including a loss in utilities.*

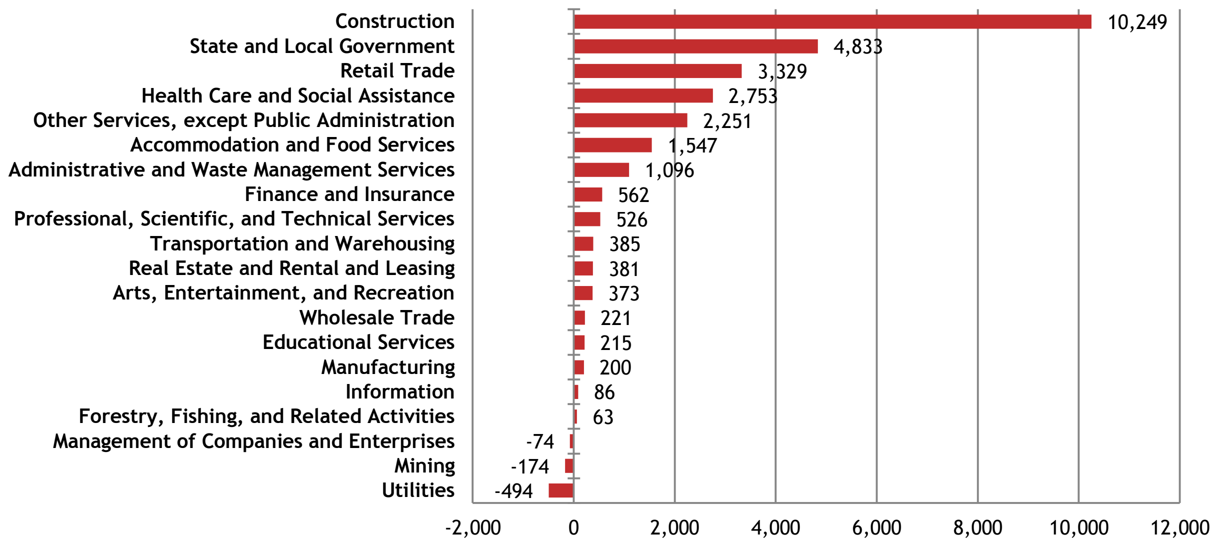
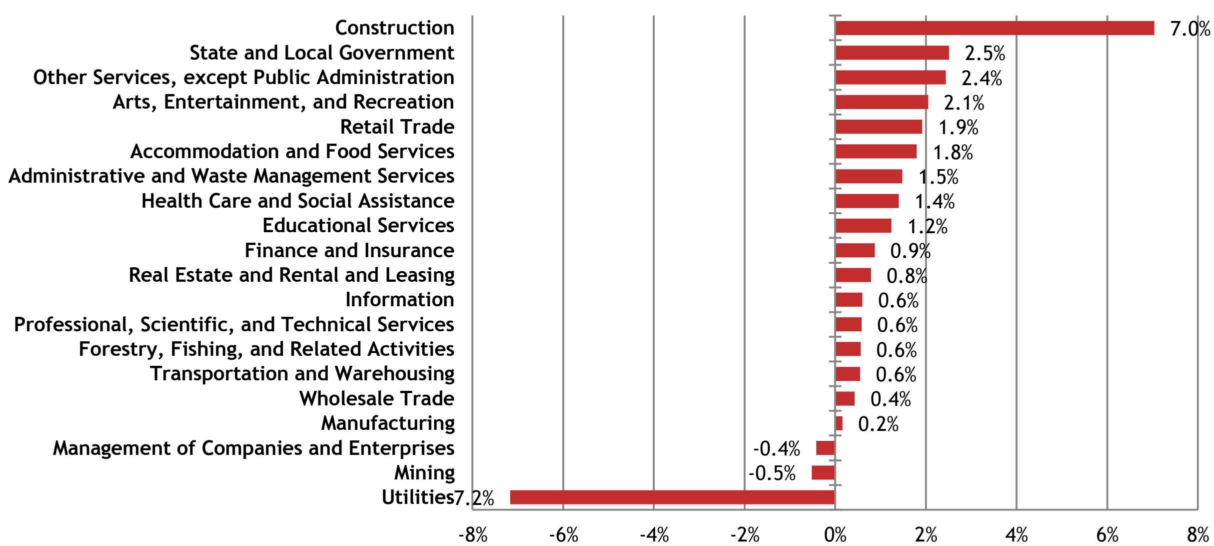
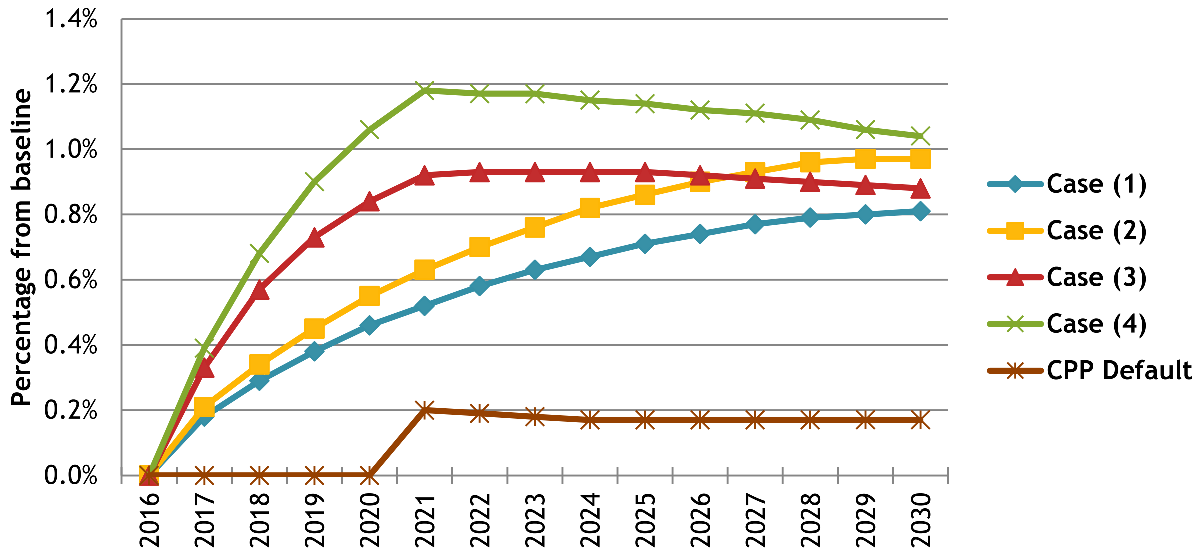


Figure 1.16 *– Construction spikes to around a 6% or 7% increase in its output from the baseline in this scenario. The other sectors shift from a 2% or 3% increase closer to a 1% or 2% increase because the dollars previously going to consumer and business rebates now go towards energy efficiency. Utilities, however, with a similar decrease in electricity demand, still have nearly the same change in their output relative to the baseline described below. Mining comes with that with a small (<1.0% total) decrease in coal and gas in Arkansas.*



Cost of Living Index

***Figure 1.17** – The chart shows the change in REMI's internal cost of living index for Arkansas in the various simulations. For instance, the case (4) results in green for 2025 is saying that Arkansas is 1.2% more expensive to live in than it would be absent any carbon fee or the CPP. This factors into REMI's calculation of real income in the model, as well.*



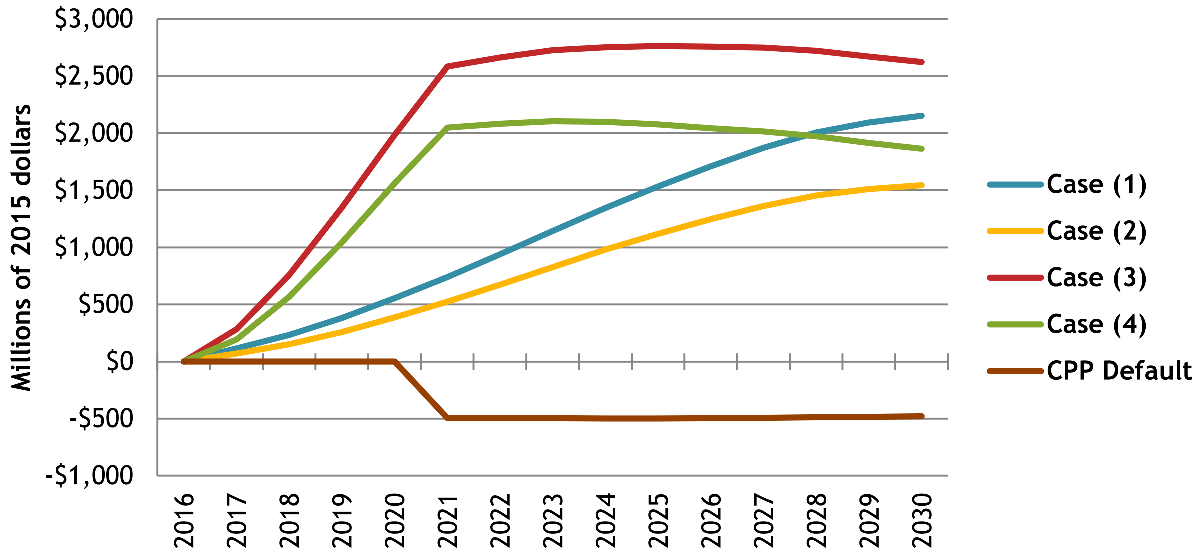
The cost of living index requires some explanation, and the result in ***Figure 1.17*** deserves further contextualization. The REMI baseline includes a gradual increase in the cost of living in the United States over time of around 2% per year—roughly equal to the long-term historical average and the inflation target of the Federal Reserve. However, policy changes and their direct impact (such as a carbon fee or a change in sales or property taxes) or indirect implications can also influence the cost of living in a region. The above shows the change when the cost of living in Arkansas is between 0.2% and 1.2% higher because of the carbon fee or the CPP. One should note these are a "vector" adjustment against a baseline. **These increases are "one-time" between 0.2% and 1.2% more expensive, and the numbers do not compound in the long-term.** Therefore, if long-term inflation is close to 2% per year, then the figures represent an additional six months' worth of inflation over the next fifteen years.

The carbon fee would make electricity more expensive in Arkansas, but remember power in the context of the overall basket of consumer goods. Electricity makes up approximately 1.9% of all consumer purchases in the Natural State. This means a doubling of electricity prices would only change the cost of living in Arkansas by 0.19%.[32] Owner-occupied homes (10.4%), hospital care (7.3%), groceries (6.3%), and prepared food (5.1%) make up a larger proportion of consumer spending and, hence, have a larger influence on the cost of living index. Electricity purchases are much closer in scale to items such as furniture and financial services in terms of how the prices of those items vary the cost of living in Arkansas. The REMI PI+ model uses the change in the price index to influence its changes to real income, which account for prices.

[32] Initial price index of 100 + 1.9% * 1.1 = 100.19, or a 0.19% increase from the initial price index (of 100)

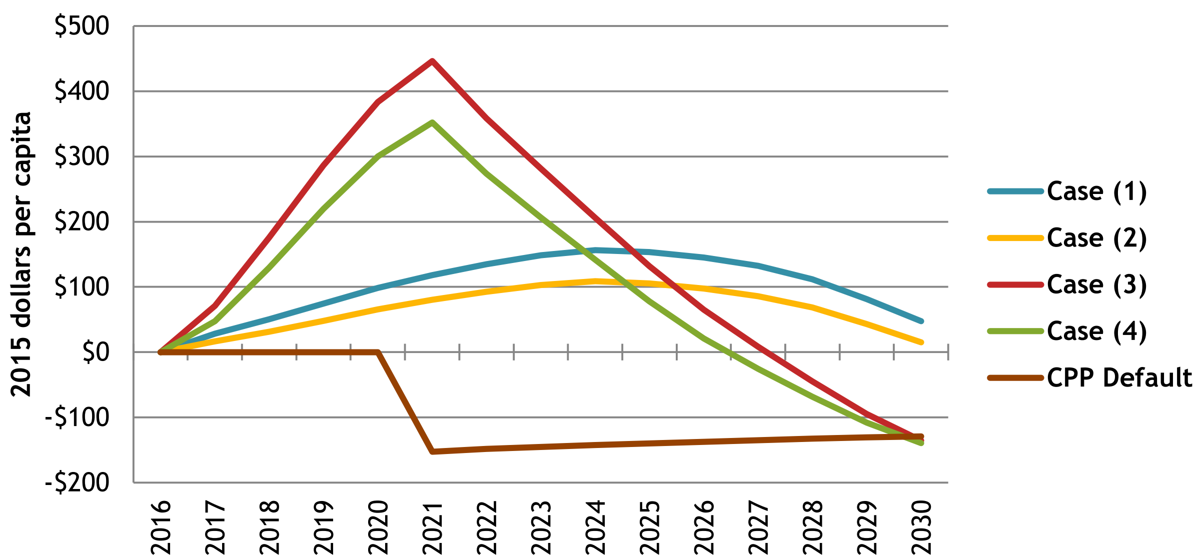
Real Disposable Personal Income (RDPI)

Figure 1.18 *–Real disposable personal income (RDPI) is the REMI calculation of household income accounting for labor income, capital income, minus taxes, and adjusted for the cost of living (as on the previous page). All of the carbon fee cases increase RDPI in Arkansas by around $2.0 billion to $2.5 billion by 2030. Case (1) and case (3) are higher than their opposite because of the larger rebates without 25% of funds held back for energy efficiency.*



RDPI per capita

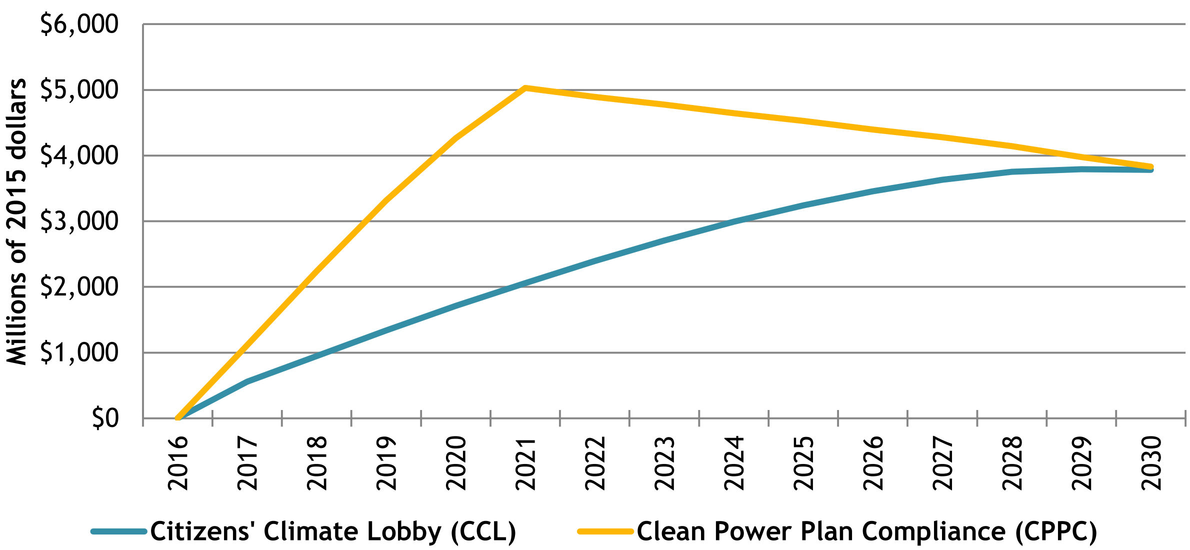
Figure 1.19 *– This is the same result adjusted for the state's population. When new jobs exist in Arkansas, they are likely to attract migrants (usually young people) from other states on the market for work. This keeps the per capita impact of a carbon fee-and-dividend in Arkansas close to $0 per capita, though it does mean Arkansas would have a larger economy (as the GSP results revealed) and population that comes with it (in the demographics section).*



The next section will transition away from the economic impact results in REMI PI$^+$ and into the tax revenue and emission results from ARCTAM. This includes the total revenues from the fee on carbon dioxide in Arkansas, the size of the rebates (for an individual, a family, and per each employee), and the amount of potential weatherization and energy efficiency. It also includes the change in demand for electricity and, by extension, carbon emissions from the state. We will provide a gentle reminder here that we make no claims about climate science in this research in regards to the CPP and, more importantly, the modeling of "climate feedbacks" are not present in this system. Climate does not factor into PI$^+$ or ARCTAM here, which makes any positive or negative impacts associated with differing weather patterns immaterial to the simulations here. This means that such highlights as sea level rises, water availability for economic development or agriculture, and the frequency of intense storms are not part of the results. In essence, this study is a straight "tax swap" study in the fiscal sense with the economic impact results included. The emissions results on the following pages, while interesting to readers and of importance compared to the strictures of the CPP, do not have direct influence on any of the economic or demographic results. **They come about independently.**

Fee Revenues

Figure 1.20 *– The below illustrates the expected revenues from the carbon fee under the two pricing paths without energy efficiency adjustments. The CCL rate and its gentle curve upwards increase revenues over time, though one would expect the blue line to "tip over" and decline sometime after the study period ends in 2030. The CPPC rate, on the other hand, peaks around nearly $5 billion in revenue for 2021 and declines thereafter. For context, the FY2015 budget passed by Little Rock funded $37.5 billion in operations.[33] While some of that comes from federal matching dollars rather than state tax revenues, the carbon fee and its revenues still offers enough to fund around 25% of current state operations. The fee could, for one instance, replace the sales and use tax, which brings around $2 billion per year.[34]*

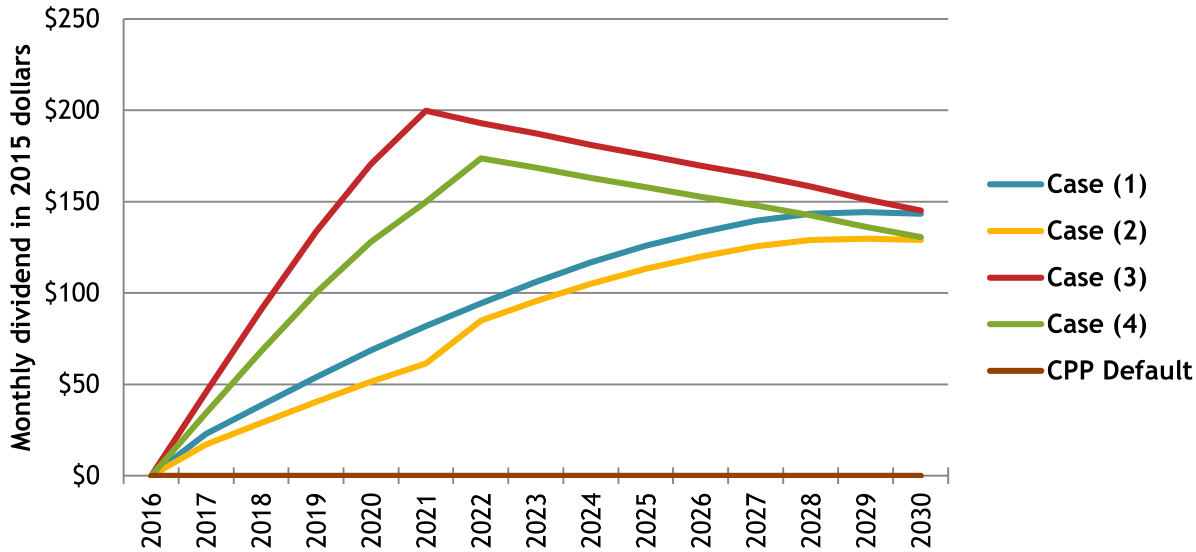


33 <http://www.dfa.arkansas.gov/offices/budget/Documents/fy2015_funded_budget_schedule.pdf>

34 <http://www.dfa.arkansas.gov/offices/exciseTax/salesanduse/Documents/TaxCollections.pdf>

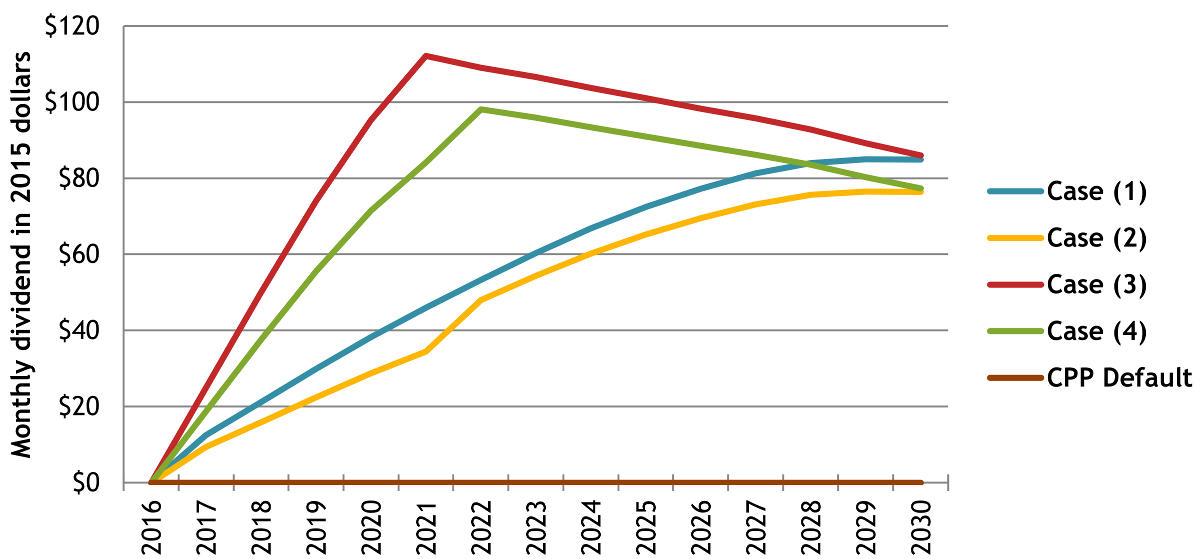
Household Rebate

Figure 1.21 *– Rebating the revenues from* ***Figure 1.20*** *to households produces the below distribution of monthly funds back to people. Assuming a family of four members (two adults, two children, 3 full shares of the dividend), the average household would receive $100 per month as soon as 2017 or 2018, a peak of $200 per month in case (3) in 2021, and settling in around $125 to $175 per month by 2030. The monthly rebate has the added benefit of increasing in size during the summer with heavy electricity use for air conditioning. Just as the price impact hits the hardest, the rebate does the most to compensate households.*



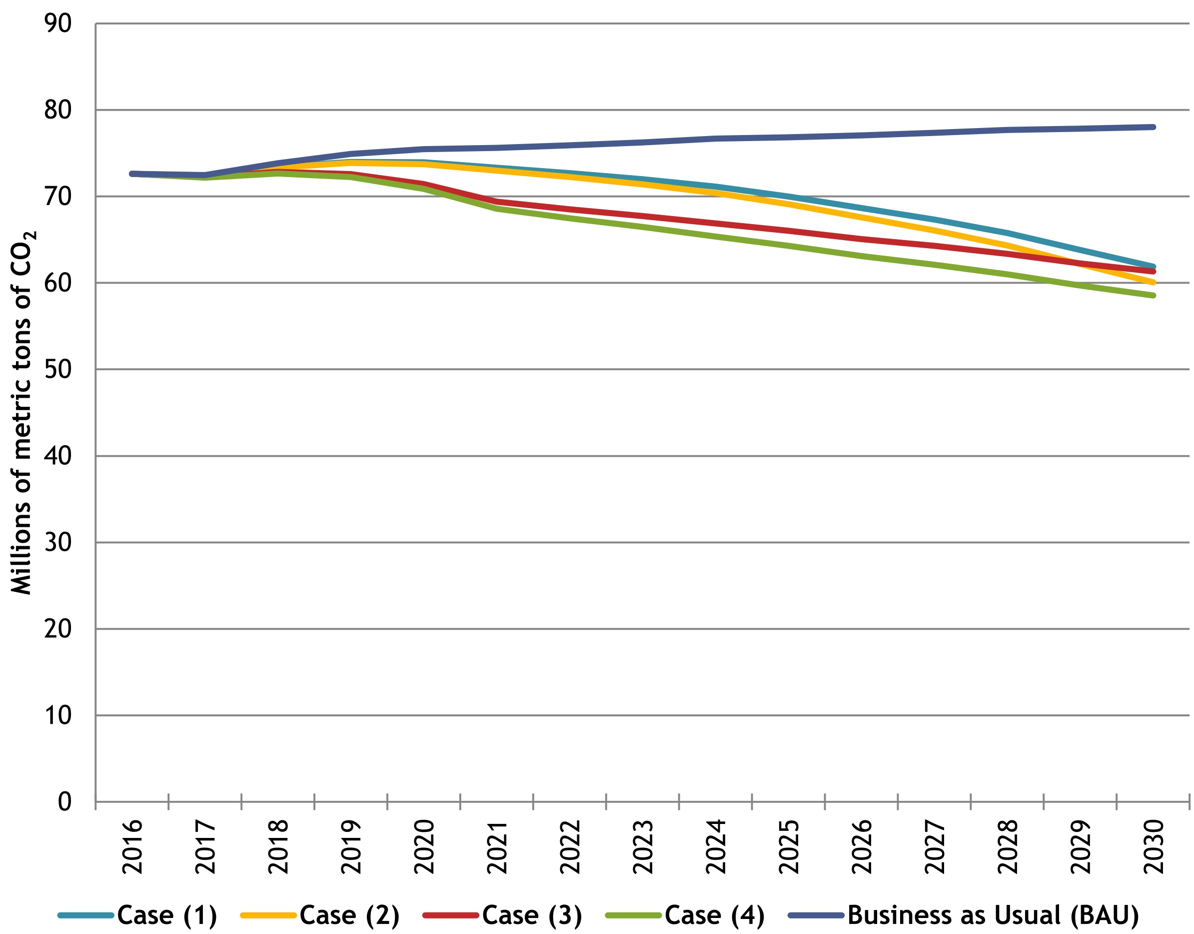
Employer Rebate

Figure 1.22 *– This shows the same results for the employer rebate. That is, for each employee under case (3) in 2021, the employer receives $115 per month back to cover their higher costs of electricity. The rebates cycles throughout the year based on electricity demand, as well.*



Carbon Dioxide Emissions (overall economy)

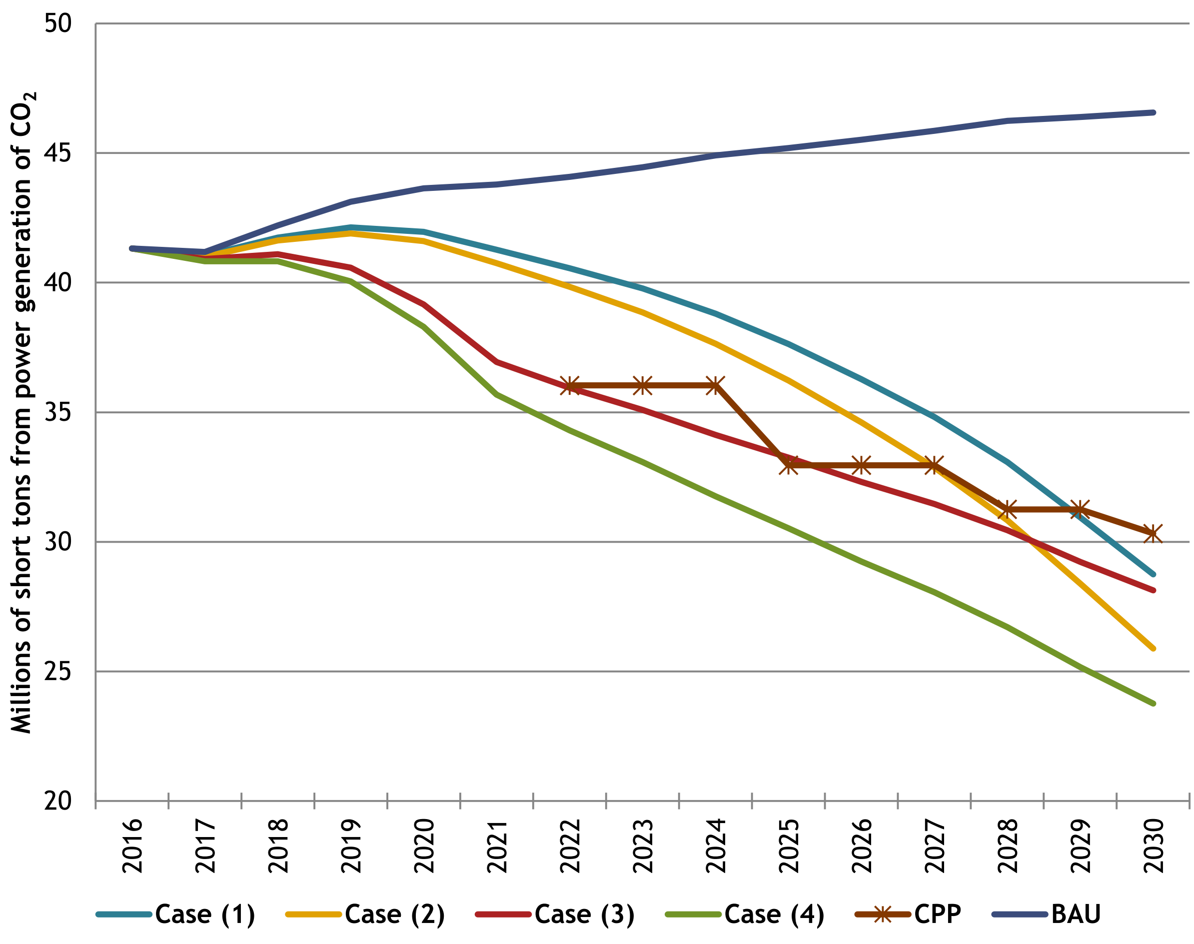
Figure 1.23 *– Here are the carbon dioxide emissions results from ARCTAM. Do note that these are emissions from (1) all sources, power generation with transportation and heating fuels included and (2) in metric tons, not the typical short tons discussed in the CPP. For the results on emissions and the CPP, continue on to* ***Figure 1.24*** *on the next page. Absent any policies, the emission forecast in ARCTAM for Arkansas follows the general trend of the South West Central (SWC) region of Arkansas, Louisiana, Oklahoma, and, mostly Texas—a slow increase in emissions from 2016 through 2020 followed by a plateau of the same in the 2020s. With the carbon fee, individuals and enterprises begin to react to higher prices by cutting emission in the process of price elasticity. In case (2) and case (4), the appropriation of the carbon fee's revenues for energy efficiency programs furthers this process. Emissions fall off their current trajectory under the carbon fee and dip below 70 million metric tons per year in all cases by 2022 and around 60 million metric tons per year in 2030 in all scenarios. For context, this would put Arkansas still over its 1990 emissions of 51.24 million metric tons—the typical number called for under the Kyoto Protocol.[35] The blue and the gold lines eventually accelerate beyond the red and the green ones for having a continual rise in their price on carbon and for price responses taking longer to come to fruition with their gentle rise.*



35 <http://www3.epa.gov/statelocalclimate/documents/pdf/CO2FFC_2013.pdf>

Carbon Dioxide Emissions (from electricity demand)

Figure 1.24 *– This result looks only at emissions from power generation implied by electricity demand in the state to meet the Clean Power Plan. The cases and baseline are in their usual colors while the CPP limits are in brown with asterisks. For the mass-based target, the final rule for Arkansas requires the targets graphed on the brown line.*[36] *Absent any policy on carbon dioxide emissions, Arkansas follows the general curve of the WSC region again in this sector. All policy designs cause a reduction in emissions, though not all comply with the intermediate requirements of the CPP. Case (1) and case (2) comply with the final goals in 2030, reducing emissions below 30.3 million short tons in the last year. Case (3) comes close to hitting all of the intermediate targets, though it does exceed the goal for 2025 without any ramping of the goals between 2024 and 2027. The green line for case (4), conversely, does meet all the intermediate goals and the final mass-based rule under the CPP for the Natural State. The results presume demand for electricity in the Arkansas region is the best proxy for emissions from the state, that price elasticity is an adequate tool for the prediction of demand from the AEO baseline, and that reducing demand for electricity from Arkansas' households and businesses would reduce stack emissions in this manner. The emissions reductions here would be considerable but could be the topic for future power modeling.*



[36] <http://www3.epa.gov/airquality/cpptoolbox/arkansas.pdf>

Population

Figure 1.25 *– The REMI model includes demographic responses in its structure. With the increase in job availability from the carbon dividend, the unemployment rate in Arkansas would begin to decline relative to other states. Labor is mobile in the United States and, hence, a strong economy in one region will draw people from another region. This happens in Arkansas here, where the jobs and opportunities bring 30,000 to 60,000 more citizens.*

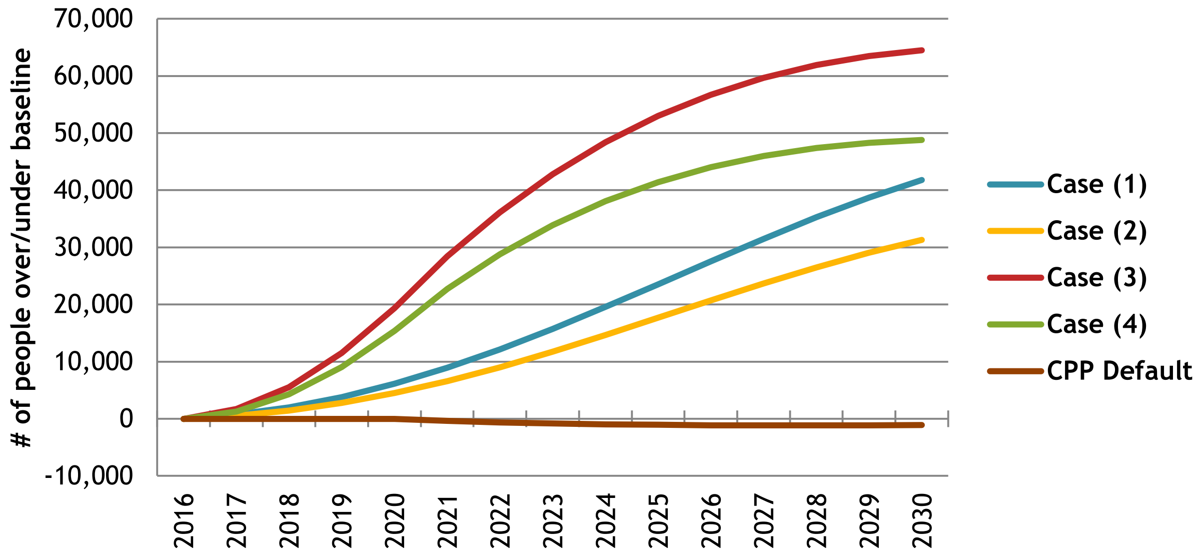
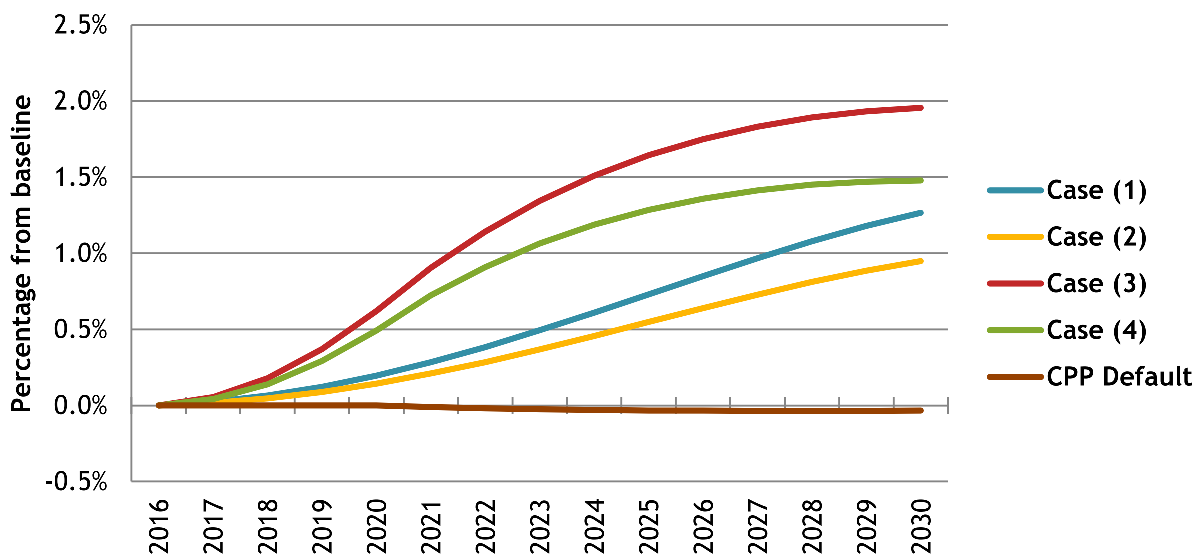


Figure 1.26 *– As with the employment and GSP results, the demographic results here are commensurate with the size of the policy relative to the whole economy. Population goes up between 1% and 2% in the simulations by 2030. Recalling* ***Figure 1.19*** *on RDPI per capita, this is why the state is unable to sustain a long-term increase in per capita income—a stronger labor market would draw more people, divide the economy between more households, and keep the results close to the baseline. Arkansas comes out with more population for this.*



General Carbon Fee

- This does include liquids and gaseous fuels
- How does this impact the economy?
- What is new by expanding fuel types?

what does REMI say? [sm]

Carbon Fee on Electricity and Liquid and Gaseous Fuels

Total Employment

Figure 2.1 *– Adding liquid and gaseous fuels to the carbon fee introduces a major factor into the macroeconomic results—the displacement of petroleum product imports. There are two refineries in Arkansas;[37] PADD 3 region[38] has 3 has 56 with 19 in Louisiana and 27 in Texas.[39] Hence, most petroleum purchases in Arkansas send of dollars into neighboring states.*

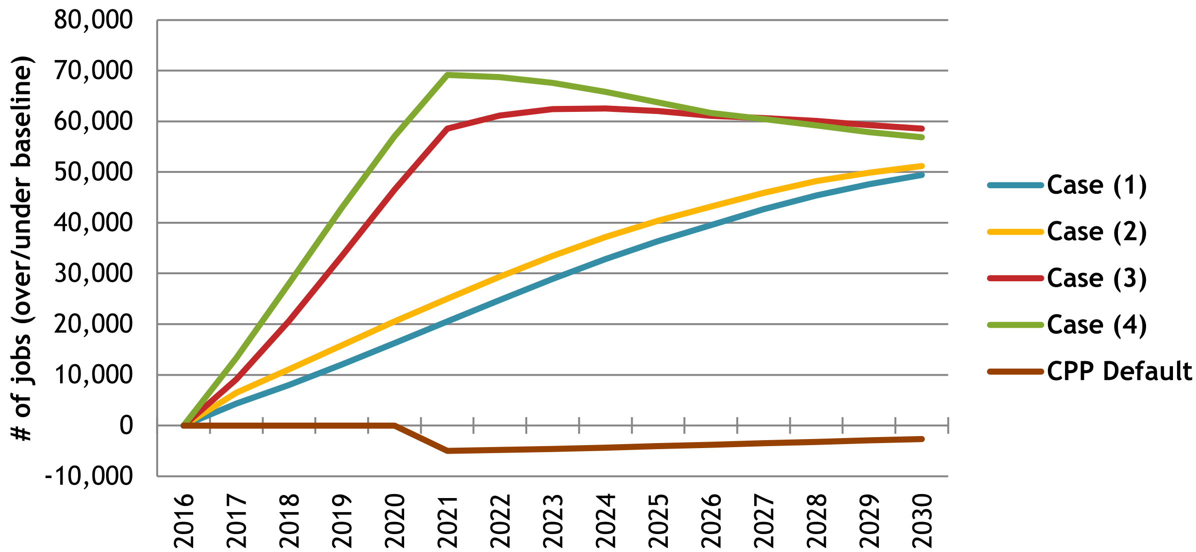
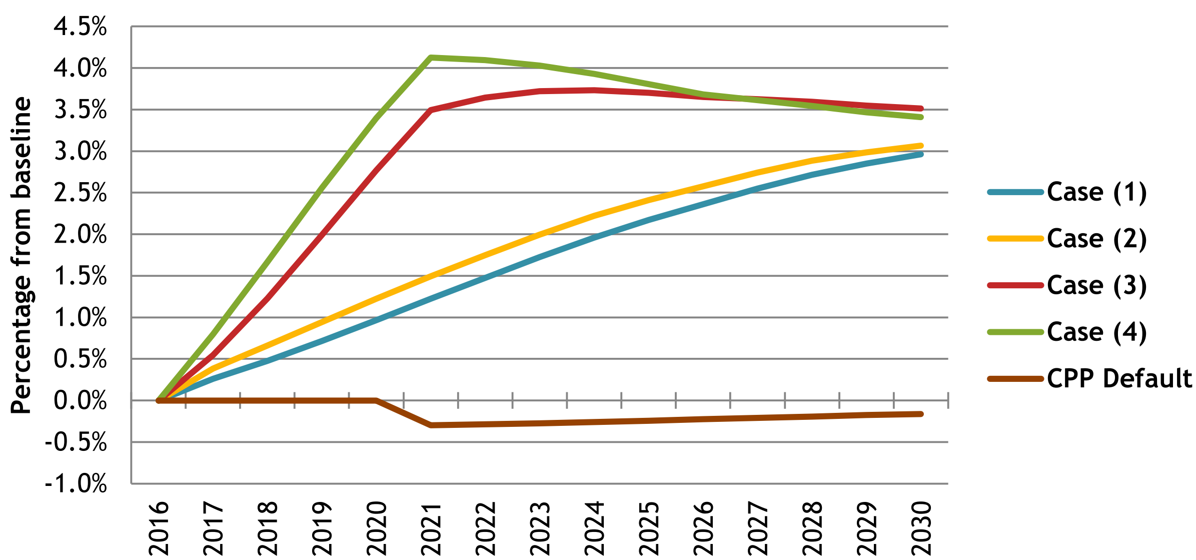


Figure 2.2 *– Arkansas' change in employment, around 3%, is the equivalent of around two years' worth of extra growth from 2016 to 2030 if average annual growth is 1.5% to 2.0%.*



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[37] El Dorado and Smackover (combined 14,390 m^3/day, or 34% of the largest refinery in Houston)
[38] Alabama, Arkansas, Louisiana, Mississippi, New Mexico, and Texas
[39] EIA data, <http://www.eia.gov/dnav/pet/pet_pnp_cap1_a_%28na%29_8O0_Count_a.htm>

Gross State Product

Figure 2.3 *– GSP surges in all the simulations relative to the baseline. As with the results for employment, reducing the dollars lost from Arkansas to petroleum and gas fields throughout the rest of the West South Central region keeps more dollars local and allows the economy to grow somewhat more rapidly. The long-term stability approaches $2 billion more in annual GSP within Arkansas, or around 1.5% or $650 per capita absent population growth.*

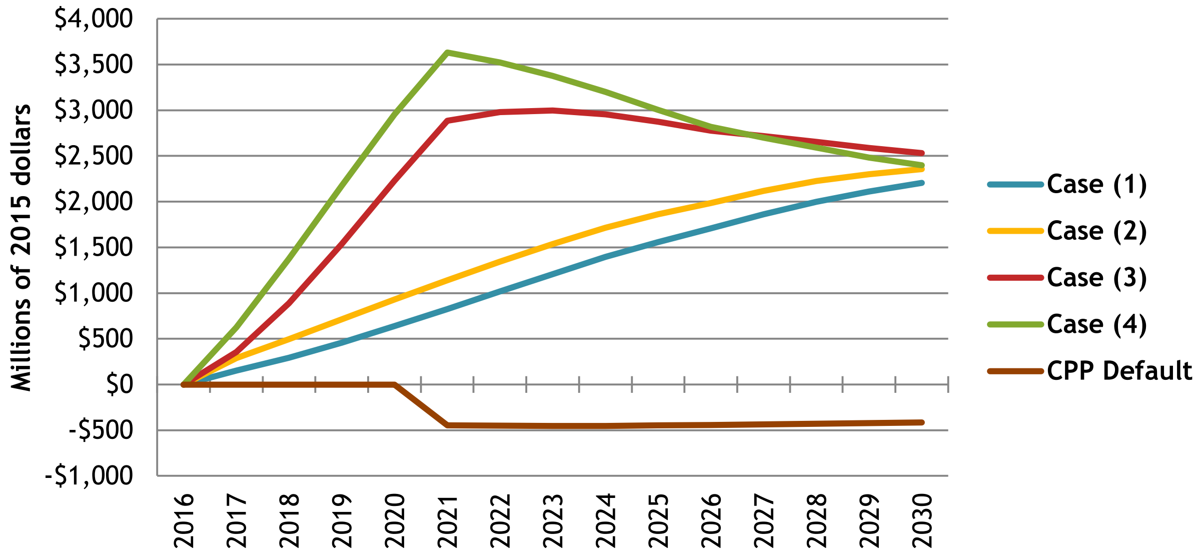
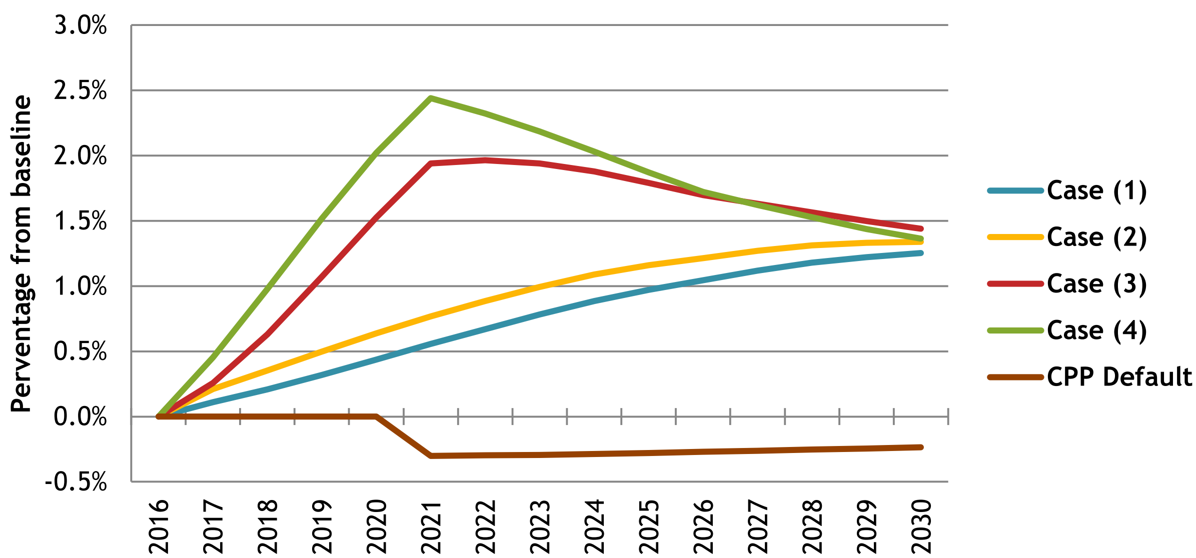


Figure 2.4 *– The GSP results here are comparable to those results from* ***Figure 1.4*** *and, in proportional terms, less than the jobs results in Figure 2.2. From this evidence, we can conclude that Arkansas is more sensitive to changing prices in liquid and gaseous fuels in terms of its size of economy than it is to electricity despite the displacement of the import of refined products in the second set of simulations. This argues for a change in the industry mixture of the state to a more labor-intensive setup with fuel inputs included.*



GSP by Industry (case (1), millions of 2015 dollars)

Figure 2.5 *– As with most studies of carbon pricing (regional, national, or international), labor-intensive and consumer-centric industries tend to perform better than heavier industries with more energy and capital needs towards the bottom. The main difference from the previous section is the decline in manufacturing, which relates to the definition of the "petroleum and coal products manufacturing" industry and its inclusion of refineries.*

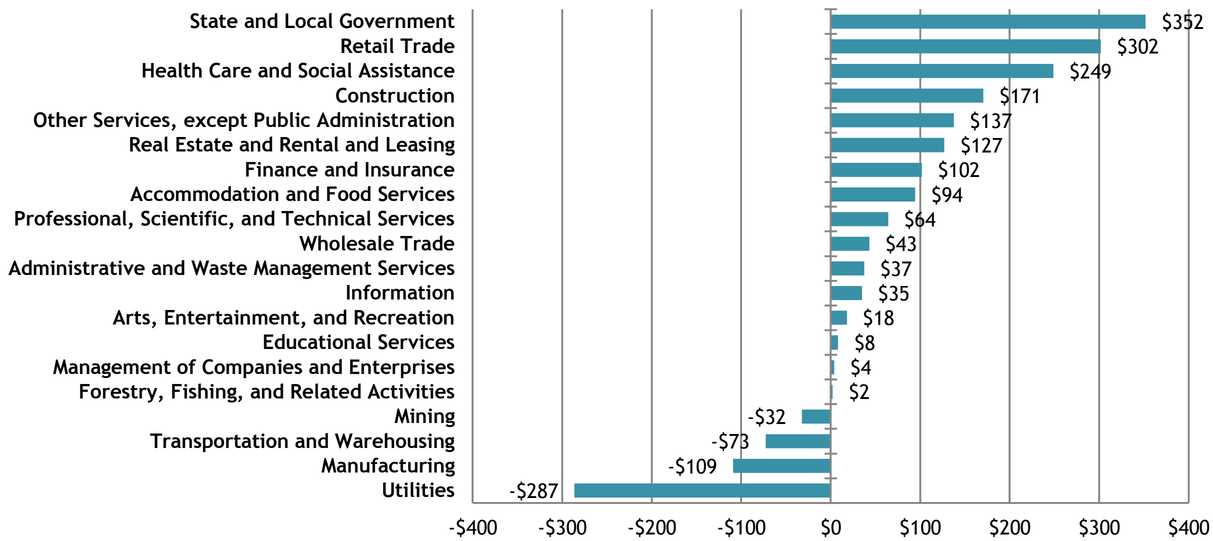
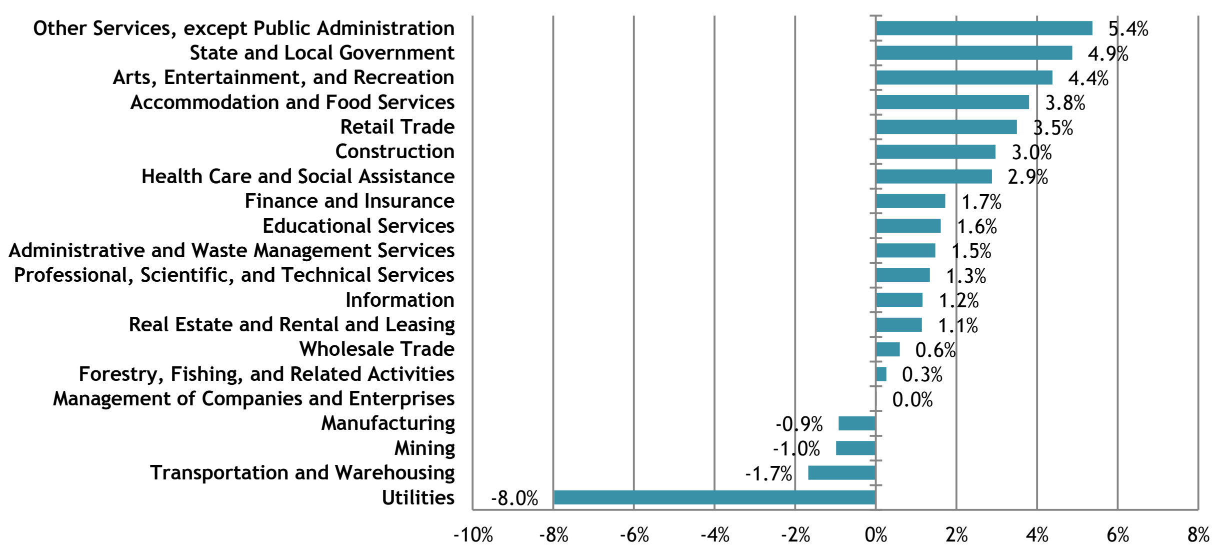


Figure 2.6 *– No industry sees a change in its 2030 output in case (1) greater than 8% (utilities, most of the change in power), and most industries stay between -2% and +4% in the results. The larger rebates from including transportation fuels and heating fuels in the carbon fee influences the higher results for the top series of numbers, where increased consumer spending and more rebates to employers boost their output in the long-term.*



GSP by Industry (case (1), millions of 2015 dollars)

Figure 2.7 *– Construction surges with an annual average improvement of over $1.2 billion in annual output in case (4). For context, the construction industry in all its forms (such as the construction of housing, commercial storefronts, industrial space, highways, and any other structures) currently has an output of $4.8 billion per year and employs 84,000 in the state. These figures increased significantly in the simulations for the efficiency-oriented case (4).*

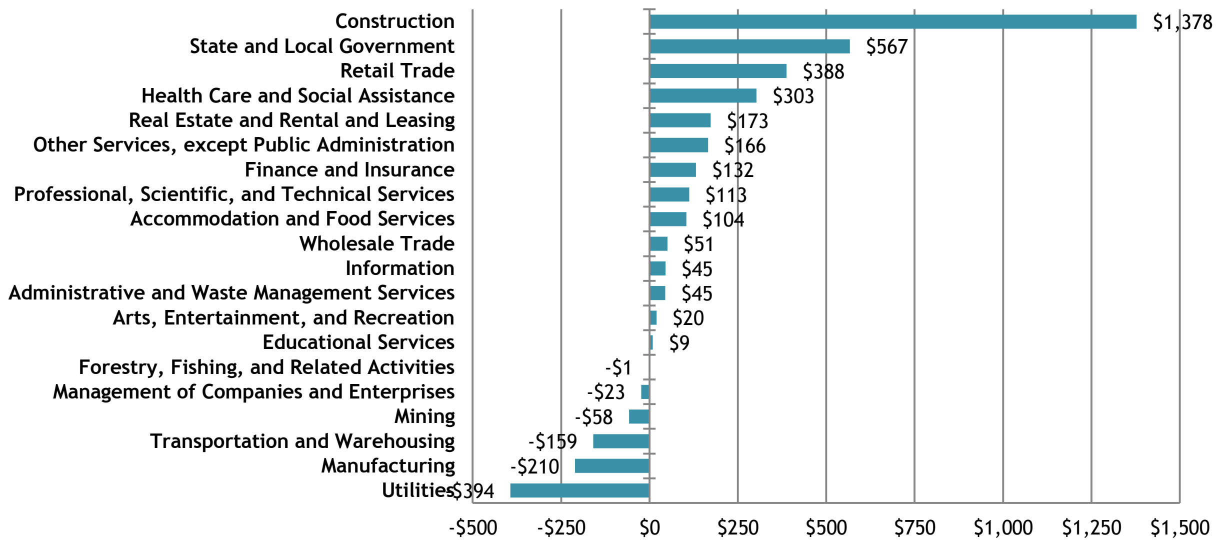
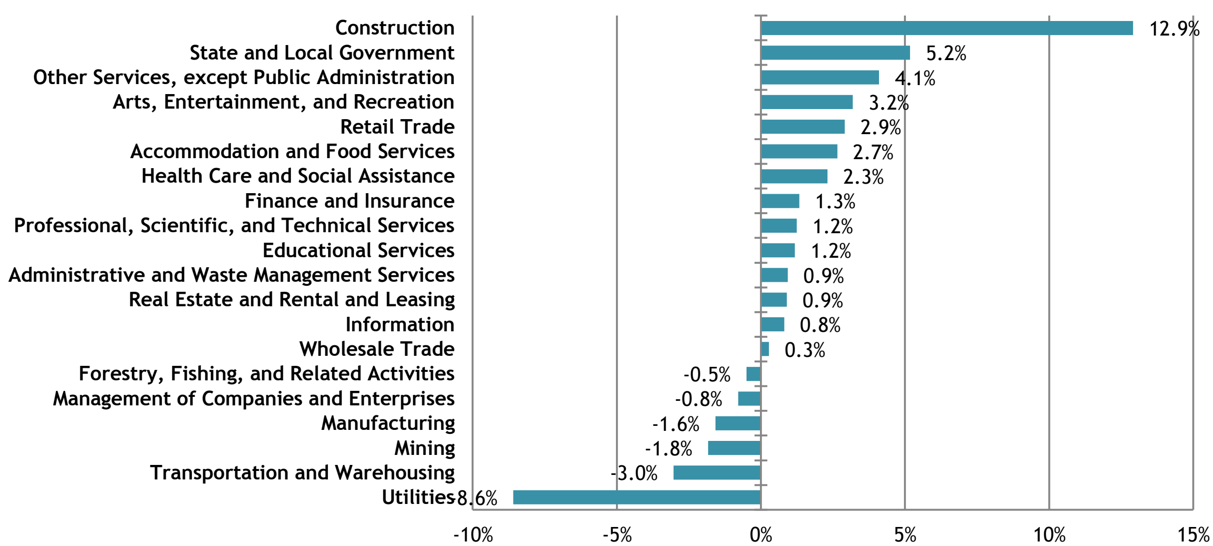


Figure 2.8 *– The impact on construction shows up, again, with a percentage change from its baseline (the annual average from 2017 to 2030) of around 13%. This would represent a substantial portion of the Arkansas economy, and the new jobs and investments that come with it, shifting into the efficiency, renovation, and retrofit activities embodied in the blue line. The remaining industries only show moderate changes of usually +/-3% save utilities. Its change of around 8% in the negative direction stays constant between all simulations.*



GSP by Manufacturing Sector (case (1), millions of 2015 dollars)

***Figure 2.9** – Most manufacturing sectors have a slight decrease in their contribution to GSP (the annual average, 2017 to 2030). Hence, manufacturing in Arkansas, and particularly in sectors such as chemicals, papers, primary metals, and food processing is more sensitive to changing prices in liquid and gaseous fuels than in electricity (in particular as the CPP would not affect transportation or heating costs as directly as it would electricity). Most of these changes, however, remain small adjustments against the total size of the industries.*

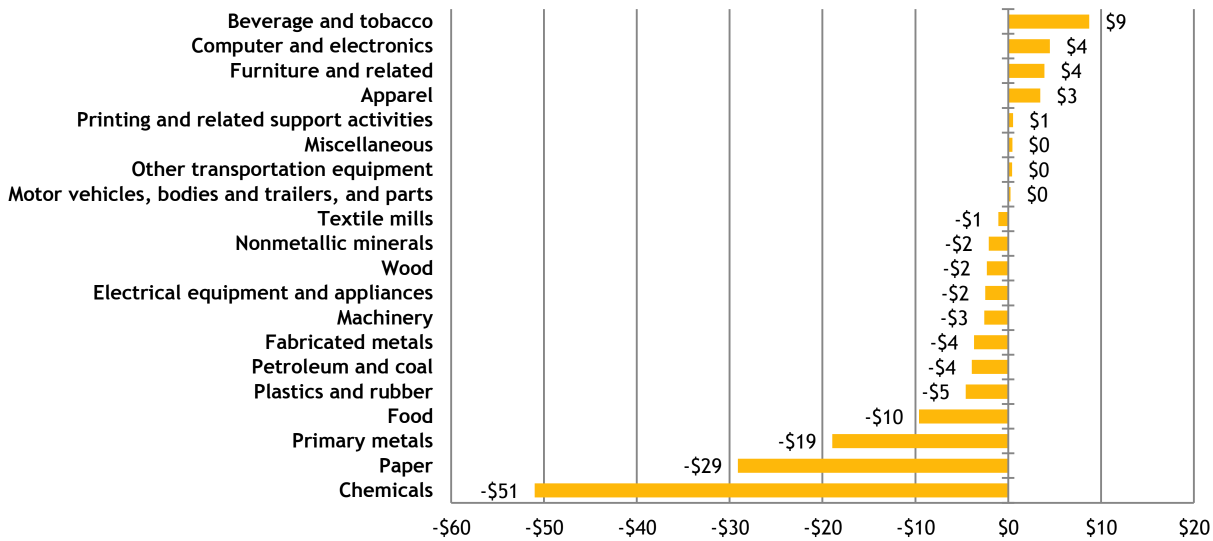
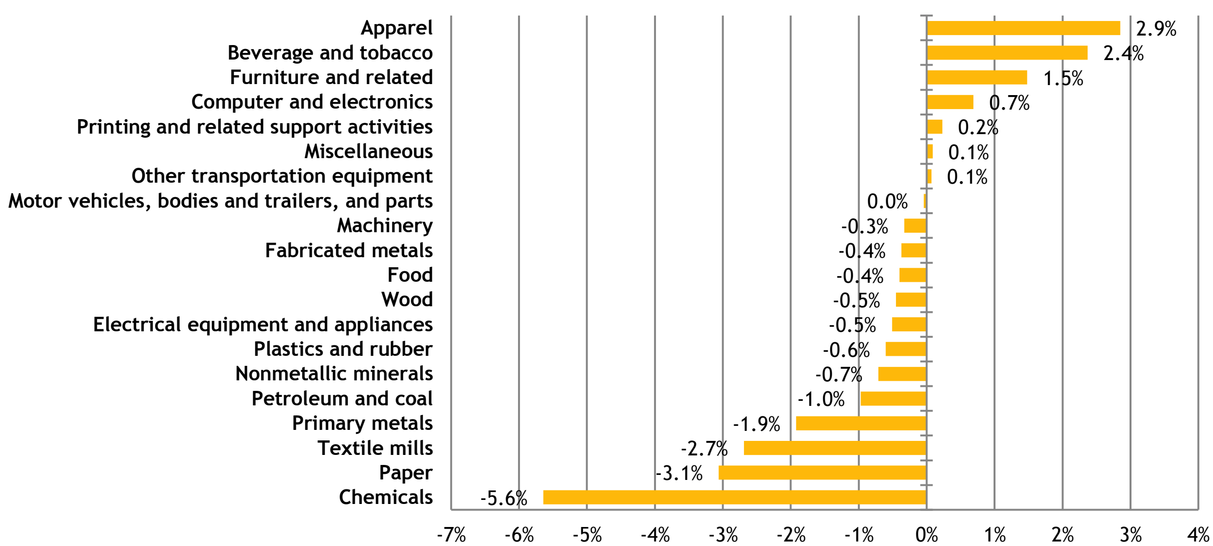


***Figure 2.10** – As described in **Figure 2.9**, the industry with the largest change is chemicals (with a fall of 5.5% from the baseline) with most industries amid +/-3% either direction. A handful of industries actually benefit with the carbon fee and dividends, particularly those related to local consumer spending, such as custom apparel, beverages, furniture, and the price-sensitive computers and electronics, lured by the rebates for its employees.*



GSP by Manufacturing Sector (case (1), millions of 2015 dollars)

Figure 2.11 *– The manufacturing results under case (4) follow the same general patterns as for case (1) though exaggerated. Reallocating 25% of the initial dollars leaves fewer funds for rebates, which has an influence on the output of price-sensitive industries such as computers, primary metals, the food-processing sector, and paper. Some of the industries related to supplying the construction sector and the production of equipment, such as the nonmetallic mineral products industry (stone, concrete, gravel, etc.) and wood/furniture, have a higher output in this scenario option for their linkage to that type of investment activity.*

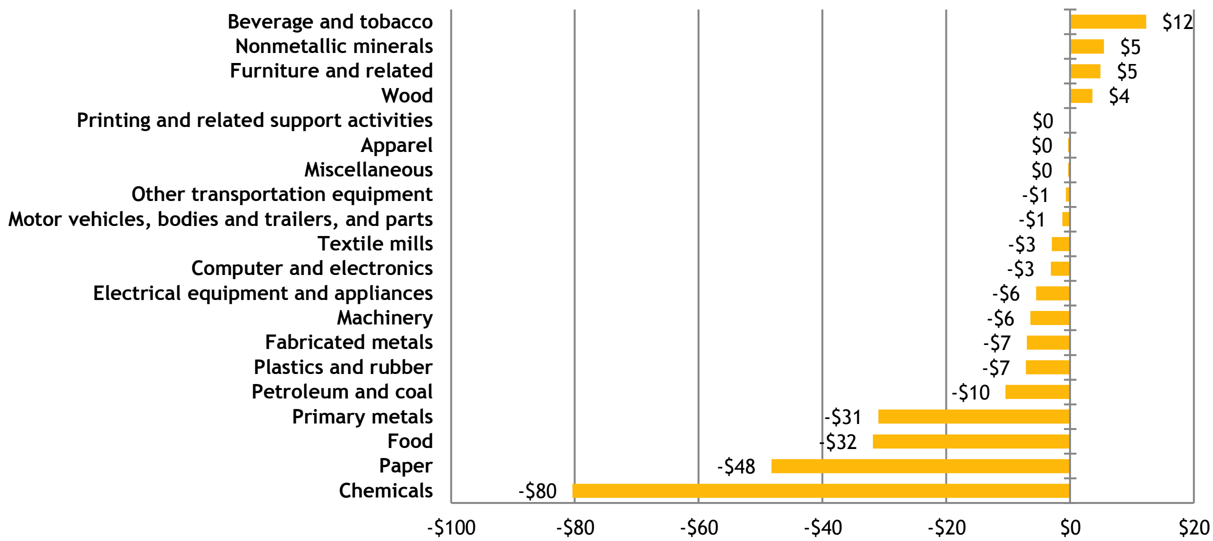
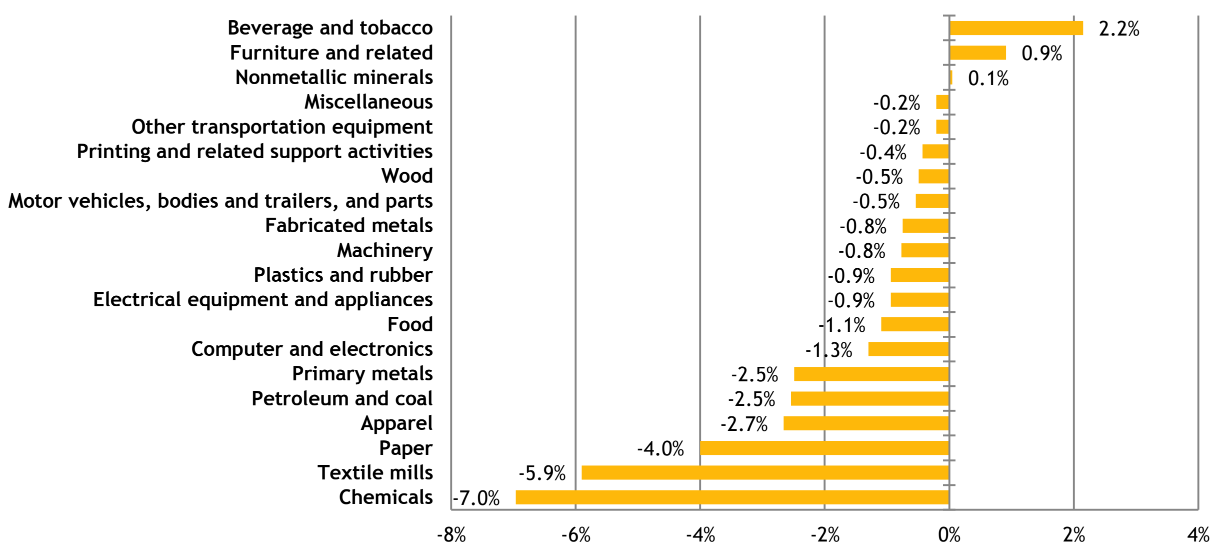


Figure 2.12 *– The percentage changes here remain small—most industries do not experience a change in their output more than 4%, and even chemical manufacturing remains under 10%. This is more sensitive than the research for the coastal states, but the declines in output here are less than the gains in the service sectors (with a net gain in GSP within Arkansas).*



Employment by Industry (case (1), # of jobs)

***Figure 2.13** – Here are the results to the labor market by industry. Most additional employment in Arkansas within these scenarios comes within state and local government, healthcare, retail, other services, construction, accommodation, or food service. These are all localized industries that would receive a heavy share of the dividend due to their closeness to consumer spending or their labor-heavy production methods to qualify for rebates.*

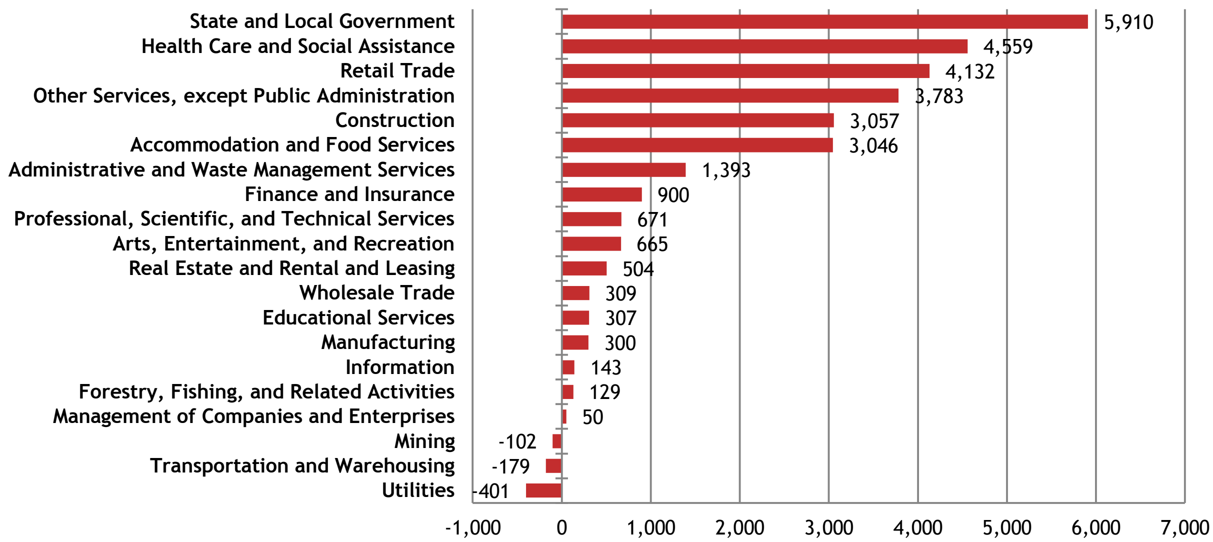
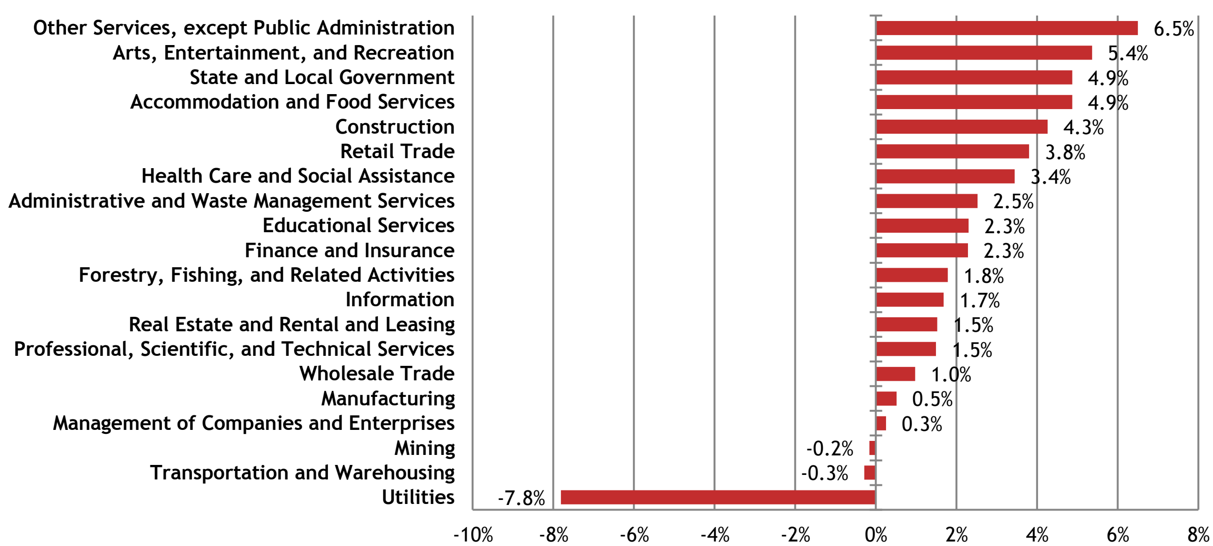


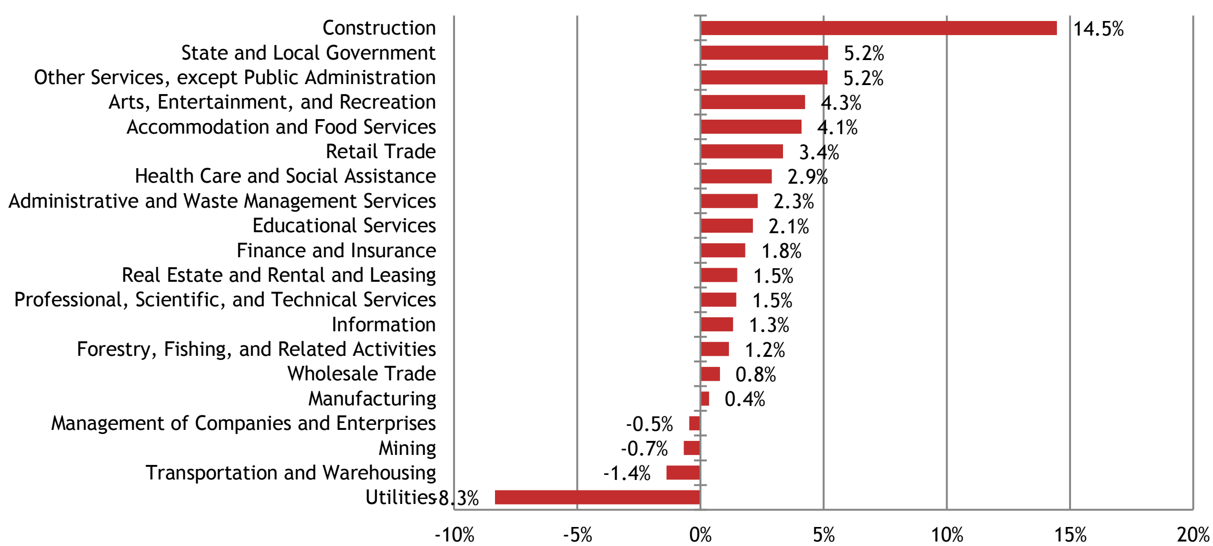
***Figure 2.14** – Nearly all industries have an increase in employment in percentage terms over the 2017 to 2030 period. Utilities sees most of its drop in power generation, with water and gas utilities likely near 0%, while even manufacturing employment stays close to the baseline. REMI accounts for the labor-intensity within the manufacturing sectors; thus, even a decline in the output of capital- and energy-intensive sectors such as chemicals and primary metals (aluminum, steel, copper, etc.) does not have a huge effect on the overall labor market.*



Employment by Industry (case (1), # of jobs)

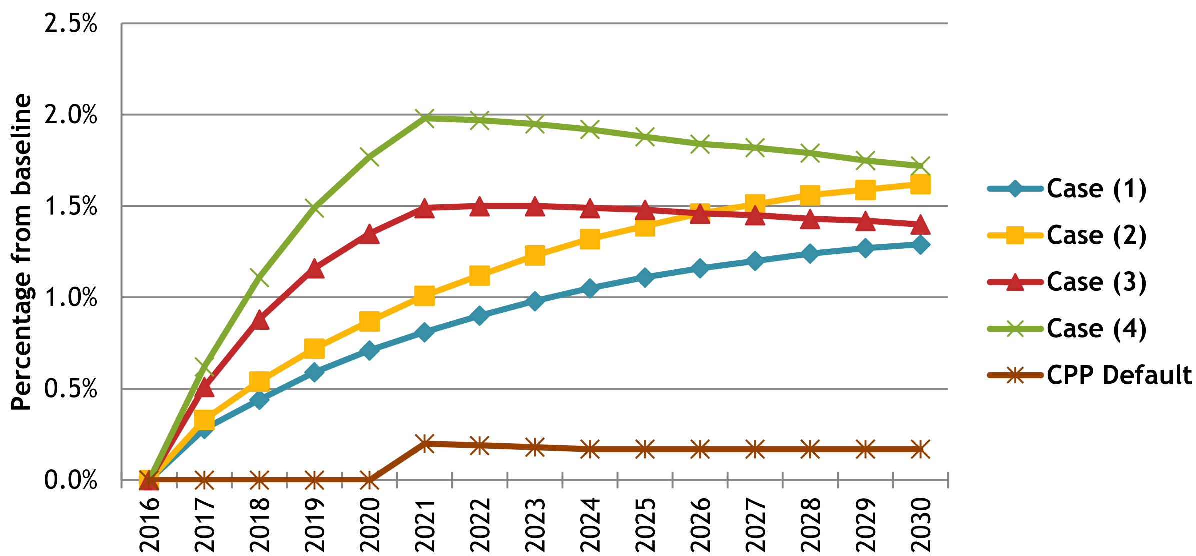
Figure 2.15 *– Results here are similar across most industries save construction. This is a direct artifact of routing 25% of the initial, run-up dollars into energy efficiency, which we then represented in the model with the construction industry. Those 20,000 jobs are the ones devoted to increasing the energy efficiency of the Arkansas economy in all its forms.*

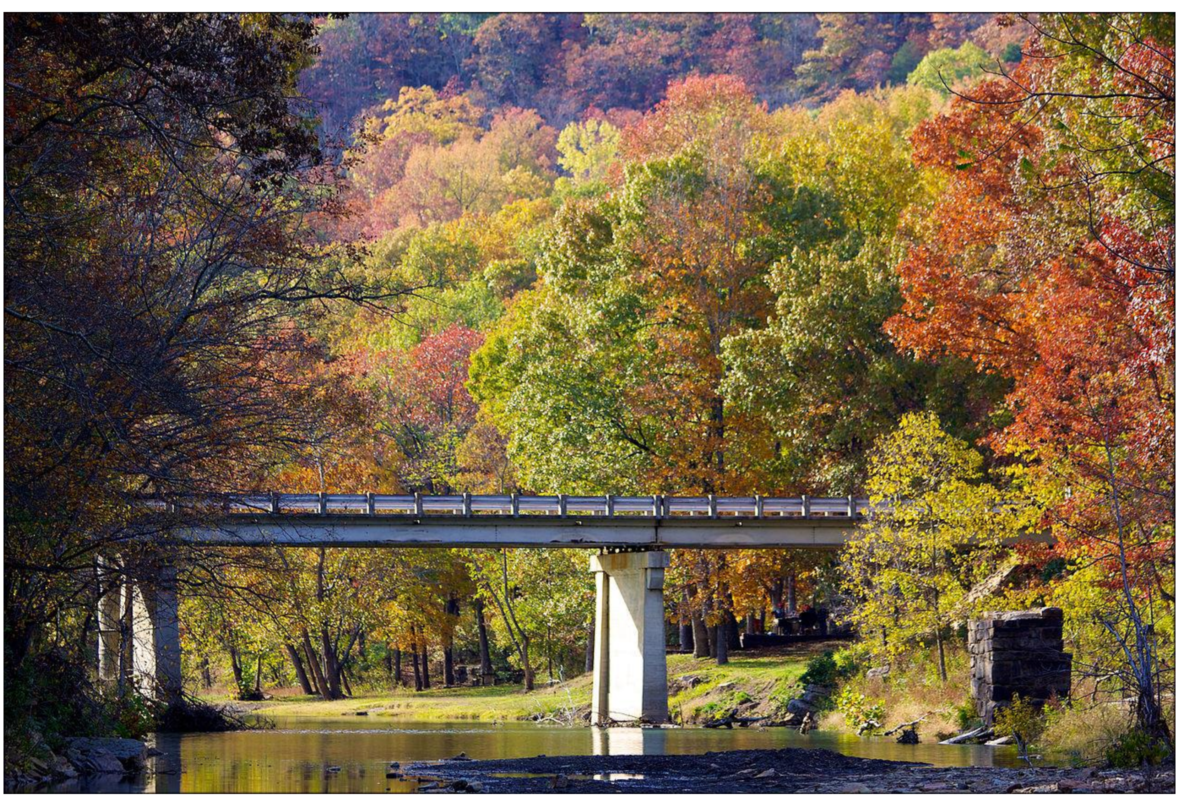
Figure 2.16 *– While 20,000 is many jobs in any industry, the construction industry in the Natural State is large enough that it represents between a 10% and 15% change (depending on the year modeled). The labor-intensity issue is on best display between these two figures with the utilities industry. Its output declines by 8% or 9%; yet, its employment in the interim's average is around 500 fewer jobs. Its average employee produces $500,000 in output in 2017 and nearly $800,000 by 2030, making the large swings in its output relatively unreflective of major changes in the labor market from its small demand for human hands.*



Cost of Living Index

Figure 2.17 *– Impacts with only electricity varied from 0.75% to 1.5% measured by the REMI internal cost of living index. Including liquid and gaseous fossil fuels increases this impact to a 1.5% to 2.0% range. While this does mean more of an impact on real incomes in the state, it still only equates to a single year's increase in cost of living distributed across a fifteen-year time horizon in the modeling. Couple this with higher dividends (with the broader base to the carbon fee) and displaced imports reduce this impact on households.*





Real Disposable Personal Income (RDPI)

Figure 2.18 *– As a reminder of the definition of RDPI, it is all income earned by households subtracting taxes and adjusted for the cost of living. Hence, this accounts for higher electricity, petroleum product, and natural gas prices that come with a carbon fee. Most of the increase comes from the rebate, increased demand for labor (with the shift in the industry mixture in Arkansas towards services and away from imported energy goods), and an overall larger population creating more need for housing, healthcare, retail, and other essentials.*

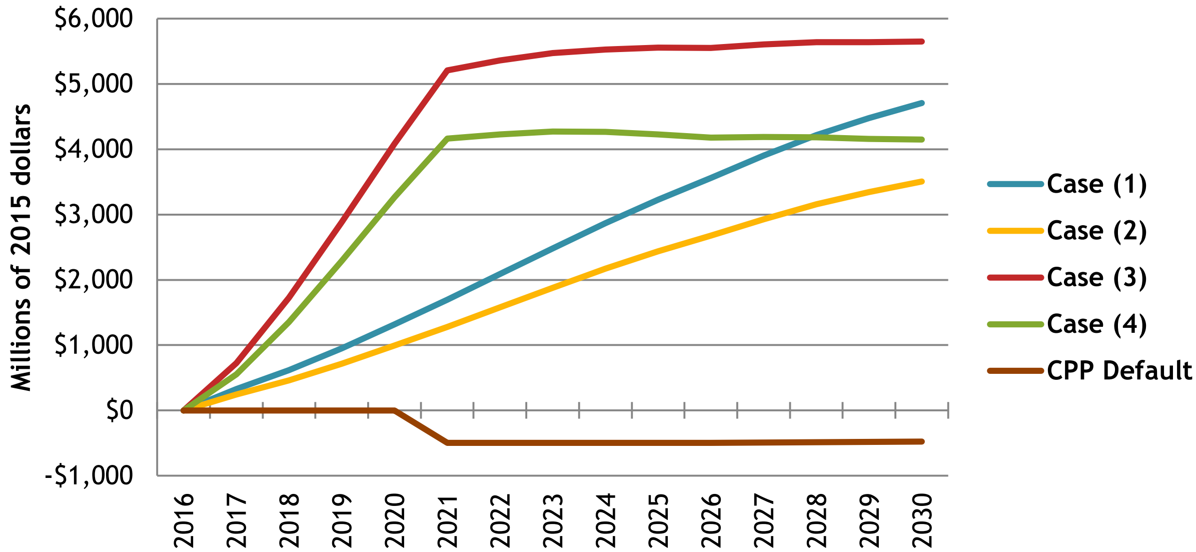
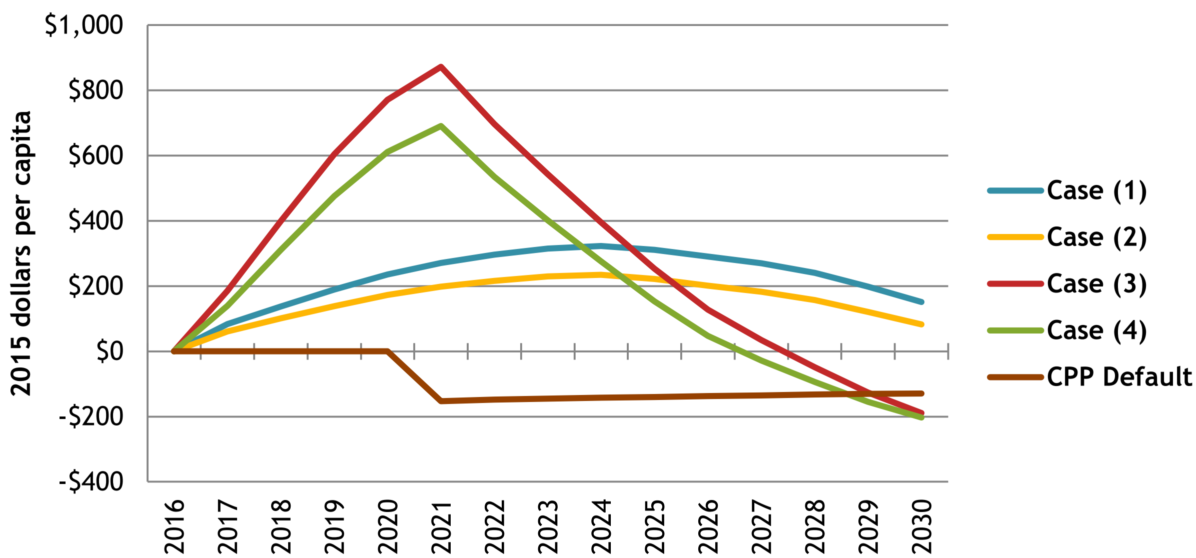
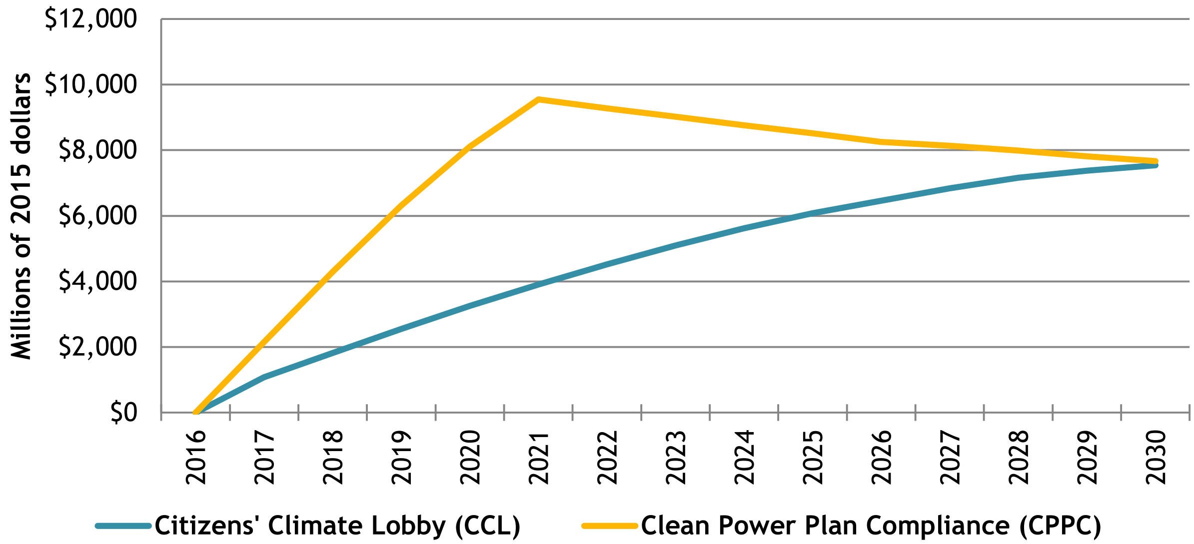


Figure 2.19 *– Real incomes per capita follow the curves from* ***Figure 2.18*** *adjusted for the response of the labor market, migration, and demographics in the Natural State. Case (3) and case (4) increase per capita RDPI by as much as $900 in the early years before the labor market reacts and more individuals and families move to the state. Eventual results to RDPI approach zero, though Arkansas now has both a larger economy and more people with it.*



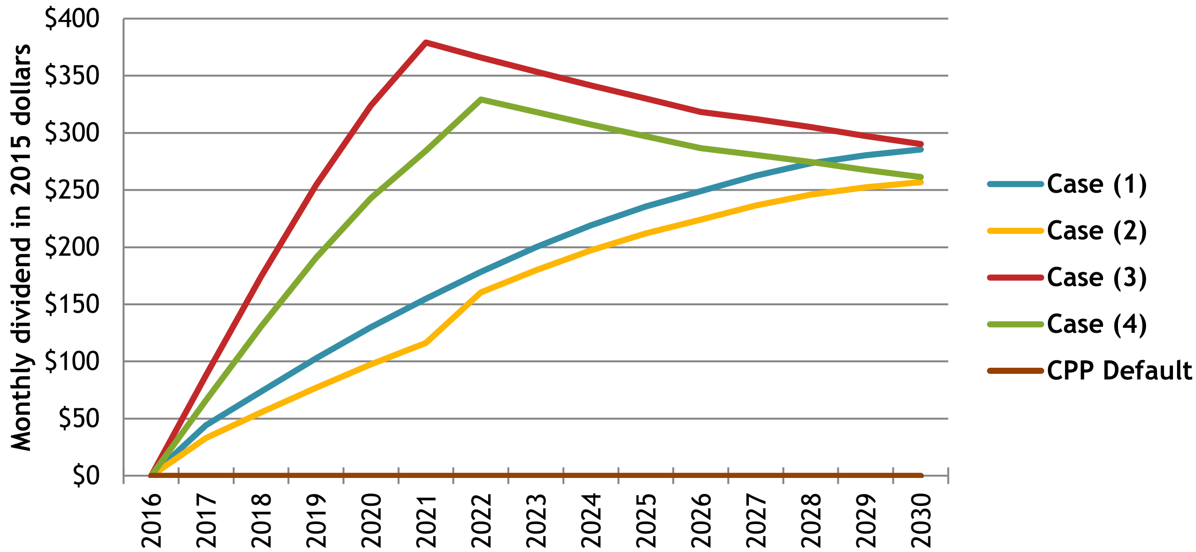
Fee Revenues

Figure 2.20 *– Current total carbon dioxide emission in Arkansas is around 72.5 million metric tons per year from EPA data. A simple calculation from the same of $15 per metric ton (CCL rate in the first year) or $30 per metric ton (CPPC rate) equals $1.1 and $2.1 billion in revenues in the first year, respectively, absent a price response. This is the observation in the results. This is enough revenue to retire a major revenue item in Little Rock's budget, like the sales and use tax or a large portion of the income tax. The results here prefer to route them into the rebates to individuals and employers on the following pages' figures and results.*



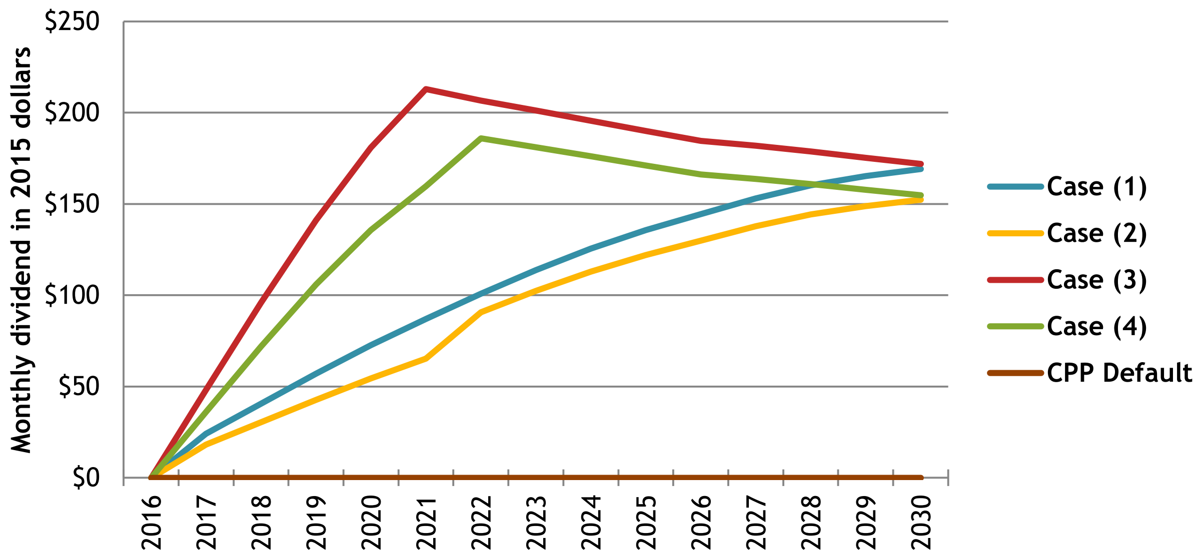
Household Rebate

Figure 2.21 *– Including liquid and gaseous fuels increases the size of the rebate to a peak of around $375 per month (in case (3) around 2021) with a long-term rebate in the $250 to $300 per month range. Including petroleum and natural gas in the fee would reduce the overall seasonality of the fee; while electricity consumption varies throughout the year with the use of air conditioning, the consumption of transportation fuels is more constant throughout the year. Heating fuels vary, as well, though not as much in a relatively southerly state.*



Employer Rebates

Figure 2.22 *– The employee rebate rises to $200 to $225 per employee at maximum and then eventually amid $150 and $175 (all in real 2015 dollars). To provide an example, while a business would have to face higher fossil energy costs, if an enterprise also employed twenty full-time equivalent workers, then it would receive $42,000 back in the annual rebate.*



Carbon Dioxide Emissions

Figure 2.23 *– With only electricity, emissions in the various cases declined to around 60 million metric tons of carbon dioxide per year. Including liquid and gaseous fuels brings this number close to 50 million metric tons per year. For context, the difference of 10 is around the annual emissions of Rhode Island (mostly a major metropolitan area in Providence). The overall difference from the baseline (around 30 million metric tons) by 2030 is equivalent to the current annual emissions from Montana, Nevada, or power generation in Iowa.*

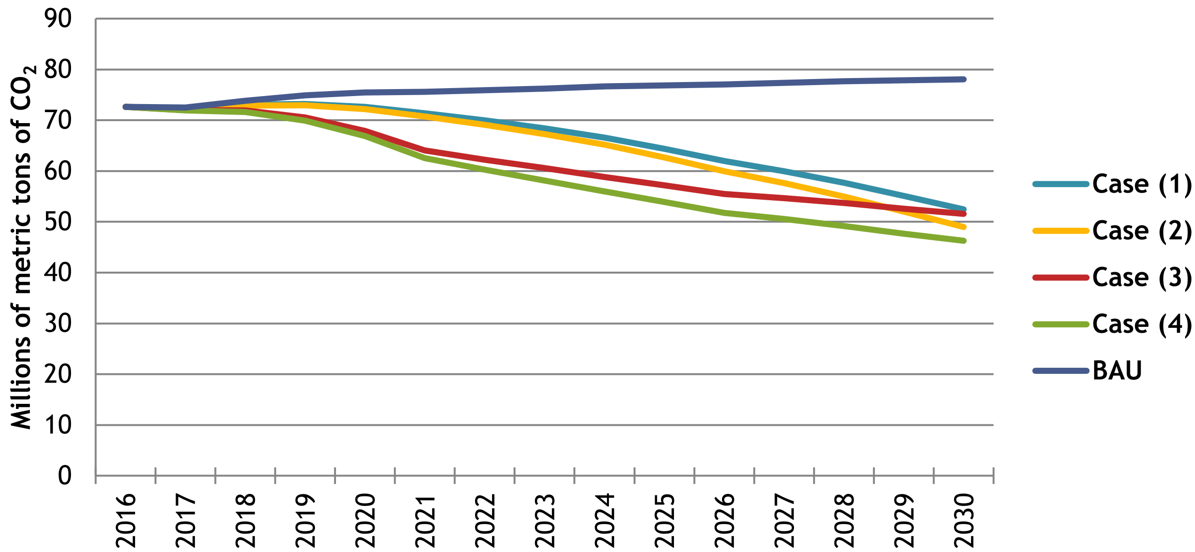
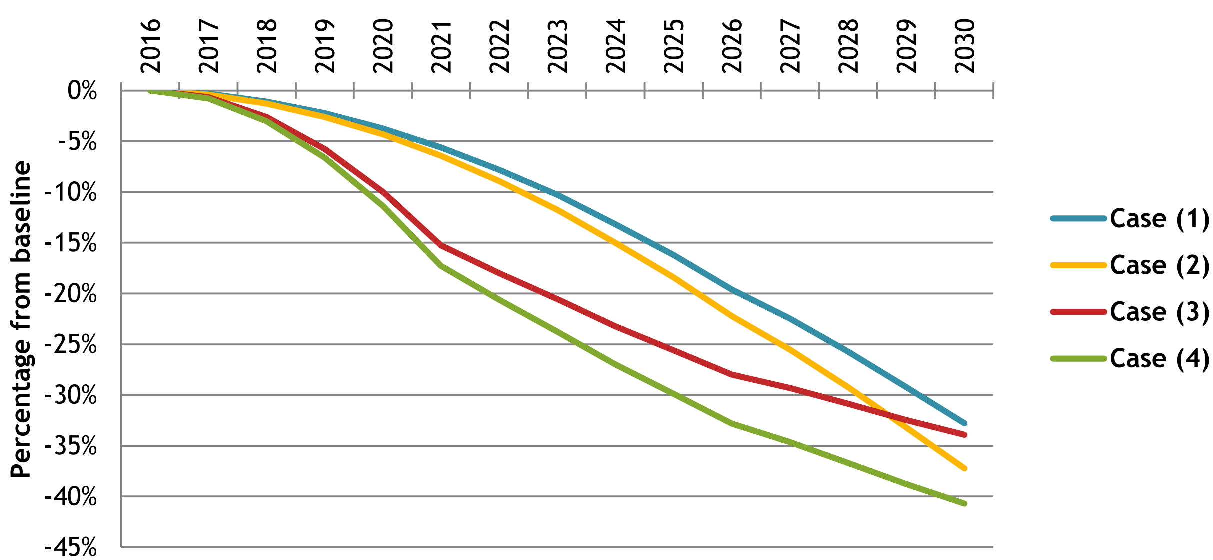


Figure 2.24 *– This recasts the data with the navy blue baseline as zero and the difference from the same. The fee reduces emissions from Arkansas of up to 15% in 2020 and up to 40% in 2030. Case (3) and (4) present the most reduction in emissions through the 2020s.* ***Power sector emissions are the same as the numbers in Figure 1.24 when including gas and petroleum—there is no change regarding compliance with the CPP.***



Population

Figure 2.25 *– Population increases with the carbon fee-and-dividend mostly from the improvement in the labor market. Higher costs of living may drive away some households. On the other hand, the overall lure of more job growth and availability makes up for this difference and brings the state's population to rise. This is why a factor such as per capita RDPI actually stays relatively close to the baseline, where labor mobility within the United States keeps one region from expanding in prosperity without attracting population.*

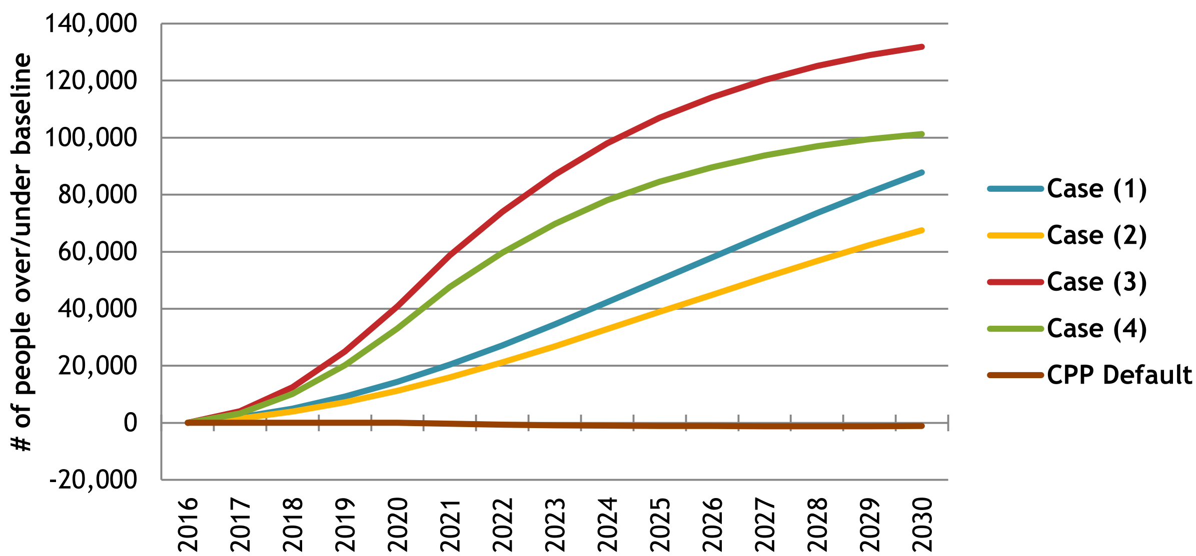
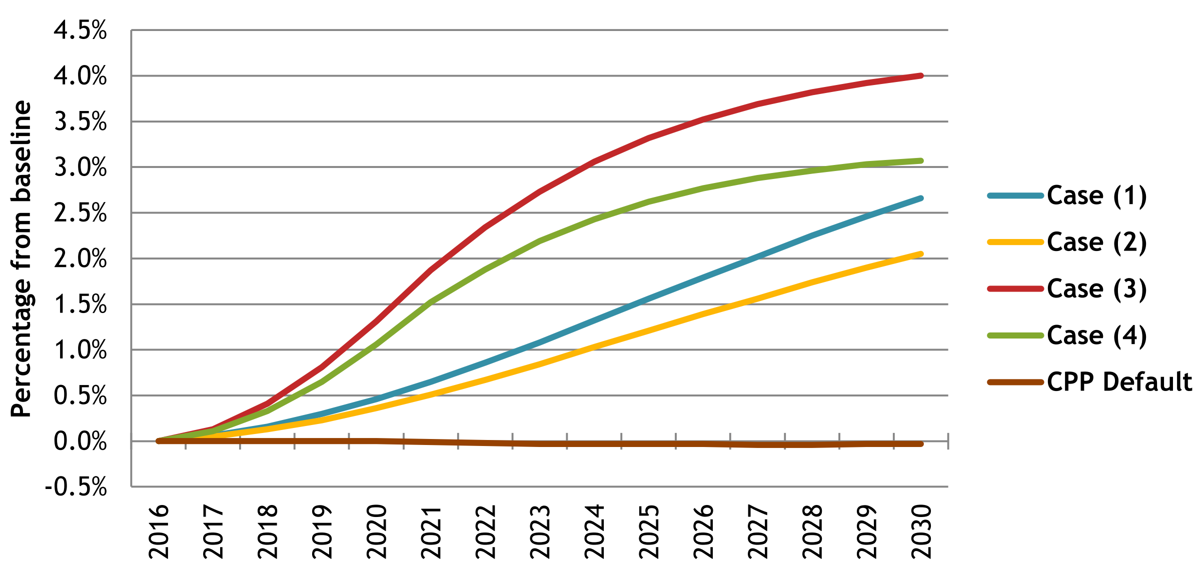


Figure 2.26 *– The below describes the population response to Arkansas in percentage terms. The rebates manage to attract enough people to increase the state's population by 3% over the baseline in 2030. Arkansas currently has a population of 3.0 million—the baseline in REMI has this increasing to 3.3 million in 2030 absent policy changes. These policies, in context, would make this number closer to 3.4 million because of its stronger economy.*



Methodology

Regional Economic Models, Inc. (REMI)

REMI is a software and consulting firm specializing in services related to regional modeling and assessing the economic, demographic, transportation, and fiscal implications of public policies. The firm incorporated in 1980 when a professor at the University of Massachusetts-Amherst, Dr. George Treyz, built a model of Massachusetts (the Massachusetts Economic Policy Analysis model, or MEPA prior to REMI).[40] The MEPA/REMI model was crucial in the assessment of the conversation of I-90 into a toll highway in the 1970s. Dr. Treyz used his model to assess any of the potential benefits from upgrading the level of service on the highway with funding derived from the tolls balanced with the costs of increasing transportation costs in the state and moving money out of the private economy and into the public sector. The current enterprise provides software, technical services, consulting reports, and issue expertise across the globe for 300+ clients in North America, Europe, Asia, and the Middle East. These groups include many federal agencies, state governments (47/50), provincial and regional authorities, cities, counties, many private consulting groups (such as major management consultants, defense contractors, and the "Big 4" accounting firms), nonprofit research groups, and 30+ academic institutions.[41] These groups use their own versions of the PI+, TranSight, or Tax-PI software packages[42] to examine policy questions and shed light on their likely economic implications in terms of jobs, GDP or equivalent, and personal income. REMI currently has an active part in policymaking and the analysis of the same in Arkansas. In the Natural State, the University of Arkansas-Little Rock (UALR) and the Institute for Economic Advancement subscribes to the service.[43] UALR uses REMI to assess a number of economic, demographic, and fiscal issues across the state, such as the exemption of military pension income from the state income tax. REMI also performed an analysis of the Big River steel mill in a consulting role for the Bureau of Legislative Research (BLR) in Little Rock for consumption by the state legislature.[44]

REMI PI+

REMI utilized a 1-region, 70-sector computerized model of the Arkansas economy as well as its underlying demographics to perform this analysis. The application of PI+ was in concert with a CTAM rebuild for Arkansas, code named "ARCTAM." The section describing ARCTAM and the integration between the two models is after the section on PI+. PI+ represents subnational units of the United States economy as dynamic, multiregional, and structural. The interface of the software derives from the ribbon featured in Microsoft Office products. The system contains over 6,000 exogenous "policy variables" to represent the direct effects of public policy decisions or private investments on the economy. These variables, of course, include the changes here to

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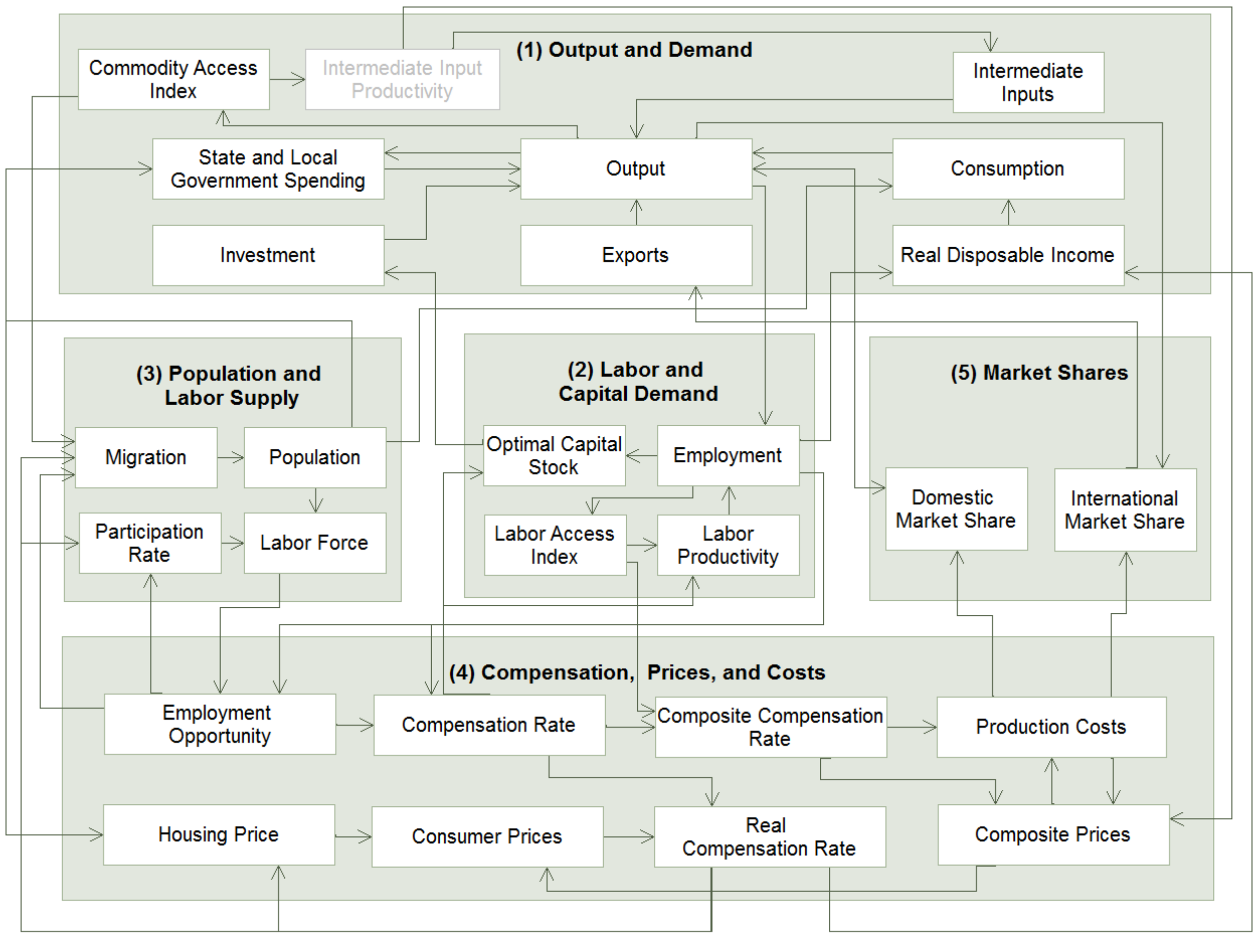
[40] George Treyz and Roy Williams, "The Massachusetts economic policy (MEPA) analysis model forecast," 1981, <https://archive.org/details/massachusettseco9811trey>
[41] For a full list, please see, <http://www.remi.com/clients>
[42] <http://www.remi.com/products>
[43] "The research unit also operates a variety of impact analysis and policy simulation models for use with assessing project economic benefits and for evaluating the economic impacts of different policies and programs," <http://iea.ualr.edu/centers-and-programs/economic-research.html>
[44] Lee Hogan, "Lawmakers discuss Big River steel project," *Arkansas Online*, March 25, 2013, <http://www.arkansasonline.com/news/2013/mar/25/lawmakers-discuss-big-river-steel-project/>

energy prices, investments in the construction and PFT industries, changes the total level of household income and net tax rates, and government spending.

***Figure 3.1** – The flowchart is the explicit linkages of cause-and-effect in the REMI model. A change in one "rectangle" will influence the rest of the model structure through a series of equations.*[45] *For instance, a change in output will stimulate businesses to hire, add to employment in the region, improve job prospects for all citizens, and induce a higher labor force participation rate as well as economic migration from other parts of the country.*



The REMI model relies on four primary methodologies and five secondary methodologies in its five blocks. This next section talks through each of the nine methodologies in their primary "homes" in each of the five blocks, in sequence:

1. *Block 1 – Output and Demand*

The output and demand block in the REMI model represents "the macroeconomy." It is what the economy wants to produce and purchase given current productivity, incomes, preferences, and prices. PI+ illustrates this through one of its secondary methodologies within Block 1, which

45 All of REMI's equations are peer-reviewed and available to the public, for the PDF, please see, <http://tinyurl.com/REMI-model-equations>

is **macroeconomic final demand** or **Keynesian aggregate demands**. "Output" is equivalent to gross domestic product (GDP) in the model, and its component parts (surrounding it in the above structure) include consumption, investments, government spending, and the net of exports minus imports. This is where total production in the economy comes together with total demand until they equal each other and take account of resource constraints and the actual preferences of businesses and consumers. Block 1 also features an **input-output (I/O) table** beneath the "intermediate inputs" rectangle. I/O modeling accounts for the linkages between industries in production supply-chains. For instance, if a consumer wishes to buy a car, then the automotive manufacturing industry (most likely in a state like Michigan or Alabama) builds it. However, a car factory has a long and complex supply-chain behind it. It might include bodies and parts manufacturers in Ohio, the steel mills of Indiana and Pennsylvania, and logistics from trucking companies in Chicago, railroads based in Omaha and Kansas City, and the boats on the Great Lakes, typically based out of ports in Wisconsin. They would all require materials from the ore mines of northern Minnesota and the Canadian Shield as well as animal products and leather from the feedlots in Montana and Texas. The I/O portion of the model takes strong account of this supply-chain effect inside the modeling.

2. *Block 2 – Labor and Capital Demand*

Block 2 in the PI$^+$ model features several methodologies to forecast the interplay between labor and capital in the economy. In general, "demand" for labor and capital comes from businesses in the model—they are the ones that need inputs, in the form of workers, equipment, software, or intellectual property, to meet the output demands from Block 1. Calculating labor productivity is crucial in this process, and the model uses **New Economic Geography** principles in adjusting productivity to the scale of local industry and the strength of local labor pools. For instance, in New England, the Boston metropolitan area (and the combined labor pool that stretches well into Rhode Island and New Hampshire) has a large, specialized labor force for such industries as scientific research, management consulting, mutual fund management, healthcare treatment and research, and education. The model recognizes these labor pools' contribution to the area's economy and gives the related industries productivity advantages. The same is true for firms in manufacturing or the related that need physical inputs. The model also has a **Ramsey-Cass-Koopmans** style model that adjusts for capital's persistence (a press might last for several years, even if only purchased in its first year of operation), its depreciation, and the need for replacement or added capital with new investment. The direction interaction between labor and capital takes place in a **Cobb-Douglas** model of factor substitution. Typically, businesses attempt to maximize their profits. One strategy for doing so is minimizing costs by picking the ideal mixture of labor and capital to perform tasks and, in some cases, choosing between the two. For instance, fast food restaurants would have the choice in some circumstances between paying a human cashier the market or the minimum wage versus installing a touch screen computer to take customers' orders. Both can perform the needed task, and the cashier comes with the added benefit of a human interaction (or more productivity), though the computer might be cheaper depending on how long it lasts in action, how easy it is to replace, and how quick comparable labor units are to replace. All of these interactions are present in Block 2 of the REMI model. **New Economic Geography** would adjust for the size and quality of the workforce, the **Ramsey** model looks at the durability of capital and the need for replacement, and the **Cobb-Douglas** aspects handle cost minimization and factor substitution. This allows the REMI model to take a detail account of the labor market and demand for net investments beyond a simply I/O transaction or simple multiplier.

3. Block 3 – Population and Labor Supply

This block of the model houses its demographic component and demographics' interaction with the economy. The fundamental, underlying methodology of Block 3 is a **Cohort-Component** survival model. The model bases net births and deaths on demographic characteristics such as age, gender, and race. Knowing an individual person's chance of living or dying in a given year, even with some basic information about their demographics and health, is next to impossible with any certainly because of the small sample size. Stretch that out over the thousands or even the millions with those characteristics in a region or the whole United States, then it becomes more predictable as a statistic problem. For fertility, the model works in much the same way, instead forecasting a woman's chance of having a baby (which is much more common in certain cohorts or certain races in certain states). Demographics interact with the economy in two major ways in the PI$^+$ model: (1) determining the composition of consumer spending as well as (2) the supply of labor. For example, an older state (such as Minnesota or Maine) will have a greater proportion of its consumer spending focus on the healthcare sector and a smaller labor force relative to the total size of its population because of its retirees ending their participation on the labor market. A young state, such as Utah or Oregon, is the opposite, where healthcare demand and the healthcare industry will be smaller and its population will have more available workers than the national average state. Long-term shifts in demographics change the final demand concepts in Block 1 as well as labor availability in Block 2.

4. Block 4 – Compensation, Prices, and Costs

Block 4 in PI$^+$ introduces two more methodologies: (1) **econometrics** and (2) **computable general equilibrium (CGE)**. **Econometrics** is present throughout the model is various ways, but it is strongest in Block 4 where it handles the statistical parameters of behavioral responses (always based on observed, historical parameters) towards changes in the markets regarding labor, housing, fuel, products, inputs, and several others. The econometric portion of the model would handle, for example, how much the purchase of kitchen appliances goes up or down in response to changing prices of blenders. **CGE** modeling attempts to balance the relative return to labor and capital across all regions of the United States. If Wisconsin has a high rate of unemployment and North Carolina has a low one then, overall, workers and households will be more willing to move to the Tar Heel State than the Badger State because of the higher "return to labor" on the labor market. The **CGE** portion of the model attempts to balance these sets of conditions over time and between regions, and the **econometrics** of the model works on the speed and strength of the responses inside of the system.

5. Block 5 – Market Shares

The market shares in the REMI model illustrate competitiveness and trade, both between the regions of the United States and with the rest of the world. PI$^+$ performs this type of analysis with a series of **gravity** models. Most regions of the United States have a few critical industries that drive their economy and exports while importing most of everything else. For example, the

Rochester, Minnesota area "exports" expert healthcare services to clients through the United States (and the world) and brings dollars back. Those dollars support local, consumer-centric industries such as housing and education. Without healthcare in Rochester, hotels and tourism in Las Vegas, Nevada, finance in New York or Charlotte, North Carolina, or carpet production in Dalton, Georgia, such regions have limited economic activity in other areas. PI+ uses **gravity** models to "tie" these regions together, where areas of excess production relative to local demand and population (such as petroleum refining in Texas and Louisiana) matchup with areas lacking in a needed good or service (such as the Great Plains state, which lack refineries but have heavy demand for fuels in their agricultural sector). These **gravity** models are not static, as well, as they adjust over time to changing demands, market conditions, costs, and competitiveness of regions versus other cities, states, and countries over time.

Policy Variables

For these simulations, we changed variables under five of the "rectangles" in *Figure 7.1* on the previous page. This represents the changing incentives of the carbon price in the economy of Arkansas. In addition, it summarizes how the model produced these results:

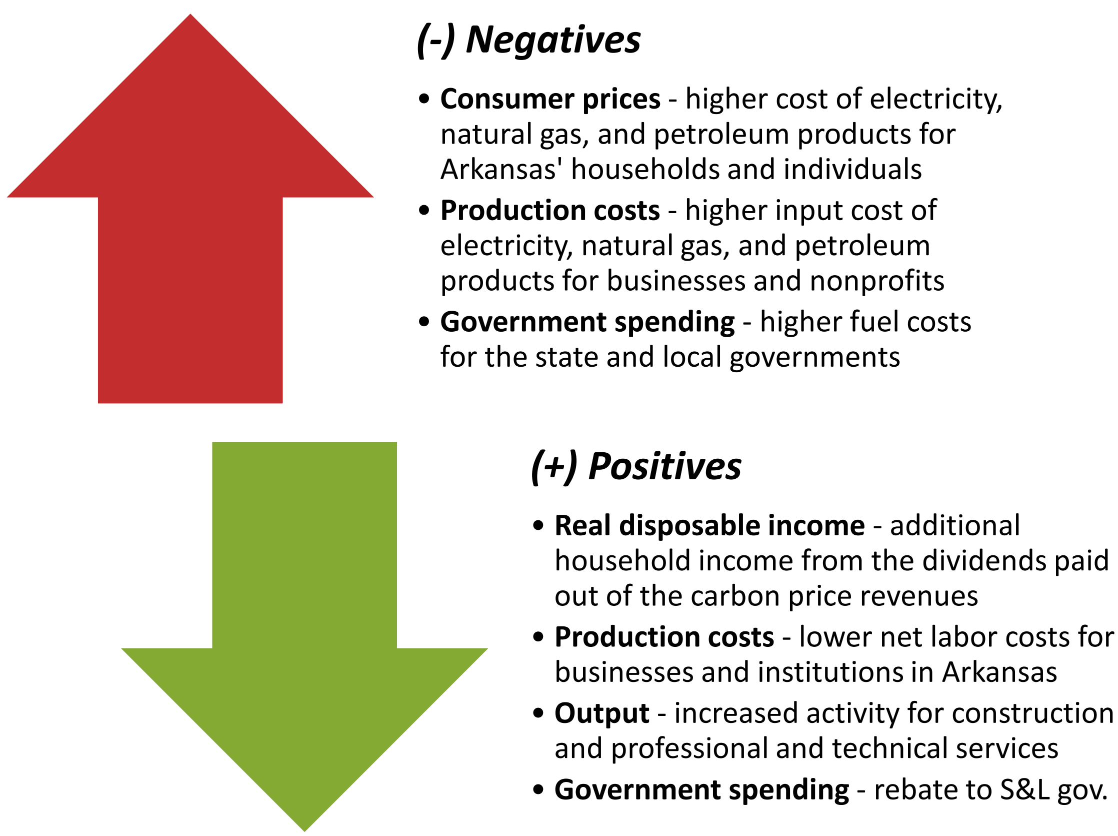
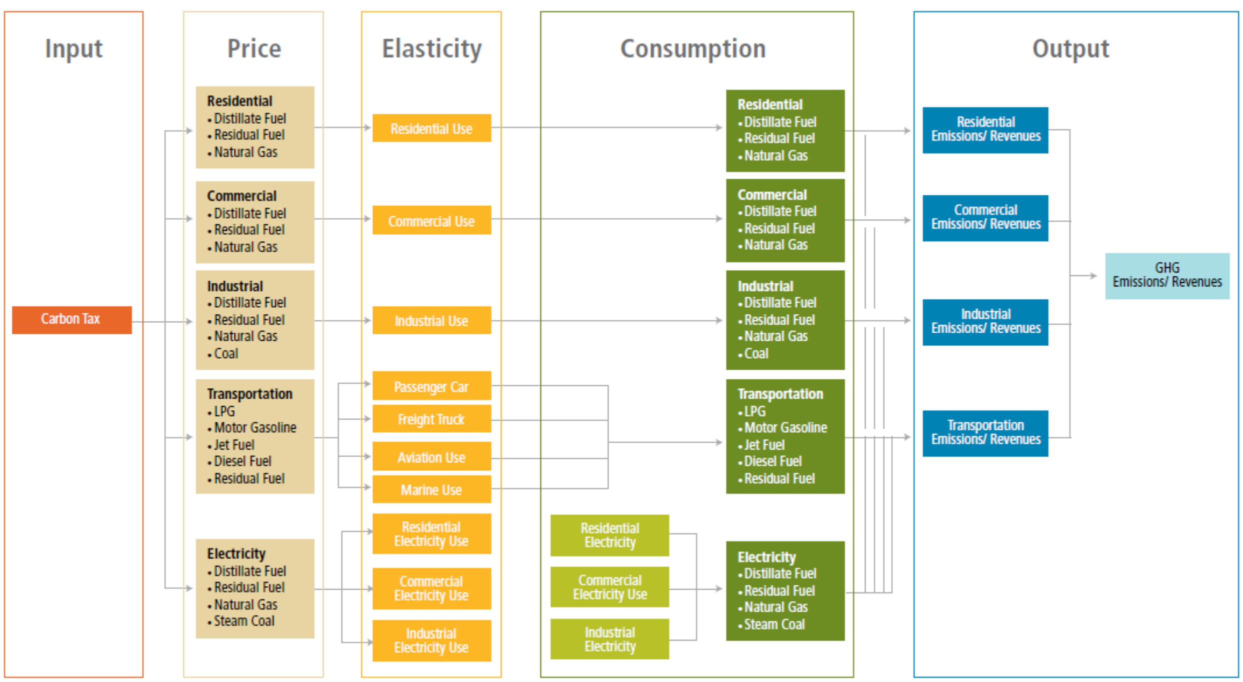


***Figure 3.2** – The "balance" describes the policy variables in the model structure used to illustrate the carbon price and four revenue scenarios. The monetary figures "removed" from the economy by the cardinal arrow equaled the money "returned" to the economy under the lime categories at the bottom. The exact numbers for the positives varied according to the exact scenario under analysis—for instance, cases (2) and (4) increased construction activity the most while cases (1) and (3) the most to RDPI directly and lowered production costs.*

Carbon Tax Analysis Model (CTAM)

We updated CTAM from Washington with West South Central and Arkansas data, which we describe here. The longer, fuller description of CTAM is available in its relevant documentation. In broad terms, CTAM uses projections from the EIA about the anticipated consumption of different fuel types (electricity, natural gas, and petroleum products) by U.S. Census regions.[46] EIA generates these forecasts with the National Energy Modeling System (NEMS), the internal government model of energy supply and demand.[47] CTAM shares these regional-level concepts down to the individual states. EIA projects energy consumption, which CTAM transforms into carbon dioxide by multiplying with emissions factors (i.e. every MMBTU of energy in a certain fuel category corresponds with a certain amount of carbon dioxide). These together allow the CTAM model to project baseline emissions in a state relying on the trends in the NEMS model. CTAM then adjusts emissions over time based on price elasticity of demand, or the sensitivity of consumers to higher energy costs. For instance, if the elasticity is -0.6, then a 10% increase in gasoline prices (multiplied by -0.6) leads to a -6% decrease in the consumption of gasoline. The default parameters in CTAM for price elasticity come from a literature survey, though we used the updated parameters for West South Central from the econometrics of PI⁺.

Figure 3.3 – This is the structure of logic in the CTAM model. A carbon price, on the left, leads to a change in prices based on emissions. The elasticity changes the quantity consumed, which then reduces carbon dioxide emission. The change in price feeds into the REMI PI⁺ model while tax revenues and emissions are interesting results from ARCTAM on their own.



46 A division of the United States into 9-regions with similar demographics, industry mixtures, and energy sectors, which has a "West South Central" or "WSC" region with Arkansas included in a larger region with Louisiana, Oklahoma, and Texas , for more information, <https://www.census.gov/geo/reference/gtc/gtc_census_divreg.html>

47 For an introduction, please see, <http://www.eia.gov/oiaf/aeo/overview/>

Integrating PI^+ and CTAM

After ARCTAM,[48] we completed a bridge between emissions and revenues of the carbon model into the economic model. CTAM has four major sectors of its "economy"—they are residential, commercial, industrial, and transportation in that model. The majority of carbon dioxide comes from transportation/motor gasoline, which sees use by both households and businesses in the real economy. This requires splitting the CTAM data into individual and business consumption when running a simulation. As an example, we imported a change in gasoline to households to the PI^+ variable for consumer prices and the cost to households to REMI's production costs. CTAM has more data available than REMI in terms of fuel types, as reported in *Figure 3.3*, so the REMI inputs agglomerated those inputs into simpler types for electricity, natural gas, and petroleum products alone. The following table describes the linkages:

	CTAM	PI^+
Residential	Kerosene, Distillate Fuel Oil	Consumer Price (Fuel Oil and Other Fuels)
	Natural Gas	Consumer Price (Natural Gas)
	Electricity	Consumer Price (Electricity)
Commercial	Liquefied Petroleum Gases, Motor Gasoline, Kerosene, Distillate Fuel Oil	Residual (Commercial Sectors) Fuel Costs, Government Spending
	Natural Gas	Natural Gas (Commercial Sectors) Fuel Costs, Government Spending
	Electricity	Electricity (Commercial Sectors) Fuel Costs, Government Spending
Industrial	Motor Gasoline, Distillate Fuel Oil	Residual (Industrial Sectors) Fuel Costs
	Natural Gas	Natural Gas (Industrial Sectors) Fuel Costs
	Electricity	Electricity (Industrial Sectors) Fuel Costs
Transportation	Motor Gasoline	Consumer Price (Motor Vehicle Fuels, Lubricants, and Fluids), Residual (Commercial Sectors) Fuel Costs, Government Spending), Residual (Industrial Sectors) Fuel Costs
	Distillate Fuel Oil	Consumer Price (Motor Vehicle Fuels, Lubricants, and Fluids), Residual (Commercial Sectors) Fuel Costs, Government Spending), Residual (Industrial Sectors) Fuel Costs
	Natural Gas	Consumer Price (Natural Gas)
	Electricity	Consumer Price (Electricity)

Figure 3.4 *– This shows the revenue categories in ARCTAM mapped into the price variables in REMI* PI^+*. These price changes generate effects on the region's competitiveness for industry and its attractiveness as a location for households' through the cost-of-living.*

[48] Efficiency parameters from the VACTAM study, "A Report to the Vermont General Assembly: Meeting the Thermal Efficiency Goals for Vermont Buildings," *Thermal Efficiency Task Force*, January 2013, <http://publicservice.vermont.gov/sites/psd/files/Topics/Energy_Efficiency/TETF/TETF%20Report%20to%20the%20Legislature_FINAL_1_15_13_2.pdf>

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Scott Nystrom[49] received his B.A. in history, his B.S. in economics, and his M.A. in economic history from Iowa State University[50] in Ames, IA. He has worked for REMI since 2011, and he is the main point of contact in its Washington, DC office for training, technical support, and for economic consulting. Mr. Nystrom works on a daily basis with clients across the United States and the rest of the world in state government, federal organs, provincial authorities, regional councils, consulting firms, universities, foundations, and non-profit research groups. His major projects have included economic analyses of the federal "fiscal cliff,"[51] Keystone XL pipeline,[52] the $500 billion long-range regional plan for Southern California Association of Governments (SCAG),[53] and Medicaid expansion (with county-level details) in North Carolina.[54] His work on carbon taxes includes similar analyses for Massachusetts, Washington, California, and at the national-level for Citizens' Climate Lobby (CCL) in concert with Synapse Energy Economics[55] out of Cambridge, Massachusetts. His other responsibilities include integrating energy models with REMI PI+, modeling transportation, commuting patterns, and business development and client service travel throughout Canada and the United States.

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49 Please see, <https://www.linkedin.com/pub/scott-nystrom/5b/274/337>
50 <http://www.iastate.edu/>
51 Scott Nystrom, Chris Brown, and David Brown, "Cheating the Future: The Price for Not Fixing Entitlements," *Third Way*, February 2013, <http://content.thirdway.org/publications/656/Third_Way_Report_-_Cheating_the_Future_The_Price_of_Not_Fixing_Entitlements.pdf>
52 Scott Nystrom and William W. Wade, "The Keystone XL Pipeline: REMI Estimates of Economic Impacts from Construction and Operations based on the Keystone Record," *Energy and Water Economics*, February 29, 2012, <http://tinyurl.com/nff6bnt>
53 Scott Nystrom and Zilin Cui, <http://rtpscs.scag.ca.gov/Pages/default.aspx>
54 Sara Wood, "Business Brief: Study shows expanding Medicaid would benefit NC economy," *National Public Radio (NPR)*, February 18, 2013, <http://whqr.org/post/business-brief-study-shows-expanding-medicaid-would-benefit-nc-economy>
55 <http://www.synapse-energy.com/>

Notes