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EPA-Mandated CO_2 Reductions Will Lower U.S. Industries' Return on Equity

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The global warming policy debate is increasing the calls for reduction of carbon-dioxide and other greenhouse-gas emissions. In the wake of the recent hike of oil prices, Congress is scrambling to develop an energy policy that addresses emissions while avoiding yet higher energy costs.[1] Although emissions reductions and stable energy prices are not *necessarily* mutually exclusive, the proposal to allow the Environmental Protection Agency (EPA) to broadly regulate emissions under the Clean Air Act will impose higher costs on U.S. industries, thus leading to slower economic growth and lower employment.

This paper estimates that owners of shares in the sampled industries over the forecast horizon experience:

- Lower average return on equity (e.g., the chemical industry loses an average of two to four percentage points per year on equity returns; the steel industry loses an average of 19 percentage points per year);
- Greater volatility in the rate of those returns (e.g., in the metal industry the standard deviation of the returns in the baseline case is plus or minus 0.7 point, while in the regulated cases the standard deviation is plus or minus 6 points).

At a time when other emerging economies are rapidly expanding and putting competitive pressure on the United States' niche of lucrative investment opportunities, command-and-control policies will further erode these investments. Everyone, investors and non-investors alike, is affected. Lower investments in U.S. companies will lead to even less economic growth and fewer jobs, creating a vicious spiral and making it that much more difficult to invest in energy-efficient technology for the future.

THE ECONOMIC CHAIN REACTION

The EPA's ability to regulate greenhouse gas emissions from non-stationary and stationary sources of emissions introduces two constraints into the economy. The first constraint is a higher level of uncertainty. The second is higher administrative and other non-productive costs. These constraints change business calculations, leading to a downward economic spiral.

Uncertainty concerning possible EPA rulings when companies are deciding whether or not to invest in new technology discounts the return on an investment more heavily. This makes it more difficult for a project to meet the required rate of return. This means less investment will be made, which decreases industry productivity and growth. Lower productivity weakens an industry's competitiveness and gives opportunities for global competitors to make their products at a lower cost. Erosion in market share by global competitors leads to an even lower return on equity, thereby diminishing sources of financing for future investments and raising the cost of capital. The weakened competitive position puts strain on employment.

1. The current decline in the petroleum prices reflects the declines in demand caused by slowing economic activity. Oil prices likely will rise again when economic growth picks up.

As demand for a U.S. industry's product decreases, the need for employees to make the products decreases as well, resulting in layoffs and job losses to overseas competitors.

It is not the emissions reductions *per se* that are the cause of harm to stockholder equity. Energy efficiency is an outstanding goal. In fact, firms are finding ways to adjust their energy use in ways that make good business sense. The contemplated regulations, though, are dampening the current demand for investments because firms are unsure about how regulations will affect that investment. The increased risk that a capital purchase will not meet future regulations lowers the expected rate of return. This makes it difficult for the project to exceed the threshold required rate of return[2] on the investment and delays investments that could be making incremental steps toward overall goals of energy efficiency.

The problem with mandates is that they are unresponsive to technological realities and unforeseen future conditions. Markets balance expected benefits with expected costs. Since expected costs do not exceed expected benefits, markets are a particularly efficient (not wasteful) way of allocating resources.[3] Because mandated "efficiencies" are not based on expected costs versus benefits, they often do more economic harm than good.[4]

SIMULATING MANDATES

Analysts at The Heritage Foundation's Center for Data Analysis used simulated forecasts of production indexes in a representative sample of industries to create estimated rates of return for those industries. These returns on equity were calculated under the baseline forecast and CO_2 policy forecast contained in the recently rejected Lieberman–Warner legislation.[5] The EPA's proposed regulations include a broad range of options, one of which is a carbon-credit trading program similar to the one Lieberman–Warner would have enacted.

The baseline assumptions for legislation such as the Energy Independence and Security Act (EISA)[6] and state and local renewable mandates, Corporate Average Fuel Economy (CAFE)[7] standards, and appliance efficiency standards are also all the same as those in Lieberman–Warner. However, the EPA's ability to regulate greenhouse gas emissions under the Clean Air Act gives it sweeping powers to regulate both non-stationary and stationary sources of emissions. Therefore, the estimates in this paper can be seen as a lower bound, or minimum, on the enormous economic costs of the EPA's expanded authority.

The Lieberman–Warner study was conducted by William Beach, Ben Lieberman, David Kreutzer,

2. Businesses often evaluate investment projects based on an internal desired rate of return. This is called the required rate of return. If an investment's expected return on equity does not exceed this required rate the project is not undertaken.
3. Market efficiency equates marginal benefits with marginal costs. If a policy, not the market, determines the level of energy efficiency, the policy is most likely pushing a target for which the additional costs exceed the additional benefits; otherwise the target would not be needed. This is why these policies are usually accompanied by subsidy "carrots." Also note: These are expected costs and benefits based on currently available information. If, after new information becomes available, it is found that costs do outweigh benefits, the markets must make a correction. This does not negate the initial efficiency of the decision.
4. Even if mandates are made based on "market research" by the regulator, the time from market research to a new targeted mandate cannot respond rapidly enough to quickly changing market conditions.
5. This refers to S. 2191, commonly known as Lieberman–Warner after the two key sponsors of the legislation, Senators Joseph Lieberman (I–CT) and John Warner (R–VA). S. 2191 would have placed strict upper limits on the emission of six greenhouse gases (GHGs) focused primarily on carbon dioxide (CO_2). Emitters would be required to purchase federally created permits (allowances) for each ton emitted, effectively capping emissions at a government targeted level.
6. EISA was signed into law on December 19, 2007, and takes effect on January 1, 2009. Among other targets, EISA requires that the Renewable Fuel Standards, which calls for minimum production levels of renewable fuels, increase nine-fold by 2022 and automobile fuel economy standards increase significantly by 2020. More information is available at *http://www.thompsonhine.com/publications/pdf/2008/01/energyupdateenergy1326.pdf* (November 3, 2008).
7. The CAFE standard, which was established in response to the energy crisis of the 1970s, sets the fuel economy standards mainly for the auto industry. See also Robert Bamberger, "Automobile and Light Truck Fuel Economy: The CAFE Standards," Congressional Research Service, September 25, 2002, at *http://www.policyalmanac.org/environment/archive/crs_cafe_standards.shtml* (October 17, 2008).

and Nicolas Loris at The Heritage Foundation. Using the Global Insight long-term macroeconomic model, they studied the effects of a 70 percent mandated reduction in atmospheric carbon content on the U.S. economy.[8] The Global Insight model produces forecasts for more than one hundred industries classified under the North American Industry Classification System (NAICS).[9] This paper studies the implication of those industry-simulation results.

The simulation takes into account the current technology and its likely trajectory based on discussions with energy industry experts. For instance, carbon sequestration techniques are one possible way to meet the requirements, but this technology is not yet available.[10]

The returns also show that industries are affected unevenly. Some industries, such as textiles and food, have relatively inelastic demand and relatively less-regulated emissions and do not experience as high a level of diminished operations due to rising costs.[11] Other industries, such as machinery and paper, which are more sensitive to price pressure and require more emissions to operate, will be greatly affected. Thus, the policy results in tilting the playing field and by doing so inadvertently picks industry winners and losers. (See Table 1.)

Graphs of the eight representative industries are shown in Charts 1a and 1b.

Equity Losses Due to EPA Regulations

Returns on Equity from Q1 2009 to Q4 2025 for Eight Key U.S. Industries

Industry	Under EPA Regulations	Baseline	Percentage Point Change
Chemical	36.49%	40.26%	**–3.77**
Petroleum	25.52	28.77	**–3.25**
Food	33.80	34.20	**–0.40**
Paper	12.28	14.11	**–1.83**
Metal	7.86	19.05	**–11.19**
Machinery	12.55	17.72	**–5.17**
Steel	26.40	45.60	**–19.20**
Textiles	8.79	9.39	**–0.61**

Sources: Heritage Foundation calculations using Global Insight's U.S. Macro Model.

Table 1 • CDA 08-12 heritage.org

EFFECT ON RETIREMENT SAVINGS, WORKERS, AND HOUSEHOLD WEALTH

Many of the equity investors in these industries are mutual funds and pension funds that provide retirement savings for individuals. Managers of these funds seek targeted rates of return in the portfolios they manage for individuals. These managers will not only experience a difficult time hitting these targeted returns, but will also be challenged to find ways to diversify the increased risk driven by the uncertainty of these returns. Individuals who rely on a certain amount of income in retirement are espe-

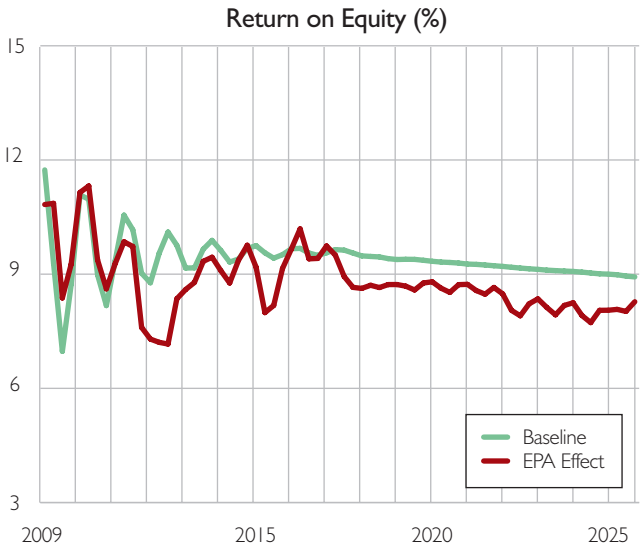
8. William W. Beach, David W. Kreutzer, Ben Lieberman, and Nicolas Loris, "The Economic Costs of the Lieberman–Warner Climate Change Legislation," Heritage Foundation *Center for Data Analysis Report* No. 08-02, May 12, 2008, at *http://www.heritage.org/Research/EnergyandEnvironment/cda08-02.cfm*.
9. The SIC and NAICS classification system is defined by the Census Bureau as follows: "The North American Industry Classification System (NAICS, pronounced Nakes) was developed as the standard for use by Federal statistical agencies in classifying business establishments for the collection, analysis, and publication of statistical data related to the business economy of the U.S. NAICS was developed under the auspices of the Office of Management and Budget (OMB), and adopted in 1997 to replace the old Standard Industrial Classification (SIC) system. It was also developed in cooperation with the statistical agencies of Canada and Mexico to establish a 3-country standard that allows for a high level of comparability in business statistics among the three countries. NAICS is the first economic classification system to be constructed based on a single economic concept." Further details and explanations are available at *http://www.census.gov/epcd/www/drnaics.htm#q1* (October 31, 2008).
10. For a full discussion of the simulation and assumptions, see David W. Kreutzer, and Karen A. Campbell, "CO_2-Emission Cuts: The Economic Costs of the EPA's ANPR Regulations," Heritage Foundation *Center for Data Analysis Report* No. 08-10, October 29, 2008, at *http://www.heritage.org/Research/EnergyandEnvironment/cda08-10.cfm*.
11. This is the industry as a whole. Individual companies within these industries often face much higher elasticities of demand. The mandates will cause the competitive landscape to change. Instead of firms being competitive on cost and quality, firms will need to compete on emissions. This will likely cause some previously economically viable companies to go out of business and result in higher consumer prices for these staple goods.

How the EPA Regulations Would Affect American Industries

The following charts show projected returns on equity for eight industries ("Baseline") and how those returns would differ under EPA regulations ("EPA Effect"), from the first quarter of 2009 through the fourth quarter of 2025.

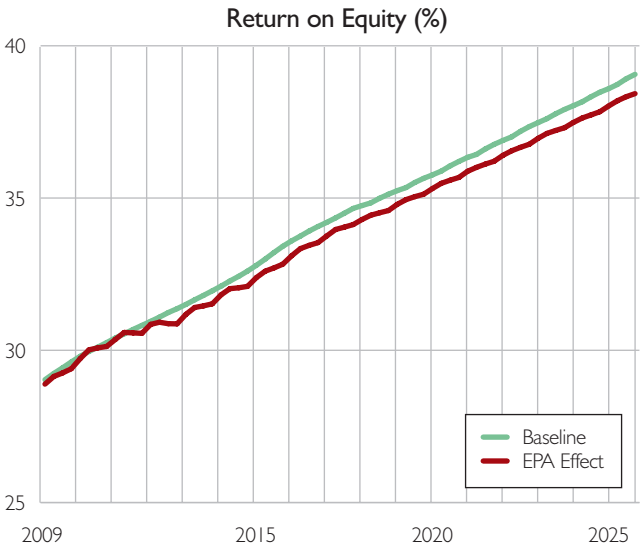
Textile

Includes Rudick Corp., Milliken & Co., Invista BV



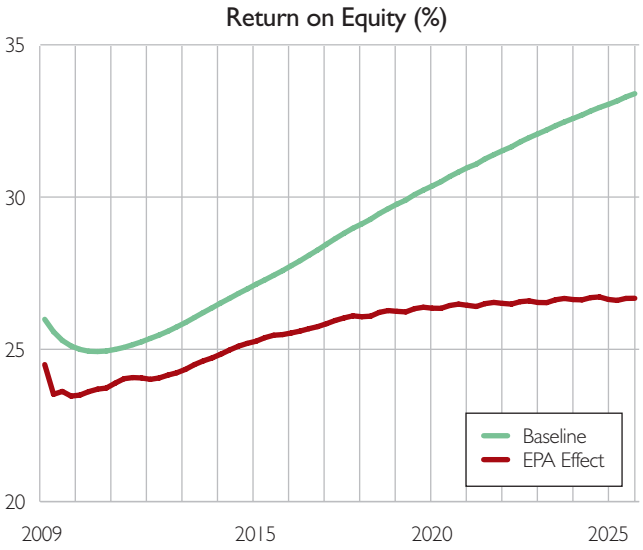
Food

Includes Procter & Gamble, Kroger, Safeway



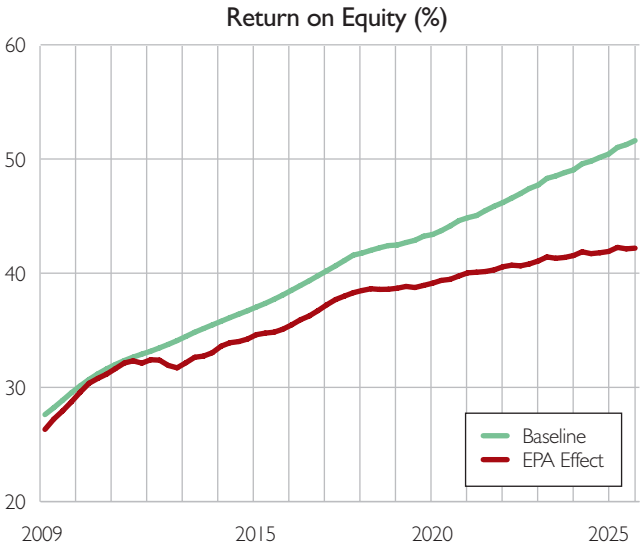
Petroleum

Includes Valero, Citgo, Hess



Chemical

Includes Cardinal Health, Johnson & Johnson, Dow Chemical



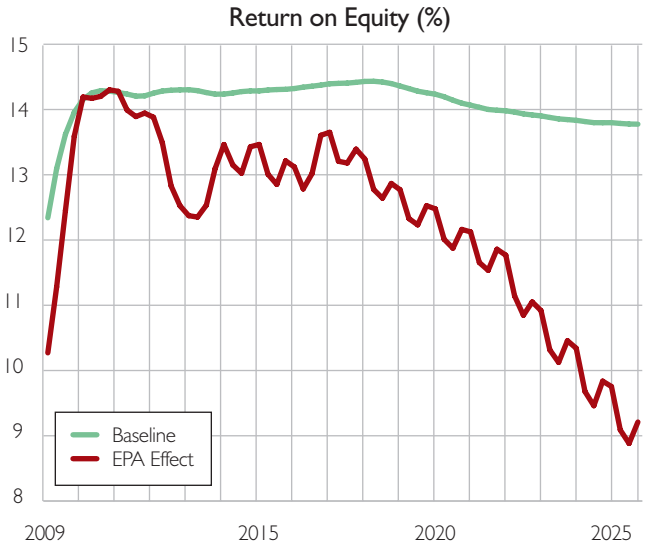
Sources: Heritage Foundation calculations using Global Insight's U.S. Macro Model.

Chart 1a • CDA 08-12 heritage.org

How the EPA Regulations Would Affect American Industries

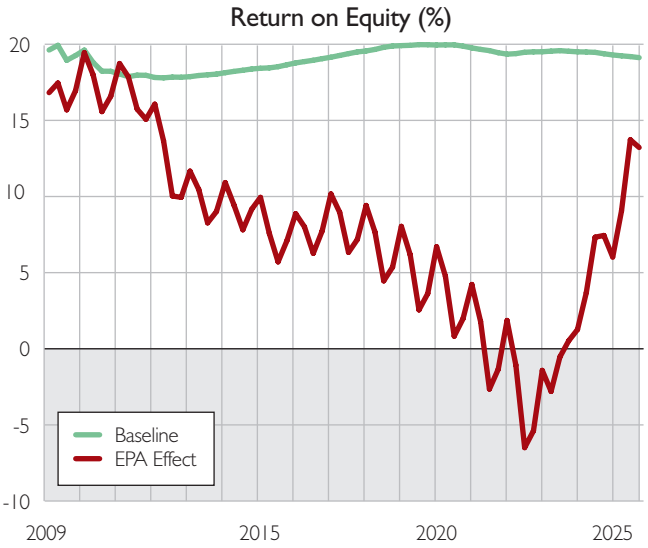
Paper

Includes Kimberly-Clark, Illinois Tool Works Inc.



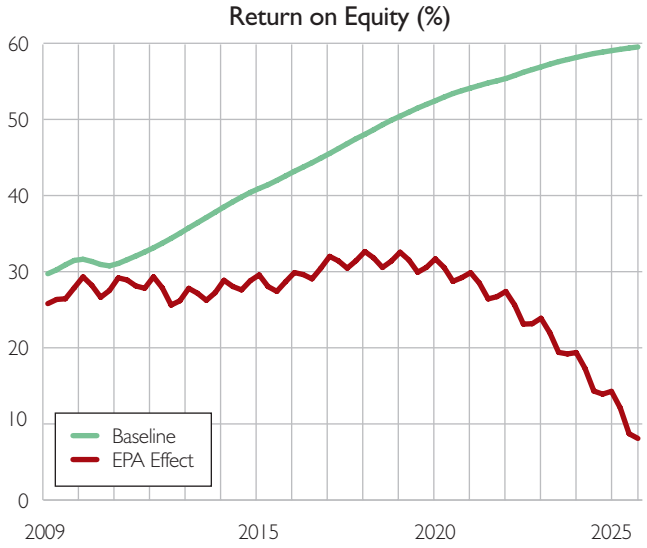
Metal

Includes Alcoa Extrusions Inc., Nucor Corp., Rea Magnet Wire Corp.



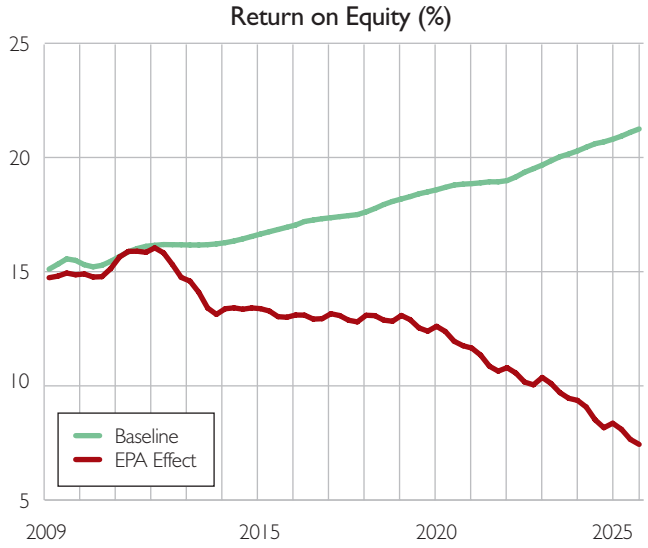
Steel

Includes Nucor Corp., Commercial Metals Co., AK Steel Holding



Machinery

Includes GE, Hewlett-Packard, IBM



Sources: Heritage Foundation calculations using Global Insight's U.S. Macro Model.

Chart 1b • CDA 08-12 heritage.org

cially sensitive. Table 2 shows what these lower returns and greater variance mean for a $1,000,000 investment in an industry at the beginning of 2009. The columns show how much this investment would be worth in 2025 if the EPA regulations go into effect as compared to the investment's value under the baseline. The present value of these dollar losses are in the right column.[12] The decreased wealth in individuals' retirement funds, as seen in the losses on a $1,000,000 investment, means a lower standard of living in retirement years, longer working years, or both.

EPA Regulations Would Reduce Value of Investments

Projections Based on an Initial Investment of $1 Million

Industry	Growth Under EPA Regulations	Baseline Growth	Loss in Return on Investment*
Chemical	$377,054,839	$674,112,579	–$129,605,308
Petroleum	$67,092,320	$112,428,372	–$19,779,969
Food	$248,257,618	$264,169,277	–$6,942,204
Paper	$7,815,180	$10,568,259	–$1,201,159
Metal	$3,723,929	$23,638,174	–$8,688,519
Machinery	$8,164,033	$19,061,571	–$4,754,560
Steel	$76,777,391	$1,517,024,758	–$628,375,156
Textiles	$4,382,505	$4,847,824	–$203,017

* Loss at the end of 17 years, present value discount of 5%.

Sources: Heritage Foundation calculations using Global Insight's U.S. Macro Model.

Table 2 • CDA 08-12 heritage.org

Employees are directly and indirectly affected as well. Decisions regarding investments in new capital and technology are based on the cost of capital. The increased uncertainty of returns due to higher volatility increases the industry risk premium. This raises the cost of capital and decreases the number of investments. These investments would have allowed companies to grow, creating more jobs and higher wages. The higher cost of capital also puts upward pressure on the borrowing costs of all individuals (those seeking mortgages, loans to start a small business, etc.).

Lower industry returns also make equity investment less attractive relative to bonds. This may skew financing toward debt financing, creating more leveraged industries. Leverage can be a powerful tool but, as seen recently in the financial industry, pushing past prudent debt-to-equity ratios can severely constrain business operations during a credit crunch. Furthermore, using debt instead of equity financing concentrates industry profits in the hands of fewer owners, which can lead to greater income disparities in the economy. The equity financing of capitalist systems allows a broad group of ordinary individuals to gain ownership in and reap the profit rewards corporations generate. Diminishing the incentive to invest in equity decreases the number of average citizens taking part in corporate profits and limits a powerful method for households to increase their wealth.

CONCLUSION

The new regulations proposed by the EPA will cause major disruptions in the productivity of U.S. industries. These will translate into lower returns on equity and create more volatility in the growth rates of those returns. This can be seen in the greater fluctuations in the returns under the EPA regulation scenario versus the baseline scenario in the graphs above. This is not surprising considering that regulations add increased uncertainty to the production environment. For owners and CEOs of corporations, increased uncertainty on the return on equity makes it difficult to plan for future investment projects. As explained above, uncertain returns can lead to caution and conservative investments in order to preserve capital. Lower investments further weaken growth and the competitiveness of U.S. industries. This has far-reaching consequences not only for industry employees and owners, but also for millions of small investors through mutual funds, pension funds, and other savings vehicles.

12. Present value is the value today of a future cash stream or future lump-sum payment. If the cash stream were available today, the money could be invested and earn interest. Therefore, not having it today represents an opportunity cost in the amount of the interest that could have been earned. A present value calculation discounts the stream of cash or lump-sum future payment by the interest rate that could have been earned.

Instead of imposing mandates, government should recognize the new technologies that are evolving and avoid restrictive regulation rhetoric that increases uncertainty in the economy and delays investments. Instead of focusing on reduction "targets," the focus needs to be on technology and U.S. productivity. Profit-seeking firms are lowering the energy use/CO_2 emissions per dollar of gross domestic product (GDP)—not because there is a mandate, but because of market competition. Between 2005 and 2006, CO_2 emissions decreased by 1.3 percent, while the U.S. economy grew at 3.3 percent. Only 0.9 percent of the decrease was due to a decrease in overall energy use during this time, which indicates that the U.S. economy is becoming less carbon-intensive even without more regulation.[13] Undermining industry returns reduces the ability of U.S. businesses to switch to more efficient technologies, practices, and products. Indeed, more and more firms are searching for ways to bring new products and energy-efficient products to U.S. households. This commitment by businesses is already demonstrated by the large marketing expenses that companies are incurring to promote their new ideas to aid in the solutions for the United States' energy and environmental needs. Consumers are already voting for the ideas they think will work with their everyday economic choices.

The United States can be a productivity powerhouse and reduce its carbon footprint at the same time. These are not mutually exclusive goals. Increasing regulatory burdens and command-and-control approaches, however, are not the way to achieve those goals.

—Karen A. Campbell, Ph.D., is a Policy Analyst in Macroeconomics in the Center for Data Analysis at The Heritage Foundation.

13. Margo Thorning, "The Impact of America's Climate Security Act of 2007 (S. 2191) on the U.S. Economy and on Global Greenhouse Gas Emissions," testimony before the Committee on Environmental and Public Works, U.S. Senate, November 8, 2007, at *http://www.accf.org/pdf/test-climate-security.pdf* (October 31, 2008).

APPENDIX
DATA AND METHOD

Center for Data Analysis (CDA) analysts obtained historical seasonally unadjusted return on equity data for 16 industries from Haver Analytics.[14] The analysts obtained the historical seasonally unadjusted industry production indices from the Federal Reserve Bank of St. Louis. The data run from the fourth quarter of 1980 to the first quarter of 2008.

Return on equity is a financial ratio of a firm's net income to its total equity (or sometimes average equity). Net income is a firm's revenue minus its costs. An industry's return on equity can be affected by changes in an industry's profits or changes in an industry's total equity position, such as assets minus liabilities. The profits of an industry should, in theory, be linked to the production of goods or services the industry provides. Current production indices for an industry would, therefore, help to explain an industry's return on equity. Moreover, changes in past production indices carry information regarding the profitability of producing the goods and services, for example, changes in the market price of the goods or changes in production costs. Likewise, past changes in return on equity indices carry information about changes in an industry's equity position.

There should be both a short-run and long-run link between an industry's fundamental operations and its financial performance. An econometric model using the autoregressive distributed lags as explanatory variables is used to estimate this linkage. When these models are written in their error-correction model form, they capture the dynamic links between two or more time series data sets. These models have two parts: the short-run movements due to changes in the variables, and the long-run part that measures the underlying long-run relationship between the levels of the two variables.

Because industry codes changed from the SIC classification to the NAICS classification around 2001, industries were chosen based on two criteria. The first was whether or not they were part of the Global Insight model (and, therefore, part of the simulation), and the second was how little the industry composition changed between the two classification systems. The Federal Reserve Bank data had the combined SIC and NAIC industry production index for each industry data series. The return on equity series were in their SIC classifications from the fourth quarter of 1980 to the third quarter of 2001, and the NAICS classification from the fourth quarter of 2000 through the first quarter of 2008. Heritage analysts combined each industry return on equity series using the geometric spline technique.[15] This method uses the information in the overlap years to adjust the two series to one continuous series.

Once this is completed, the data series are tested for stationarity. All returns on equity series are stationary. The production index series is largely trend stationary and first difference (I(1)) stationary.[16]

Because changes in industry composition and classification over the historical period may have severed a meaningful relationship between the return on equity index and the production index, a Granger-causality test was performed on the two series for each industry. This is a test of whether one time series has information that is useful for predicting another times series.[17] In other words, whether one series can help predict another series in either a uni-directional way or bi-directional feedback, or

14. Haver Analytics is a database and software company that maintains over 150 economic and financial databases. Data available upon request and Haver's approval of release of its proprietary data.
15. Robert J. Hill and Kevin J. Fox, "Splicing Index Numbers," *Journal of Business & Economic Statistics*, Vol. 15, No. 3 (July 1997), pp. 387–389. These authors show that this technique is more consistent than using the arithmetic mean. This paper also contains the algorithm and an example of the technique.
16. A true co-integration analysis is based on the non-stationarity of two or more series. Since both series here are already stationary, the test for co-integration (that relies on finding a stationary relationship) is moot. The investigation here uses the error-correction representation shared with co-integration analysis to represent the *a priori* long-run relationship (due to the accounting identity) rather than using co-integration analysis to investigate whether there is a long-run relationship.
17. Note: This test does not necessarily imply true causality in the sense that one is an independent variable that can be manipulated to change the dependent variable. For example, there could be a third factor that is driving both series.

whether there is no predictive relationship between the two series. In brief, the test uses the F-statistic, posits a vector autoregressive structure, and tests whether eliminating the explanatory variables can be accomplished leaving only an ARIMA-type model. The two models are compared to see if the one including the explanatory model is significantly better estimating the dependent variable.

Based on this test, six industries were eliminated from the sample due to the production index including no predicative ability.[18] Two other industries, the vehicle parts and transportation industries, had structural breaks in the trend and the level in their return on equity series. Although there are econometric methods for handling historical structural breaks, finding a consistent estimated relationship with which to forecast a future return on equity series from a future production series is not robust enough to change assumptions regarding those breaks. For this reason, these two series were dropped from the sample.

The relationship between the historical time-series for the remaining eight representative industries' return on equity and production index series was estimated accordingly using the following ECM:[19]

$$\Delta y_t = \beta_1 \Delta x_t + \beta_2 \Delta y_{t-1} + \beta_3 y_{t-1} + \beta_4 x_{t-1}.$$

Provided that there is only one cointegrating relationship, the ordinary least squares (OLS) estimate outperforms the Johanssen method.[20] The adjustment parameter of the cointegrating relationship is not expressly modeled. Instead, it is combined in the parameter estimates of the levels of the variables. Peter Kennedy explains, "mixing levels and differences in the regression is acceptable because the cointegrated variables automatically combine during estimation to resolve the dilemma of mixed order of integration."[21]

Comparing Historical and Predicted Ratios for Key Industries

The "Historical" column shows the ratio of the historical average return on equity to the average production index. The "Predicted" column shows the ratio of the predicted average return on equity to the average production index.

Industry	Historical Ratio	Predicted Ratio
Chemical	0.26	0.26
Petroleum	0.20	0.20
Food	0.25	0.25
Paper	0.14	0.12
Metal	0.10	0.14
Machinery	0.11	0.12
Steel	0.03	0.34
Textiles	0.10	0.16

Sources: Heritage Foundation calculations using Global Insight's U.S. Macro Model.

Appendix Table 1 • CDA 08-12 heritage.org

The purpose of the estimation is to capture the dynamic relationship of the two series and use this relationship to predict the effects of the proposed EPA regulations on industry performance. The historical relationship was estimated using the above econometric model with STATA/SE 10.1 for Windows. The estimates were then applied to the baseline production indexes and the EPA-regulated production indexes that had been simulated using the Global Insight long-term macroeconomic model of the U.S. economy. The specific number of lags of the dependent variable was selected as the minimum needed to remove serial autocorrelation in the residuals. This was determined by a Breusch-Godfrey test of the residuals from an OLS regression.[22]

The model fit is determined in two ways: econometrically and theoretically. First, econometrically,

18. One industry, fabricated metal, was found to have bi-directional feedback between the two series. That is, industry return on equity helps predict the industry production index as much as the industry production index helps predict industry return on equity. This merits further investigation because, theoretically, at the industry level, changes in return on equity could indicate that there are changes in industry conditions that would cause future production levels to change. However, because this exercise already estimated the future path of production indexes through simulation, this industry was eliminated from this study.
19. This is the simplest form taken. Some industries included more lags. The amount of lags selected was the minimum amount necessary such that the residuals of the regression were white noise. For some industries, lags were skipped and others included based on the robust t-statistic for the coefficient.
20. Peter Kennedy, *A Guide to Econometrics* (Cambridge, Mass.: MIT Press, 2003), pp. 337.
21. *Ibid.*

the model is chosen to minimize the sum of squared residuals. Second, a check is performed on the predicted average ratio of return on equity to its production index. If there is a long-term relationship between the two series, then the ratio of average return on equity to its average production index should be fairly stable. Thus, the historical average return on equity to historical average production index is compared to the model's predicted average ratio in the baseline scenario.[23] These results are shown in the Appendix Table 1.

The coefficient estimates and the forecasted series for the industries are available upon request.

22. The model was also estimated using the Prais-Winston approach that takes into account autocorrelation. The results were not significantly different.

23. In most cases, the model's prediction is within 1 to 2 percent of its historical ratio. In the textile and steel industry there is a greater than 5 percent difference. This is because there were large and volatile swings in the historical data that dampened the ratio while the Global Insight baseline production index predicts relatively smooth growth.