Damaging Consequences

The Economic Impact of a Federal Carbon Tax

By Rea S. Hederman Jr., Sai C. Martha, and Aswin Prabhakar

THE BUCKEYE INSTITUTE

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Executive Summary

Climate activists have pursued net-zero carbon emissions polices at the federal level with scant success. The Obama and Biden administrations tried using regulatory and fiscal policies to achieve net-zero goals but were stymied by voters and the Supreme Court. With Republicans in control of Congress and the White House, environmental activists have now resorted to public nuisance litigation in state courts, publicly acknowledging their goal of imposing "an indirect carbon tax" as part of their environmental, social, and governance (ESG) agenda.[1]

To gauge the effects that net-zero policies would have on the American economy, The Buckeye Institute used its macroeconomic model—STELA—to simulate an $800 billion annual carbon tax as a proxy for various ESG plans. The tax burden splits evenly between energy companies and consumers as producers absorb some of the cost and raise prices to cover the balance. The result: U.S. gross domestic product (GDP) would contract by $980.4 billion, the economy would shed nearly two million jobs, and the per capita output loss would reach $2,900.

Scenario One: Cost of a Federal Carbon Tax to Achieve Net-Zero Carbon Emissions (2027)

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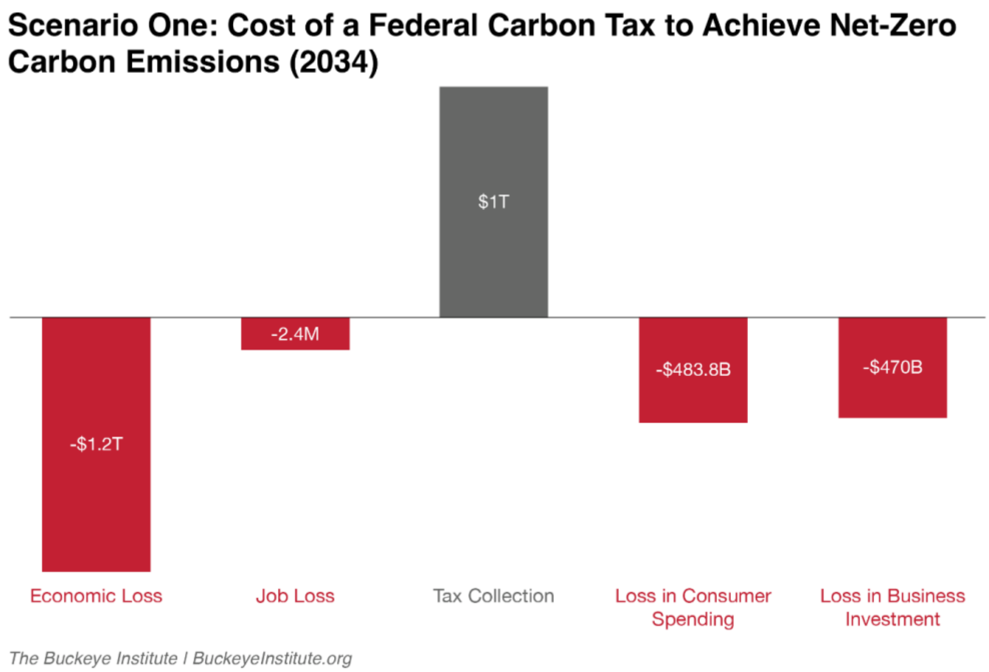
[1] Kamden Mulder, **Lawyer Behind Colorado Climate Suite Says the Quiet Part Out Loud: Litigation is a Tax on Oil Companies**, NationalReview.com, October 20, 2025.

By 2034, annual GDP losses would grow to $1.2 trillion, with 2.4 million jobs lost.



Introduction

Liberals have been trying to enact heavy-handed climate change policies for decades but have been consistently thwarted by voters and the judiciary. Congress refuses to pass sweeping energy policies aimed at achieving net-zero carbon emissions because they are unpopular. The Obama and Biden administrations imposed some climate policies through executive orders, international treaties, and bureaucratic agency regulations, but the Supreme Court and the Trump administration have rejected many of those efforts.[2] Undaunted, climate activists have filed novel legal actions in state courts to pursue their interests through public nuisance litigation. If successful, the lawsuits and net-zero policies will increase the price of electricity, food, goods, and services. Europe's higher energy and production costs are an economic warning that U.S. policymakers would be wise to heed. Slower growth, lost jobs, and a weaker economy today and tomorrow are the inevitable consequences of the misguided net-zero, ESG agenda.

[2] ***West Virginia v. EPA***, 597 U.S. 697 (2022).

The High Price of Net-Zero Policies

Proponents of net-zero carbon emissions policies tried unsuccessfully to impose their agenda on U.S. households and businesses during the Obama and Biden administrations. President Obama proposed the Clean Power Plan, sweeping regulatory legislation that was rebuffed by the courts but revived by President Biden via executive orders and federal subsidies. Both efforts severely restricted carbon emissions by power plants, automobiles, and farms; and both heavily subsidized intermittent energy sources like wind and solar. Their policies mimicked those adopted by the European Union (EU), which tax carbon emissions, subsidize intermittent energy sources, and have dramatically increased EU energy prices.[3] European leaders now recognize that these climate-control policies and higher prices have put their businesses at a competitive disadvantage.[4]

The Biden administration ignored Europe's peril, immediately joined the Paris Climate Accords, restricted carbon emissions at gas and coal powerplants, and mandated that most cars and trucks sold in the U.S. would be all-electric by 2032.[5] The regulations were so onerous and economically disruptive that the Biden administration slowed the timeline and rescinded some initial requirements to avoid mass layoffs, steep corporate losses, and disgruntled voters. Other policy proposals would have raised diesel and fertilizer prices, and restricted loans and financial support for farmers. Had they been fully implemented, the Biden-era climate policies would have cost the Ohio economy $3.2 billion and 10,000 jobs by 2032,[6] raised operating costs for small farms by over 30 percent, and added $1300 to a typical family's annual grocery bill.[7]

Most of the Biden administration's costly policies have been rejected by courts or repealed by the second Trump administration, leading net-zero advocates to sue

[3] **Ohio Cannot Afford the European Union's Energy policies,** The Buckeye Institute, December 23, 2016.
[4] Mario Draghi et al, **The Future of European Competitiveness**, European Commission, September 2024.
[5] Coral Davenport, **E.P.A Lays Out Rules to Turbocharge Sales of Electric Cars and Trucks**, *The New York Times*, April 12, 2023.
[6] Rea S. Hederman Jr., Michael E. Reed, and Trevor Lewis, **The Economic Impact of a Potential New Clean Power Plan on Ohio and California**, The Buckeye Institute, April 12, 2023.
[7] Trevor Lewis and M. Ankith Reddy, **Net-Zero Climate Control Policies Will Fail the Family Farm**, The Buckeye Institute, February 7, 2024.

energy companies under the public nuisance doctrine. This novel legal strategy abuses the historical use of public nuisance law and relies on questionable economics to calculate the liability of energy producers.[8] As their proponents admits, awarded nuisance damages would effectively impose a backdoor carbon tax, which will raise business and energy costs and ultimately mean higher prices for goods and services for American families.[9] To achieve net-zero carbon emissions, some climate activists estimate that an annual $800 billion carbon tax would be necessary.[10]

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[8] Rea S. Hederman Jr., David C. Tryon, Sai C. Murtha, and Aswin Prabhakar, **Climate Change as a Public Nuisance: A Backdoor Scheme to Dictate America's Energy Policy**, The Buckeye Institute, April 9, 2026.
[9] Kamden Mulder, **Lawyer Behind Colorado Climate Suite Says the Quiet Part Out Loud: Litigation is a Tax on Oil Companies**, NationalReview.com, October 20, 2025.
[10] Citizens' Climate Lobby, **Why Put a Price on Carbon?** (Last visited April 9, 2026).

Modeling A Federal Carbon Tax Impact on the Economy

Economists modeled the economic impact of net-zero carbon emissions using an $800 billion annual carbon tax as an effective proxy for the regulatory or judicial actions needed to achieve the net-zero objective. The tax burden splits evenly between energy companies and consumers as producers absorb part of the cost and pass along the balance through higher prices.

Federally or judicially imposed abatements on this scale would act like a tax on American energy production and consumption. Using STELA, The Buckeye Institute's dynamic scoring model, economists estimated the impact of such abatements on the U.S. economy.

Scenario One: Cost of a Federal Carbon Tax to Achieve Net-Zero Carbon Emissions

This scenario models the economic effects of a court-ordered abatement of carbon emissions, using an $800 billion annual carbon tax as an effective proxy. The tax burden is split evenly between energy companies and consumers, reflecting that producers absorb part of the cost while passing the remainder through as higher prices. STELA's model estimates changes in GDP, investment, consumer spending, and employment.

Table I presents the dynamic effects of this scenario. In 2027, GDP would decrease by $980.4 billion (2024 dollars); investment would decline by $385.8 billion; consumer spending would fall by $378.4 billion; and the economy would shed two million jobs. On a per capita basis, every American would bear nearly $2,900 in lost economic output. By 2034, annual GDP losses would grow to $1.2 trillion, investment would decline by $470.0 billion, consumer spending would fall by $483.8 billion, and 2.4 million jobs would be lost, as the sustained tax burden compounds across the economy.

Table I | Scenario One: Cost of a Federal Carbon Tax to Achieve Net-Zero Carbon Emissions

Dollar figures are in millions of 2024 dollars. Employment figures are in thousands of persons.

Year	2027	2028	2029	2030	2031	2032	2033	2034
Baseline GDP	$31,891,116	$32,847,850	$33,833,285	$34,848,284	$35,893,733	$36,970,545	$38,079,661	$39,222,051
Change to GDP	($980,390)	($1,009,150)	($1,038,240)	($1,068,070)	($1,098,740)	($1,130,300)	($1,162,790)	($1,196,220)
Baseline Employment	174,360	179,590	184,980	190,530	196,250	202,140	208,200	214,450
Change to Employment	(1,989)	(2,043)	(2,098)	(2,154)	(2,212)	(2,271)	(2,333)	(2,396)
Baseline Tax Revenue	$3,387,262	$3,488,880	$3,593,546	$3,701,353	$3,812,393	$3,926,765	$4,044,568	$4,165,905
Change to Tax Revenue	$823,590	$848,280	$873,760	$900,010	$927,060	$954,920	$983,610	$1,013,160
Baseline Consumption	$21,654,068	$22,303,690	$22,972,801	$23,661,985	$24,371,844	$25,103,000	$25,856,090	$26,631,772
Change to Consumption	($378,430)	($392,070)	($406,160)	($420,710)	($435,730)	($451,240)	($467,260)	($483,790)
Baseline Investment	$5,772,292	$5,945,461	$6,123,825	$6,307,539	$6,496,766	$6,691,669	$6,892,419	$7,099,191
Change to Investment	($385,770)	($395,250)	($406,500)	($418,400)	($430,710)	($443,410)	($456,490)	($469,950)

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Source: The Buckeye Institute's STELA model. Note: Each of the totals include the following information: GDP, tax revenues, consumption, and investment are reported in millions of 2024 inflation-adjusted dollars; employment is full-time equivalent non-farm jobs, in thousands of jobs; differences from baseline results are rounded to the nearest $10 million for GDP, tax revenue, and investment and are rounded to the nearest thousand for employment. • Created with Datawrapper

Conclusion

The United States should learn from Europe's expensive mistake to pursue net-zero emissions, not repeat it. ESG policies and heavy-handed climate change regulations impose crippling costs on businesses trying to compete in a global market. Higher energy and production prices are inevitably passed along to consumers and households. European businesses have learned these lessons the hard way, and many have relocated abroad or reduced economic activity—neither result being good for Europe. Congress has repeatedly failed to pass a carbon tax for good reason. Its effects would be expensive and unpopular. Recent efforts to achieve a similar result via public nuisance lawsuits are but another misguided attempt to side-step public sentiment and indirectly impose an unpopular agenda. If successful, such lawsuits could subject energy firms to the equivalent of an $800 billion annual carbon tax, which would contract U.S. GDP by $980.4 billion and cost 2 million jobs in 2027. Those are high prices for an environmental economic policy that the country does not need or want.

APPENDIX

Appendix A: STELA's Methodology

Economists at The Buckeye Institute developed and maintain a dynamic scoring model—STELA (state tax and economic long-run analysis)—to analyze how changes to tax policy impact not only government revenues but also economic output, job creation, and business investment. Unlike static models that do not account for human or market responses to policy changes, STELA predicts how individuals, households, and businesses will alter their economic choices in response to changes in the private economy and public policy over time.

For this paper, The Buckeye Institute calibrated STELA for the United States using publicly available federal data and relied on a similar dynamic scoring framework used by federal agencies to evaluate federal tax proposals. Though primarily used to model state-level tax policy changes, in this case, STELA was calibrated specifically to predict how court-imposed climate-related damages and a national carbon tax will affect GDP, employment, tax revenue, consumption, and investment at the national level.

STELA has undergone a double-blind peer review and incorporated comments from those reviews consistent with current academic standards and methodologies, and a full technical description provided below will allow researchers to validate STELA's accuracy and the authors' conclusions.

STELA's Framework

STELA provides a framework representing a generic state economy, with its parameters calibrated to the specific state being analyzed. It allows researchers to study the interaction of households' economic choices and firms' profit maximizing decisions with a state government that pays for its budget by taxing households and businesses. STELA's framework is similar to those used to study national policy, modified with some conditions tailored to the specific economic conditions of a state. Because states have more limits to trade and debt relative to a national economy, for example, STELA includes a condition in which state governments satisfy a budget constraint where debt cannot increase beyond a certain level. STELA is comprised of the following three parts:

1) *The Household Problem*: Households choose how much to consume and how much to work based on their preferences and their budgets. Households can also choose to take on debt or invest in capital used by

firms. Their budgets factor in sales and excise taxes on consumption, labor income (at the state and federal level), capital income (at the state and federal level), and licensing. The parameters governing these taxes are estimated using state and federal data.

2) *The Firm Problem*: Firms choose labor and capital, supplied by the household, to maximize profits taking the costs of production (wages, the price of capital, and taxes) as given. Using state-level data, STELA simulates production within separate sectors. The output produced is used for consumption, government expenditures, or investments in factors of production.

3) *The Government Sector*: The government sets taxes to collect revenue to pay for its expenditures; however, deficits and surpluses are allowed to a limited degree. The state's trade balance is a mathematical output of what is consumed, invested in, and government expenditures less total production in the economy.

With this framework, The Buckeye Institute then explicitly defines how households and firms make their economic choices.

In STELA's environment, time is discrete and lasts forever. In every period the economy is populated by heterogeneous households specialized in the production of one of s types of goods. The Bureau of Economic Analysis (BEA) reports macroeconomic data for the 50 states in yearly intervals, so each period represents a year in this framework. Each sector s is populated by a large number of firms specialized in the production in their sector. The economy also features a government sector that collects taxes and purchases goods from all sectors. A share $q^e \in (0,1)$ of households has earning ability $e = \{1, \dots, E\}$. These shares are such that the total population is $\sum_{e=1}^{E} q^e = 1$. The share of households with the required skills to work in sector s is $\mu_s \in (0,1)$ such that $\sum_{s=1}^{S} \mu_s = 1$. The Buckeye Institute then outlines each part of STELA: the household problem, the firm problem, and the government sector.

The Household Problem

The household has preferences between consumption and leisure. These preferences are represented by a period t utility function U_t, which takes the following form:

$$U_t = \sum_{s=1}^{S} \alpha_s \ln\left(c_{e,t}(s)\right) - \chi_e l_{e,t}(s)^{\left(1+\frac{1}{\psi_e}\right)}$$

Taking the prices, taxes, and previous period $t-1$ choices as given, each period t, household e chooses: how much to consume $c_{e,t}(s)$ from each sector s; the amount of future capital stock $k_{e,t}(s)$ for each sector s; investment $x_{e,t}(s)$ for each sector s; how much to borrow in debt $d_{e,t}$; and how much to work $l_{e,t}(s)$ in each sector s. Households place a utility weight on consumption goods according to $\alpha_s \in (0,1)$ where α_s represents the share of total GDP in sector s. Period time is split between labor and leisure such that total time is normalized to 1. Leisure $h_{e,t}$ can be defined as:

$$h_{e,t} = 1 - \sum_{s=1}^{S} l_{e,t}(s)$$

where $h_{e,t} \in [0,1]$ and $l_{e,t}(s) \in [0,1]$. The parameter that regulates the Frisch elasticity of labor supply is denoted ψ_e. χ_e is a scaling factor that helps match hours worked observed in the data. The household seeks to maximize its utility by solving the following problem:

$$V_{e,t}(s) = \max_{c_{e,t}(s), x_{e,t}(s), l_{e,t}(s), k_{e,t}(s), d_{e,t}} U\left(c_{e,t}\right) - \chi_e l_{e,t}(s)^{\left(1+\frac{1}{\psi_e}\right)} + \beta E[V_{e,t+1}(s)]$$

The economic decisions for period t are subject to the following constraints:

$$
\begin{aligned}
d_{e,t} = (1+\tau_t^c+\tau_t^{ex})\sum_{s=1}^{S} c_{e,t}(s) + \sum_{s=1}^{S} x_{e,t}(s) + \left(1+i_{r,t-1}\right)d_{e,t-1} + \tau_t^k \sum_{s=1}^{S} k_{e,t-1}(s) \\
+ \left[\frac{\phi}{2}\left(\sum_{s=1}^{S} k_{e,t}(s) - \sum_{s=1}^{S} k_{e,t-1}(s)\right)^2\right] - \ (1-(1-\eta_{e,t}^{i,n})\tau_{e,t}^{i,n} - \tau_t^o \\
- \tau_{e,t}^{i,n,f}) \sum_{s=1}^{S} w_{e,t}(s) l_{e,t}(s) - (1-(1-\eta_{e,t}^{i,r})\tau_{e,t}^{i,r} - \tau_t^o - \tau_{e,t}^{i,r,f} \\
- \tau_t^{corp}) \sum_{s=1}^{S} r_{e,t}(s) k_{e,t-1}(s) \\
k_{e,t}(s) = x_{e,t}(s) + (1-\delta) k_{e,t-1}(s) \\
c_{e,t}(s) \geq 0 \\
k_{e,t}(s) \geq 0,\ k_{e,t+1}(s) = 0
\end{aligned}
$$

$V_{e,t}(s)$ defines expected utility discounted at a patient factor $\beta \in [0,1]$. As in Mendoza (1991), ϕ denotes a capital adjustment cost. The return on capital lent to firms is $r_{e,t}(s)$. The wage paid to workers of type e in sector s is $w_{e,t}(s)$. Future capital stock $k_{e,t}(s)$ is the sum of current capital stock $k_{e,t-1}(s)$, accounting for depreciation δ, and investment $x_{e,t}(s)$. $i_{r,t}$ denotes the interest rate at which domestic residents can borrow from international markets in period t, and $d_{e,t}$ is household debt.

Following Schmitt-Grohé and Uribe (2003), we assume a debt elastic interest rate. This is modeled as $i_{r,t} = i_{r,w} + \zeta(e^{D_t - D} - 1)$ where $i_{r,w}$ is the world interest rate faced by domestic agents and is assumed to be constant and ζ and D are constant parameters that are calibrated to match the state's economy. $\zeta(e^{D_t - D} - 1)$ is the state specific interest rate premium that increases with the level of debt. D_t represents the aggregate state level of debt, such that $D_t = \sum_{e=1}^{E} d_{e,t}$.

τ_t^c is the tax on household consumption purchases, which includes general sales tax, and τ_t^{ex} is the excise tax rate. $\tau_{e,t}^{i,n}$ is the statutory individual labor income tax rate, and $\tau_{e,t}^{i,r}$ is the individual capital income tax rate. $\eta_{e,t}^{i,n}$ and $\eta_{e,t}^{i,r}$ are the proportions of labor income and capital income respectively that are deducted or otherwise exempt from income taxes. $\tau_{e,t}^{i,n,f}$ is the individual labor income tax collected by the federal government, and $\tau_{e,t}^{i,r,f}$ is the individual capital income tax collected by the federal government. Income tax rates depend on the individual earning ability e. τ_t^k is a tax on fixed assets owned by households. τ_t^{corp} is the corporate income tax faced by the owners of capital. τ_t^o is the share of income paid to all other taxes, fees, and revenue sources for the state government not included specifically in STELA.

The variables representing households' economic decisions for each period t and sector s can be summarized as the set: $\left\{\{c_{e,t}(s), x_{e,t}(s), l_{e,t}(s), k_{e,t+1}(s)\}_{s=1}^{S}, d_{e,t}\right\}_{t=0}^{\infty}$. The household then maximizes the utility function subject to the resource constraint and a no-Ponzi scheme constraint that implies that the household's debt position must be expected to grow at a rate lower than the interest rate in the long-run.

The Firm Problem

In each sector s, a large number of competitive firms produce goods according to the following constant elasticity of substitution (CES) production function:

$$y_t(s) = a_t\left(\sum_{e=1}^{E}\left((\theta_s)\left(k_{e,t-1}(s)\right)^{-\rho} + (1-\theta_s)\left(z_e\, l_{e,t}(s)\right)^{-\rho}\right)^{-\frac{1}{\rho}}\right)$$

where a_t is total factor productivity (TFP), θ_s is associated with the capital share of total output in sector s, and $\sigma_{CES} = \frac{1}{1-\rho}$ is the constant elasticity of substitution between capital and labor. z_e is labor productivity specific to a household member's earning ability. These firms solve the following profit maximization problem:

$$\Pi_t = (1-\tau_t^{CAT})a_t\left(\sum_{e=1}^{E}\left((\theta_s)\left(k_{e,t-1}(s)\right)^{-\rho} + (1-\theta_s)\left(z_e\, l_{e,t}(s)\right)^{-\rho}\right)^{-\frac{1}{\rho}}\right) - \sum_{e=1}^{E} w_{e,t}(s) l_{e,t}(s) - \sum_{e=1}^{E} r_{e,t}(s) k_{t-1}(s)$$

It is important to note that the demand for labor and capital is sector s specific. τ_t^{CAT} is a commercial activity tax, modeled as a tax on a firm's revenues.

The representative firm in sector s hires labor according to the following condition:

$$(1-\tau_t^{CAT})\,(1-\theta_s)a_t\left((\theta_s)\left(k_{e,t-1}(s)\right)^{-\rho}+(1-\theta_s)\left(z_e\, l_{e,t}(s)\right)^{-\rho}\right)^{-\frac{1}{\rho}-1}\left(z_e l_{e,t}(s)\right)^{-\rho-1} z_e = w_{e,t}(s),$$

where $w_{e.t}(s)$ is the wage rate for type e in sector s. The demand for capital is such that:

$$(1-\tau_t^{CAT})(\theta_s)a_t\left((\theta_s)\left(k_{e,t-1}(s)\right)^{-\rho}+(1-\theta_s)\left(z_e\, l_{e,t}(s)\right)^{-\rho}\right)^{-\frac{1}{\rho}-1}\left(k_{e,t-1}(s)\right)^{-\rho-1} = r_{e,t}(s),$$

The Buckeye Institute assumes a_t follows a stationary mean zero autoregressive process of order 1 in the log, which can be represented in the following way:

$$(a_t) = \rho_A(a_{t-1}) + \epsilon_{A,t}$$

The innovation shock $\epsilon_{A,t}$ is drawn from a standard normal distribution.

The Government Sector

The government sets taxes and collects revenue to make purchases. Its contribution to the rainy-day fund RF_t is the excess of tax revenue plus federal government transfers net of government spending added to the previous period's balance.

$$RF_t = TR_t + FF_t - g_t + \left(1 + i_{r,t}\right)RF_{t-1}$$

Deficits—negative contributions—to the rainy-day fund reduce the fund's balance.

The state government's tax revenues TR_t are given by:

$$TR_t = \sum_{s=1}^{S}\left(\sum_{e=1}^{E}\Big(\tau_t^{\mathrm{CAT}} y_{(e,t)}(s) + (\tau_t^c + \tau_t^{ex})c_{e,t}(s) + (1-\eta_{e,t}^{i,n})\tau_{e,t}^{i,n}\, w_{e,t}(s)l_{e,t}(s) + (1-\eta_{e,t}^{i,r})\tau_{e,t}^{i,r}\, r_{e,t}(s)k_{e,t-1}(s) + \tau_t^k k_{e,t-1}(s)\Big) + \tau_t^o\, y_t(s)\right)$$

Government spending is proportional to GDP and is specified as $g_t = \hat{g}_t y_t$. This implies that government spending is assumed to grow as the economy grows. Spending policy $\hat{g}_t$ is assumed to evolve according to:

$$\hat{g}_t = \left(1 - \rho_{g,h}\right)(\hat{g}) + \rho_{g,h}(\hat{g}_{t-1}) + \epsilon_g$$

where $\hat{g}$ is the state share of income spent by the government sector in the long-run, the steady-state equilibrium. Variables without the time subscript denote steady-state values.

The tax instruments follow the exogenous processes:

$$\tau_t^{i,n} = (1 - \rho_{i,n})\tau^{i,n} + \rho_{i,n}\tau_{t-1}^{i,n} + \epsilon_{i,n}$$
$$\tau_t^{i,r} = (1 - \rho_{i,r})\tau^{i,r} + \rho_{i,r}\tau_{t-1}^{i,r} + \epsilon_{i,r}$$
$$\tau_t^{c} = (1 - \rho_{c})\tau^{c} + \rho_{c}\tau_{t-1}^{c} + \epsilon_{c}$$
$$\tau_t^{ex} = (1 - \rho_{ex})\tau^{ex} + \rho_{ex}\tau_{t-1}^{ex} + \epsilon_{ex}$$
$$\tau_t^{corp} = (1 - \rho_{corp})\tau^{corp} + \rho_{corp}\tau_{t-1}^{corp} + \epsilon_{corp}$$
$$\tau_t^{k} = (1 - \rho_{k})\tau^{k} + \rho_{k}\tau_{t-1}^{k} + \epsilon_{k}$$
$$\tau_t^{o} = (1 - \rho_{o})\tau^{o} + \rho_{o}\tau_{t-1}^{o} + \epsilon_{o}$$
$$\tau_t^{i,n,f} = (1 - \rho_{i,n,f})\tau^{i,n,f} + \rho_{i,n,f}\tau_{t-1}^{i,n,f} + \epsilon_{i,n,f}$$
$$\tau_t^{i,r,f} = (1 - \rho_{i,r,f})\tau^{i,r,f} + \rho_{i,r,f}\tau_{t-1}^{i,r,f} + \epsilon_{i,r,f}$$
$$\eta_t^{i,n} = (1 - \rho_{\eta,n})\eta^{i,n} + \rho_{\eta,n}\tau_{t-1}^{i,n} + \epsilon_{\eta,n}$$
$$\eta_t^{i,r} = (1 - \rho_{\eta,r})\eta^{i,r} + \rho_{\eta,r}\eta_{t-1}^{i,r} + \epsilon_{\eta,r}$$

As in Schmitt-Grohé and Uribe (2003), we write the trade balance to GDP ratio (TB) in steady-state as:

$$TB = 1 - \frac{[c + x + g]}{y}$$

The Competitive Equilibrium

A competitive equilibrium is such that given the set of exogenous processes, households solve the household utility maximization problem, firms solve the profit maximization problem, and the capital and labor markets clear.

The Deterministic Steady-State

The characterization of the deterministic steady state is of interest for two reasons. First, the steady-state facilitates the calibration of STELA. This is because the deterministic steady-state coincides with the average position of the model economy to a first approximation. Because of this, matching average values of endogenous variables to their observed counterparts (e.g., matching predicted and observed average values of the labor share, the consumption shares, or the trade-balance-to-output ratio) can reveal information about structural parameters that can be used in the calibration of STELA. Second, the deterministic steady-state is often used as a convenient point around which to approximate equilibrium conditions of the stochastic economy (see Schmitt-Grohe and Uribe, 2003). For any variable, The Buckeye Institute denotes its steady-state value by removing the time subscript.

Using the solution from the households' and firms' choice problems, the steady-state implies that:

$$1 = \beta\left[\left(1-(1-\eta_e^{i,r})\tau_e^{i,r} - \tau^o - \tau_e^{i,r,f} - \tau^{corp}\right)r_e(s) + 1 - \delta - \tau^k\right]$$

$$y(s) = a\left(\sum_{e=1}^{E}\left((\theta_s)\left(k_e(s)\right)^{-\rho} + (1-\theta_s)\left(z_e\, l_e(s)\right)^{-\rho}\right)^{-\frac{1}{\rho}}\right)$$

$$(1-\tau^{CAT})a\left[\theta_s\left(\frac{k_e(s)}{l_e(s)}\right)^{-\rho} + (1-\theta_s)z_e^{-\rho}\right]^{-\frac{1}{\rho}-1}\theta_s\left(\frac{k_e(s)}{l_e(s)}\right)^{-\rho-1} = r_e(s)$$

These expressions deliver the steady-state capital-labor ratio, which The Buckeye Institute denotes $\omega_e(s)$

$$\omega_e(s) \equiv \frac{k_e(s)}{l_e(s)} = (1-\theta_s)^{-\frac{1}{\rho}}(z_e)\left(\frac{\beta^{-1} - 1 + \delta + \tau^k}{a(1-\tau^{CAT})\theta_s\left(1-(1-\eta_{e,t}^{i,r})\tau_e^{i,r} - \tau^o - \tau_e^{i,r,f} - \tau^{corp}\right)} - \theta_s\right)^{\frac{1}{\rho}}$$

The steady-state level of capital is:

$$k_e(s) = \omega_e(s)l_e(s)$$

Finally, the steady-state level of consumption can be obtained by evaluating the resource constraint at the steady-state:

$$\sum_{e=1}^{E} c_e(s) = y(s) - \delta\sum_{e=1}^{E} k_e(s) - g\mu_s - TBy(s)$$

which implies: $y = c + x + g + TBy$

As for the parameter that dictates households' preference for leisure:

$$\chi_e = \frac{\alpha_s}{(1+\tau^c+\tau^{ex})c_e(s)} \times \frac{(1-(1-\eta_{e,t}^{i,n})\tau_e^{i,n} - \tau^o - \tau_e^{i,n,f})w_e(s)}{\left(1+\frac{1}{\psi_e}\right) l_e(s)^{\frac{1}{\sigma_e}}}$$

Data and Calibration

The Buckeye Institute's data for calibrating STELA for this current project comes from publicly available federal data sources. First, Buckeye presents its sources for STELA's output variables, then presents the sources for STELA's parameters and its empirical methodology for calibrating STELA.

Output Variables

The Buckeye Institute's measure of GDP, employment, tax revenue, consumption, and investment take data reported by the Federal Reserve Bank of St. Louis and grow that data at a three percent real rate of growth per year.

All variables are reported in 2024 dollars.

The Buckeye Institute used the following methodology to estimate the effects of the tax policy scenarios on employment because STELA measures employment in hours worked (intensive margin). First, Buckeye uses employment multiplied by the average hours worked per year (2,080 hours). This total number of hours worked per year is multiplied by the effect of the corresponding scenario in order to obtain the change in total hours worked for each scenario. Finally, the change in hours is converted into the number of full-time equivalent jobs gained or lost by dividing it by 2,080, which is the number of hours worked by a full-time equivalent employee according to the CBO's definition (Harris and Mok, 2015).[11]

STELA's Parameters and Calibration

Typically, a calibration assigns values to STELA's parameters by matching first and second moments of the data that the model aims to explain. The Buckeye Institute utilizes moments in state and federal data to estimate STELA's parameters.

[11] Edward Harris and Shannon Mok, **How CBO Estimates the Effects of the Affordable Care Act on the Labor Market**, working paper, Congressional Budget Office, Working Paper 2015-09, December 2015.

Because depreciation data are not reported at the state level by the BEA, The Buckeye Institute refers to data for the U.S. economy. The sum of current cost depreciation in nonresidential private fixed assets and consumer durable goods is divided by the sum of current cost net stock of nonresidential private fixed assets and consumer durable goods for the years 1963-2015. The average over this period represents the depreciation rate in STELA. The depreciation rate of capital is $\delta = 0.1$.

The world interest rate is $i_{r,w} = 0.04$.

To compute the sector-specific labor shares, The Buckeye Institute uses data from the BEA Regional Income Division. Similar to Gomme and Rupert (2004), the compensation of employees is divided by the personal income for each sector.[12] As personal income is not available for sectors, Buckeye constructs it by multiplying the earnings per sector by the total economy's personal income-to-earnings ratio, which is from the BEA Regional Income Division. The capital share is simply one minus the labor share. The values refer to the years 2013-2018. The sector specific parameter θ_s is set to match the observed average labor shares for each of the $S = 9$ production sectors.[13] In the present STELA, the labor share is given by the ratio of labor income to output which is $1 - \theta_s$ at all times. To ensure that capital and investment are not being overstated (or understated), the parameter ν, a cost on holding capital, is applied to adjust the steady state rental rate of capital, calibrating it to match the state's investment share of GDP.[14]

The earning ability for household types is based on the distribution of income and population as reported by the Internal Revenue Service's Statistics of Income Division for tax year 2022:

- Earning ability 1 has an adjusted gross income (AGI) of less than $1 per year;
- Earning ability 2 has an AGI from $1 to $9,999.99;
- Earning ability 3 has an AGI from $10,000 to $24,999.99;
- Earning ability 4 has an AGI from $25,000 to $49,999.99;
- Earning ability 5 has an AGI from $50,000 to $74,999.99;
- Earning ability 6 has an AGI from $75,000 to $99,999.99;

[12] Paul Gomme and Peter Rupert, **Measuring Labors Share of Income**, working paper, Federal Reserve Bank of Cleveland, Policy Discussion Paper number 04-07, November 2004.
[13] See complete list of sectors in Appendix B.
[14] The holding cost of capital is incorporated mathematically in the following way to steady state rental rate of capital: $r^*_{e,s} = \frac{\frac{1}{\beta}+\tau^k_e+\nu-(1-\delta)}{(1-(1-\eta^{i,r}_{e,t})\tau^{i,r}_e-\tau^{i,r,f}_e-\tau^{co}-\tau^s_s-\tau^o)}$.

- Earning ability 7 has an AGI from $100,000 to $199,999.99;
- Earning ability 8 has an AGI from $200,000-$499,999.99;
- Earning ability 9 has an AGI from $500,000 to $999,999.99; and
- Earning ability 10 has an AGI of more than $1,000,000 per year.

The share of household members by earning ability, q^e, is the share of returns per earning ability group. The labor productivity per earning ability, z_e, is the income per return for each earning ability with the labor productivity for group 1 being normalized to one. The Buckeye Institute takes the Frisch elasticity estimate $\psi_e = 0.4$ from Reichling and Whalen (2012).[15] The parameter D is set to match the observed average trade-balance to output ratio since $TB = i_{r,w}\frac{D}{y}$. Buckeye estimates tax rates similar to the methodology used by McDaniel (2007).[16]

The full list of parameters is included in Appendix B.

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[15] Felix Reichling and Charles Whalen, **Review of Estimates of the Frisch Elasticity of Labor Supply**, working paper, Congressional Budget Office Working Paper 2012-13, October 2012.
[16] A complete explanation of the methodology is included in Appendix B; Cara McDaniel, **Average tax rates on consumption, investment, labor, and capital in the OECD 1950-2003**, working paper, March 2007.

Appendix B: STELA's Parameters

Tax Rate Estimates

The tax rates calculated in this paper are average effective federal tax rates based on data from the Internal Revenue Service's Statistics of Income Division.

Sectors

STELA uses nine production sectors. The BEA reports GDP for each two-digit North American Industry Classification System (NAICS) industries, which The Buckeye Institute uses to calculate each sector's percentage in total GDP (see Table B-4). Some of the sectors are the same as reported by the BEA, the remaining sectors are constructed by combining several NAICS industries as shown in Table B-1.

Table B-1: Definition of Sectors

Sector	NAICS Sectors
Agriculture, Forestry, Fishing, and Hunting	Agriculture, Forestry, Fishing, and Hunting
Mining	Mining
Utilities, Transportation, and Warehousing	Utilities Transportation and Warehousing
Construction	Construction
Manufacturing	Manufacturing
Trade	Wholesale Trade Retail Trade
Services	Information Finance and Insurance Professional, Scientific, and Technical Services Management of Companies and Enterprises Administrative and Waste Management Services Educational Services Arts, Entertainment, and Recreation Accommodation and Food Services Other Services
Real Estate, Rental, and Leasing	Real Estate Rental and Leasing
Health Care and Social Assistance	Health Care and Social Assistance

Parameters

The following tables present the calibrated parameters for the United States in STELA.

Table B-2: Household Parameters*

Parameter	Values
Disutility of Labor	$\chi_e = 50.0$
Real Interest Rate	$i_{r,w} = 0.04$
Annual Depreciation Rate of Capital	$\delta = 0.1$
Frisch Elasticity of Labor Supply	$\psi_e = 0.4$
Holding Cost of Capital	$\nu = 0.050$

*The real interest rate is based on the difference between the nominal interest rate for three-month Treasury bills and the GDP deflator from 1950 to 2015 using St. Louis Federal Reserve Bank FRED data. The annual depreciation rate of capital is based on data from the BEA for the U.S. economy. It is the average of the sum of current cost depreciation in nonresidential private fixed assets and consumer durable goods divided by the sum of current cost net stock of nonresidential private fixed assets and consumer durable goods for the years 1963 to 2015. The Frisch elasticity of labor supply is based on the central estimate from Reichling and Whalen (2012).

Table B-3: Labor Productivity for the United States

Labor Productivity	Population Distribution
$z_1 = 1$	$q^1 = 0.096$
$z_2 = 1$	$q^2 = 0.096$
$z_3 = 1$	$q^3 = 0.096$
$z_4 = 4.44$	$q^4 = 0.229$
$z_5 = 7.42$	$q^5 = 0.148$
$z_6 = 10.45$	$q^6 = 0.096$
$z_7 = 16.61$	$q^7 = 0.162$
$z_8 = 34.80$	$q^8 = 0.062$
$z_9 = 81.12$	$q^9 = 0.010$
$z_{10} = 408.94$	$q^{10} = 0.005$

Table B-4: Sector Specific Parameters for the United States

Sector	Output Share	Employment Share	Capital Share
Agriculture, Forestry, Fishing, and Hunting	$\alpha_1 = 0.011$	$\mu_1 = 0.021$	$\theta_1 = 0.675$
Mining	$\alpha_2 = 0.017$	$\mu_2 = 0.008$	$\theta_2 = 0.602$
Utilities, Transportation, and Warehousing	$\alpha_3 = 0.055$	$\mu_3 = 0.052$	$\theta_3 = 0.449$
Construction	$\alpha_4 = 0.048$	$\mu_4 = 0.062$	$\theta_4 = 0.484$
Manufacturing	$\alpha_5 = 0.122$	$\mu_5 = 0.077$	$\theta_5 = 0.334$
Trade	$\alpha_6 = 0.139$	$\mu_6 = 0.149$	$\theta_6 = 0.364$
Services	$\alpha_7 = 0.375$	$\mu_7 = 0.449$	$\theta_7 = 0.391$
Real Estate, Rental, and Leasing	$\alpha_8 = 0.150$	$\mu_8 = 0.055$	$\theta_8 = 0.642$
Health Care and Social Assistance	$\alpha_9 = 0.084$	$\mu_9 = 0.129$	$\theta_9 = 0.366$

Table B-5: Average Effective Income Tax Parameters for the United States

Tax Bracket	Input Value
Individual labor income tax rate for AGI 1	$\tau_1^{i,n} = 0.0505$
Individual capital income tax rate for AGI 1	$\tau_1^{i,r} = 0.0505$
Individual labor income tax rate for AGI 2	$\tau_2^{i,n} = 0.0505$
Individual capital income tax rate for AGI 2	$\tau_2^{i,r} = 0.0505$
Individual labor income tax rate for AGI 3	$\tau_3^{i,n} = 0.0505$
Individual capital income tax rate for AGI 3	$\tau_3^{i,r} = 0.0505$
Individual labor income tax rate for AGI 4	$\tau_4^{i,n} = 0.0529$
Individual capital income tax rate for AGI 4	$\tau_4^{i,r} = 0.0529$
Individual labor income tax rate for AGI 5	$\tau_5^{i,n} = 0.0759$
Individual capital income tax rate for AGI 5	$\tau_5^{i,r} = 0.0759$
Individual labor income tax rate for AGI 6	$\tau_6^{i,n} = 0.0926$
Individual capital income tax rate for AGI 6	$\tau_6^{i,r} = 0.0926$
Individual labor income tax rate for AGI 7	$\tau_7^{i,n} = 0.1177$
Individual capital income tax rate for AGI 7	$\tau_7^{i,r} = 0.1177$
Individual labor income tax rate for AGI 8	$\tau_8^{i,n} = 0.1744$
Individual capital income tax rate for AGI 8	$\tau_8^{i,r} = 0.1744$
Individual labor income tax rate for AGI 9	$\tau_9^{i,n} = 0.2412$
Individual capital income tax rate for AGI 9	$\tau_9^{i,r} = 0.2412$
Individual labor income tax rate for AGI 10	$\tau_{10}^{i,n} = 0.2709$
Individual capital income tax rate for AGI 10	$\tau_{10}^{i,r} = 0.2709$

Table B-6: Other Tax Parameters for the United States

Parameter	Values
General sales tax rate (effective rate)	$\tau^{c} = 0.0000$
Excise tax rate (effective rate)	$\tau^{ex} = 0.0000$
Corporate income tax rate (effective rate)	$\tau_1^{corp} = 0.1970$
Tax revenues proportion of GDP	$\frac{TR}{Y} = 0.1062$
Other tax collections rate	$\tau^{o} = 0.0135$

Appendix C: Glossary of Terms

Calibrated – Matching the simulated model to the observable, real-life data by adjusting parameters to ensure the model represents the economy.

Capital adjustment cost – The time and monetary costs of changing the capital a firm uses, such as installing new machinery at a factory.

Capital share – Relative to labor, the proportion of output attributable to capital.

Cobb-Douglas production function – A simple production function in which different combinations of labor and capital quantities are used to obtain a certain quantity of product.

Comparative statics – A method of comparing different economic outcomes before and after a specified change.

Constant elasticity of substitution production function – A production function that assumes the elasticity of substitution is constant, meaning that a change in input factors will result in a constant change in output.

Debt elastic interest rate – An economy-wide interest rate that changes based on the economy's foreign debt holdings.

Depreciation rate – The rate at which capital, such as a car or computer, loses value over time.

Discrete – Measured as separate, distinct points in time, e.g., a person's age in years.

Dynamic scoring – A model that evaluates how changes in policy will change people's economic behavior, or the secondary impacts of a change (e.g., examining the employment and GDP changes that occur as a result of a policy change).

Elasticity – A measure of how the demand of a good responds to a price change for that good.

Employment share – The proportion of the working population employed in each sector of the economy.

Exogenous processes – External factors that influence household decisions.

Lagrangian function – A function that allows you to optimize a variable dependent on constraints, effectively combining a function being optimized with constraint functions.

Markets clear – The result when producers use the price that consumers are willing to pay for a product and there is no shortage or extra product.

Output share – The proportion of the total output of the economy produced by each sector.

Ponzi scheme – An investment fraud in which old investors are paid with money from new investors. Scammers often promise high returns with little or no risk.

Production function – An equation that shows how much product can be made from every combination of input factors, such as capital and labor.

Return on capital – Reveals how well a company is using its capital to make a profit.

Static analysis – A policy analysis that does not consider the economic behavior changes that may occur as a result of a policy change. Primarily, such analysis focuses solely on the changes to tax revenue due to a policy change without factoring in the human response to that change.

Steady-state capital-labor ratio – The ratio of the amount of capital to the amount of labor utilized for production when all markets clear in an economy.

Steady-state equilibrium – The economic choices and prices when market supply and demand are balanced and constant over time.

Stochastic economy – An economy that is affected by random, outside effects.

Tax instruments – The different ways that a government can levy a tax, or different types of taxes (e.g., corporate income tax, sales tax, and property tax).

Utility – The total gratification received from a person consuming a good or service. Economists use utility to capture individual's preferences for differing goods and services. It is assumed that people want to maximize their utility.

About the Authors

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Prior to joining Buckeye, Hederman was director, and a founding member of the Center for Data Analysis (CDA) at the Heritage Foundation, where he served as the organization's top "number cruncher." Under Hederman's leadership, the CDA provided state-of-the-art economic modeling, database products, and original studies.

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Damaging Consequences: The Economic Impact of a Federal Carbon Tax

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