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Development of Regional Power Sector Coal Fuel Costs (Prices) for the Short-Term Energy Outlook (STEO) Model

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1. Overview

The U.S. Energy Information Administration's *Short-Term Energy Outlook* (STEO) produces monthly projections of energy supply, demand, trade, and prices over a 13-24 month period. Every January, the forecast horizon is extended through December of the following year. The STEO model is an integrated system of econometric regression equations and identities that link data on the various components of the U.S. energy industry together in order to develop consistent forecasts. The regression equations are estimated and the STEO model is solved using the EViews 9.5 econometric software package from IHS Global Inc. The model consists of various modules specific to each energy resource. All modules provide projections for the United States, and some modules provide more detailed forecasts for different regions of the country.

The coal module provides forecasts of coal supply (production, stocks, waste coal), trade (imports and exports), consumption, prices, coal coke (production, consumption, trade, and stocks), and raw steel production. The coal module contains 73 equations, of which 23 are estimated regression equations. Some of the input variables to the coal module are exogenous, coming from other modules in the *STEO* model (e.g., natural gas and petroleum prices) or forecasts produced by other organizations (e.g., weather forecasts from the National Oceanic and Atmospheric Administration). A projection of national coal prices is developed using the coal module, which is passed to several other modules in STEO. The coal module, in conjunction with the STEO electricity fuel consumption module, returns a projection of national coal demand. Figure 1 provides a visual overview of the production, trade, and power sector stocks portions of the coal module. The current STEO coal module documentation can be found at http://www.eia.gov/forecasts/steo/documentation/steo_coal.pdf.

Many equations in the coal module, as well as those proposed in this document, include monthly dummy variables to capture the normal seasonality in the data series. For example, JAN equals 1 for every January in the time series and is equal to 0 in every other month. Dummy variables for specific months may also be included in regression equations where the observed data may be outliers because of infrequent and unpredictable events such as hurricanes, survey error, or other factors. Generally, dummy variables are introduced when the absolute value of the estimated regression error is more than 2 times the standard error of the regression (the standard error of the regression is a summary measure based on the estimated variance of the residuals). No attempt was made to identify the market or survey factors that may have contributed to the identified outliers.

Dummy variables for specific months are generally designated Dyymm, where yy = the last two digits of the year and mm = the number of the month (from “01” for January to “12” for December). Thus, a monthly dummy variable for March 2002 would be D0203 (i.e., D0203 = 1 if March 2002, = 0 otherwise).

Dummy variables for specific years are designated Dyy, where yy = the last two digits of the year. Thus, a dummy variable for all months of 2002 would be D02 (i.e., D02= 1 if January 2002 through December 2002, 0 otherwise). A dummy variable might also be included in an equation to show a structural shift in the relationship between two time periods. Generally, these shifts are modeled using dummy variables designated DxxON, where xx = the last two digits of the year at the beginning of the shift period. For example, D03ON = 1 for January 2003 and all months after that date, and D03ON = 0 for all months before 2003.

Figure 1. Short-Term Energy Outlook Coal Module (production, trade, power sector stocks)

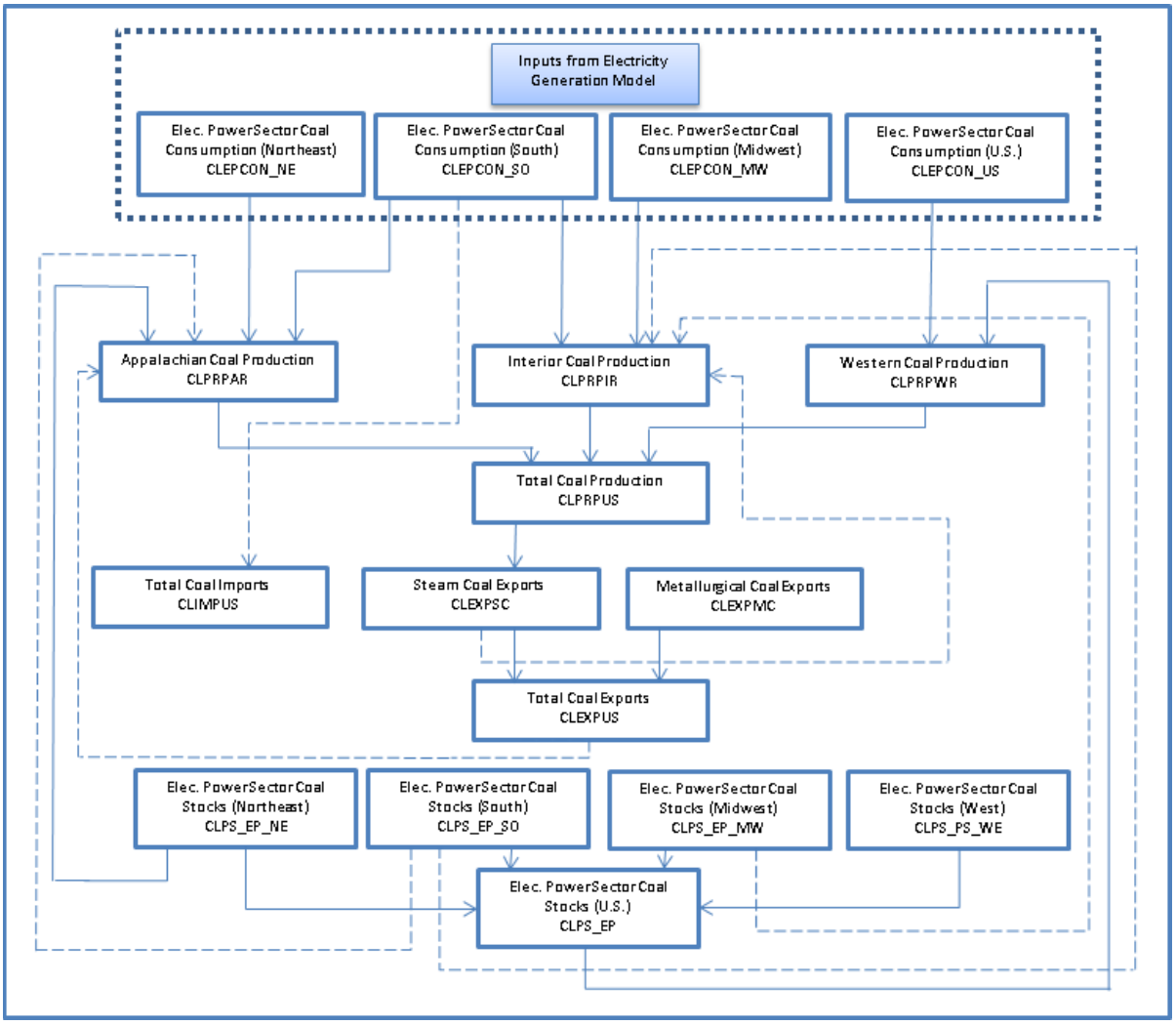


Figure 2 provides a visual overview of the coal consumption and consumer stocks portions of the coal module. Inputs from the STEO electricity fuel consumption module, as well as the coal coke section (Figure 3), provide exogenous inputs to consumption and stocks.

Figure 2. Short-Term Energy Outlook Coal Module (consumption, consumer stocks)

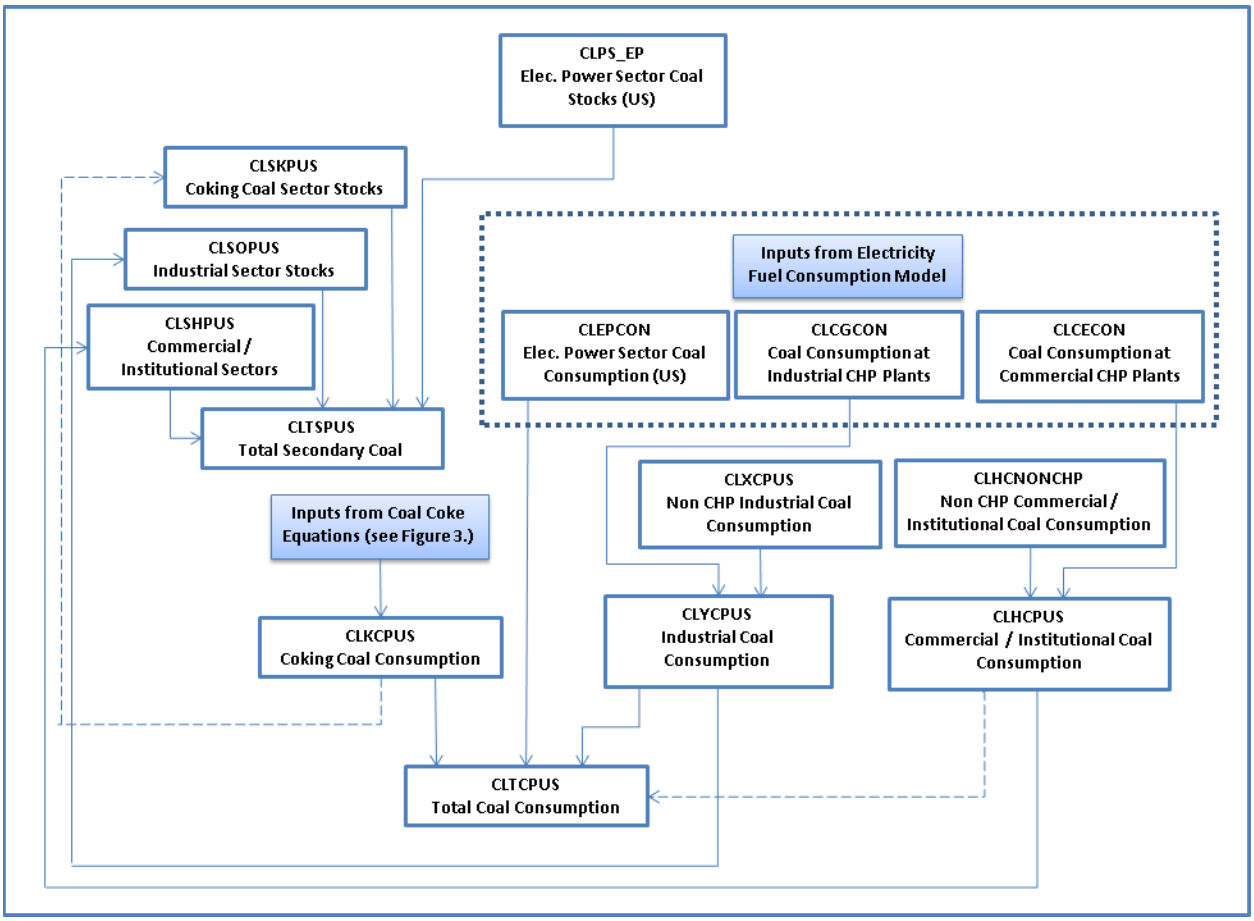


Figure 3. Short-Term Energy Outlook Coal Module (coal coke)

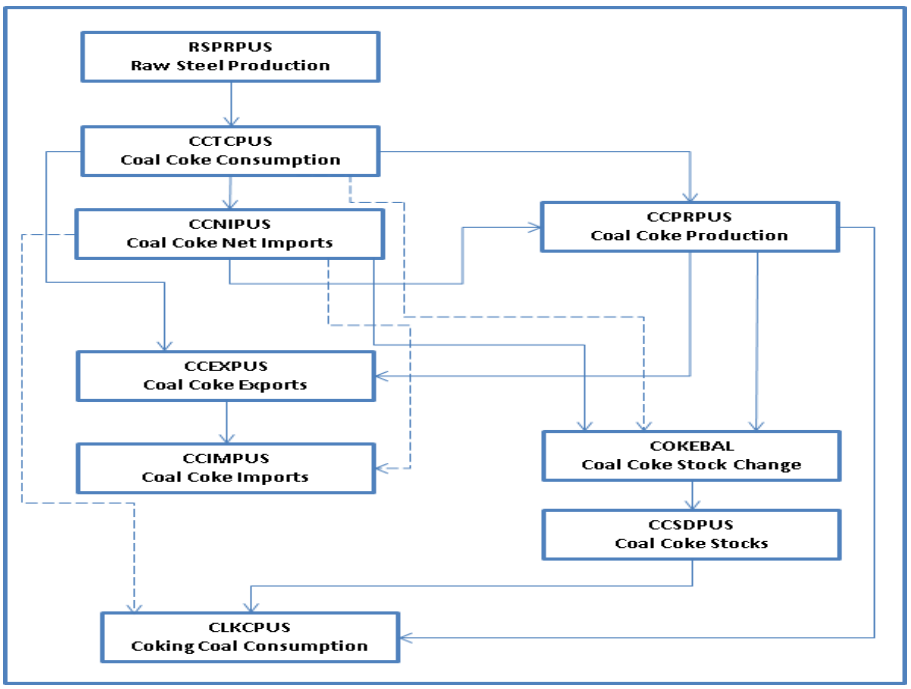
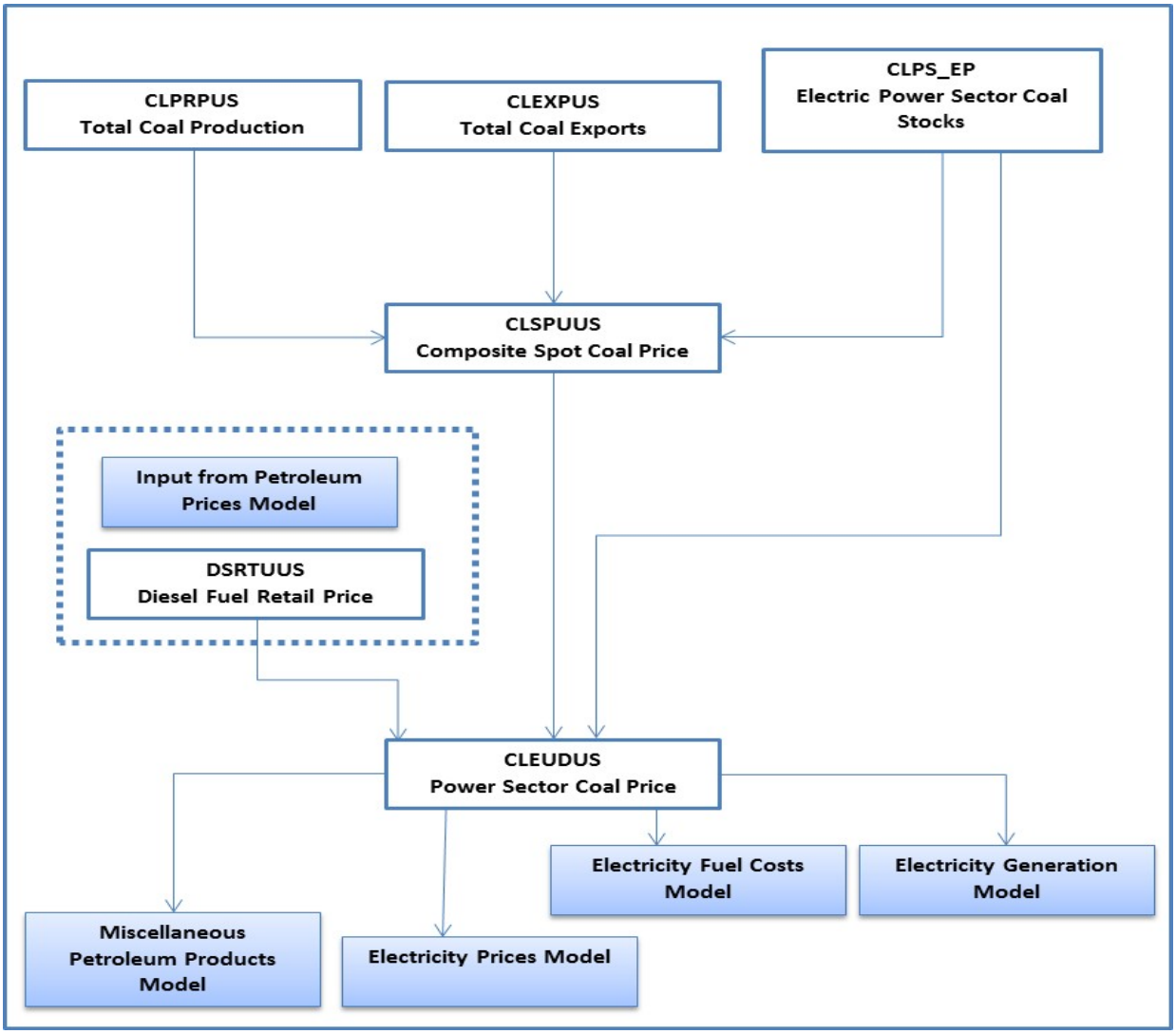


Figure 4 shows a visual overview of the prices section of the coal module. Other sections of the coal module (production, trade, and stocks) and the petroleum prices module provide exogenous inputs into this module. The projected electric power sector coal price then serves as an exogenous input to several STEO models: electricity generation model, electricity fuel costs model, electricity prices model, and the miscellaneous petroleum products model.

Figure 4. Short-Term Energy Outlook Coal Module (prices)



2. Coal Prices in the Current STEO Model

A. Introduction

The coal prices section of the coal module contains two regression equations. The first equation is for a production-weighted, composite national coal spot price and the second is for an average price for coal delivered to the electric power sector.

EIA reports weekly spot prices, in dollars per short ton, for five domestic coal production regions in the *Coal Markets Report (CMR)*. The five regions are Central Appalachia (CAPP), Northern Appalachia (NAPP), Illinois Basin (ILB), Powder River Basin (PRB), and Uinta Basin (UIB). The historical data for the spot prices is proprietary, and EIA cannot release more than the current week's spot price data plus data from the previous four weeks. However, averaged historical data is permitted for publication by EIA, and EIA creates monthly averages for publication in STEO by averaging the weekly prices. When a week extends into a new month, the weekly price is allocated on a daily basis and incorporated into the appropriate months. The prices are then converted from dollars per ton to dollars per million Btu (MMBtu), using the Btu per ton conversion factors from the *CMR* report. Monthly proxies for coal production from each of the five commodity regions are developed using EIA data, and a composite spot price is calculated based on the prices and their corresponding production.

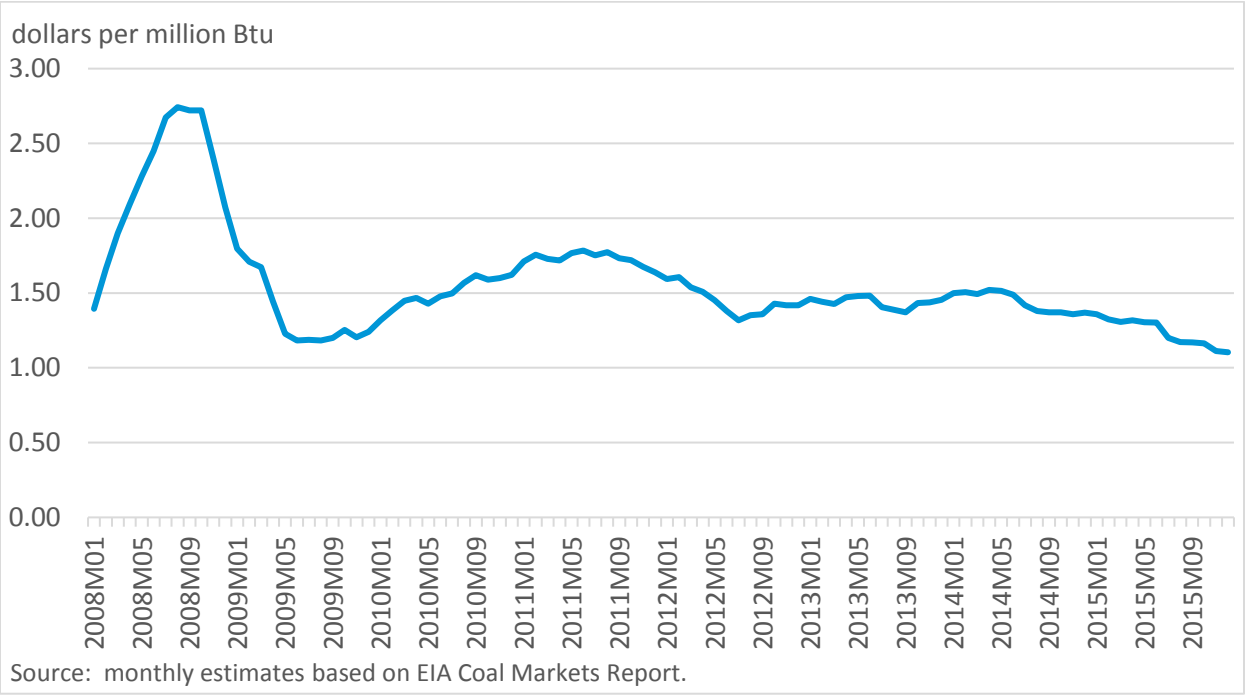
Prices for coal delivered to the electric power sector are reported in the *Electric Power Monthly* (*EPM)* in dollars per ton and in dollars per MMBtu. The *STEO* model uses the latter measure so price comparisons to other power sector fuels such as natural gas and petroleum, which are also reported in dollars per MMBtu, are consistent.

B. Coal Price Equations

1. Composite Spot Price

The composite spot price of coal has decreased by 46% over the past eight years from an average of $2.26/MMBtu in 2008 to an average of $1.23/MMBtu in 2015 as shown in Figure 5. The CAPP spot prices fell the most over this period (52%). Coal prices for the western producing regions declined significantly less compared with coal prices for the eastern regions. The PRB spot prices fell by 14% over the period and the UIB prices fell by 26%.

Figure 5. Composite spot price, Jan. 2008 - Dec. 2015



Source: monthly estimates based on EIA Coal Markets Report.

The monthly composite spot price of coal is estimated as a function of coal production, electric power sector coal stocks (inventories), and total coal exports (Equation 1).

Equation 1:

CLSPUUS = a0 + a1 * CLPRPUS + a2 * CLPS_EP + a3 * CLEXPUS + monthly dummy variables

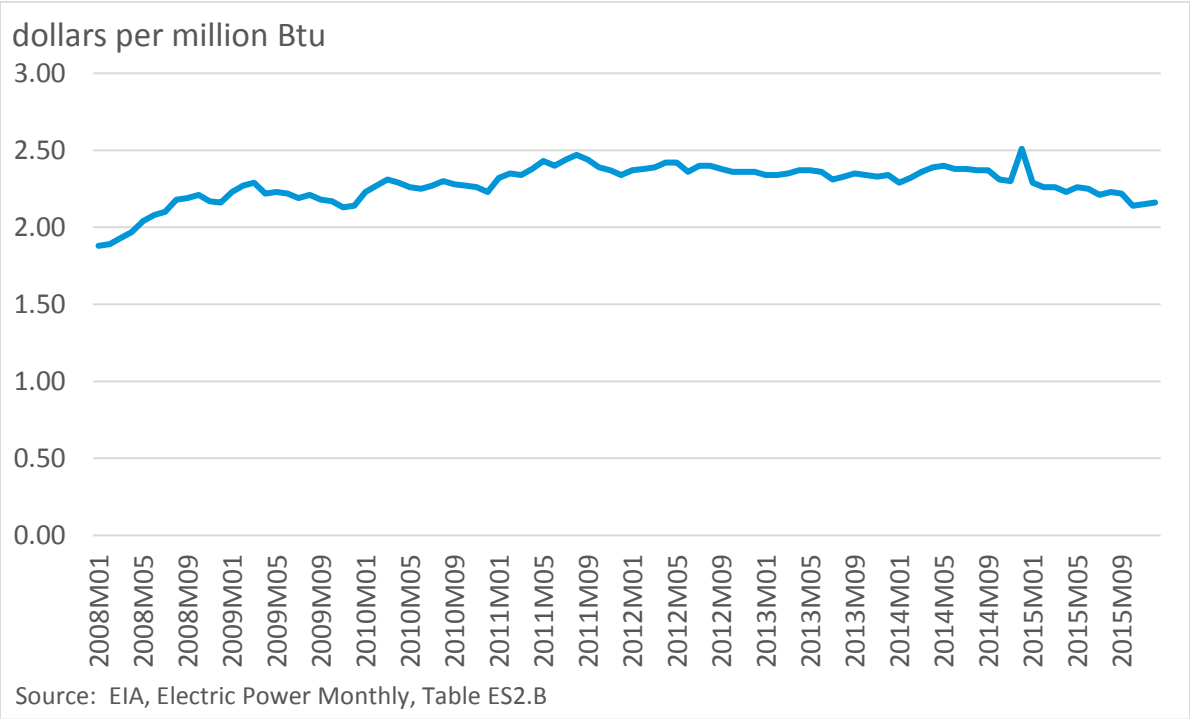
Where:

CLSPUUS = production-weighted, composite spot coal price, dollars per million Btu;
CLPRPUS = total coal production, million short tons per day;
CLPS_EP = total electric power sector coal stocks, million short tons; and
CLEXPUS = total coal exports, million short tons per day.

2. Electric Power Sector Coal Price

The price of coal delivered to the electric power sector has increased by almost 8% over the past eight years from $2.07/MMBtu in 2008 to $2.22/MMBtu in 2015 as seen in Figure 6.

Figure 6. Electric power sector coal price, Jan. 2008 - Dec. 2015



Source: EIA, Electric Power Monthly, Table ES2.B

The price of coal delivered to the electric power sector, as shown in Equation 2, is estimated as a function of the composite spot coal price, the retail diesel fuel price to reflect transportation costs, and power sector coal stocks (inventories). The resulting prices are passed to several other STEO modules.

Equation 2:

CLEUDUS = a0 + a1 * CLSPUUS + a2 * DSRTUUS + a3 * CLPS_EP + monthly dummy variables

Where:

CLEUDUS = power sector coal price, dollars per million Btu;
CLSPUUS = production-weighted composite spot coal price, dollars per million Btu;
DSRTUUS = diesel fuel retail price, cents per gallon;
CLPS_EP = total electric power sector coal stocks, million short tons.

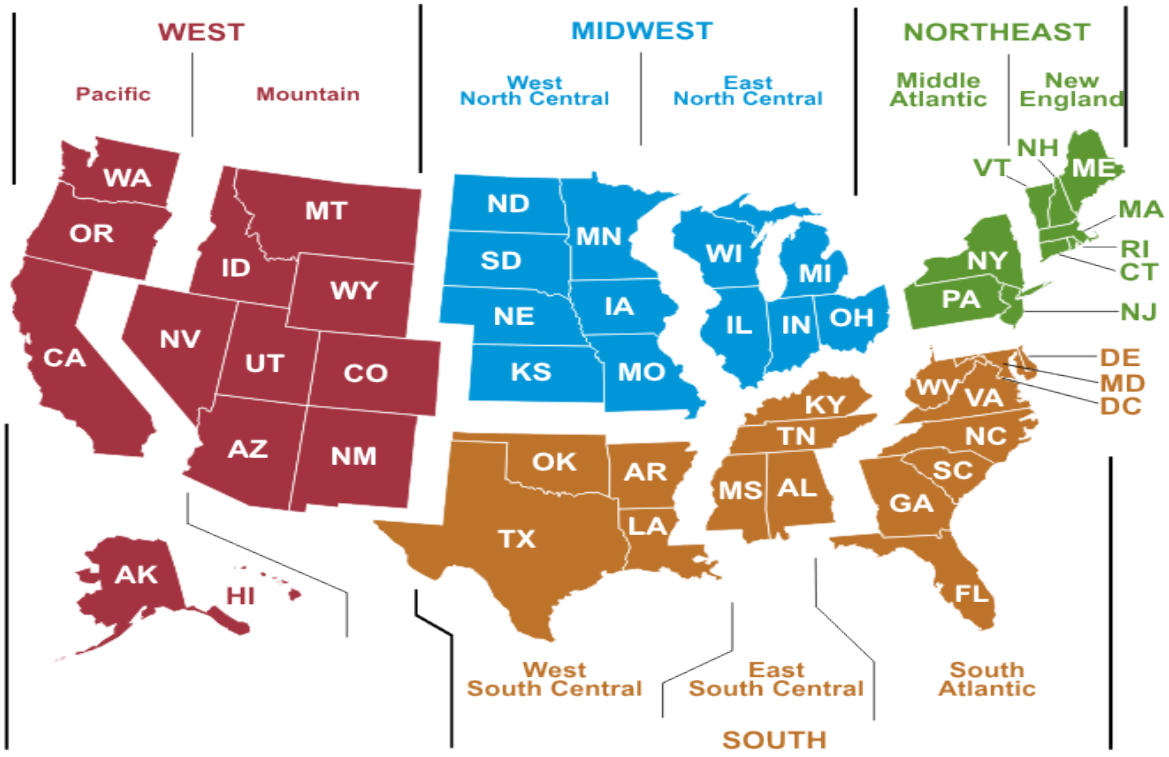
3. Proposed Regional Coal Prices for STEO Model

A. Introduction

As illustrated in Figure 4, the forecast of the national power sector coal price (CLEUDUS) serves as an endogenous input to several other modules of the STEO model. Equations in both the electricity generation and electricity price module that use CLEUDUS are constructed at a regional level. Other inputs to these equations are at a regional level, and it makes sense, both logically and econometrically, that the coal price (fuel cost) inputs be regional as well, if possible.

Several energy flows related to the power sector including: generation, energy consumption, fuel receipts, and fuel costs (energy prices) are currently available in the STEO database by regional aggregations. These flows are aggregated in relation to U.S. Census-defined groupings, either by the defined census division (smaller) or census region (larger). Figure 7 displays how the United States is divided along these lines.

Figure 7. U.S. Census Regions and Divisions



Historical electric power sector delivered coal fuel costs (prices) can be calculated for each census region. Based on this data, two different approaches to determining the regional prices of coal were evaluated. The first method indexes the regional prices to the currently forecasted national level price (CLEUDUS) based on the historical relationship between the national and regional delivered prices. The second method starts at the regional level by developing econometric equations for each regional price, and then applying a revised method for estimating the national level price forecast (CLEUDUS_R) as a

weighted composite of the econometrically-derived regional prices to ensure consistency with regional price estimation.

B. Regional Indexing Method

The regional indexing method generates a forecast of each region's delivered coal price based on the historical relationship of each region's price to the national delivered price, and applying this relationship to the forecasted values of the national price. The relationship (Index or ratio adjustment factor) between the regional delivered price and the national delivered price is defined in Index 1.

Index 1:

FCCOAL_INDX_*Region* = FCCOAL_*Region* / FCCOAL_US

Where:

FCCOAL_INDX_*Region* = Historically calculated index for a region
FCCOAL_*Region* = Regional delivered coal price, cents per million Btu
FCCOAL_US = National delivered coal price, cents per million Btu

And:

Region = NE (Northeast Region)
= MW (Midwest Region)
= SO (South Region)
= WE (West Region)

To extend the indexes through the forecast horizon, two methods were evaluated, one that used a moving monthly-average of the index and the other which used the last full year's average index.

1. Monthly Index

Indexes of a two-year and a three-year moving average were considered for use in developing the regional delivered coal price forecasts. Although the two-year average would normally be sufficient to cover the entire forecast horizon, which is typically two years, the three-year average was considered for the instances when the forecast period is greater than two years. The two-year moving average for the index for a particular month of the year is defined in Index 2.

Index 2:

FCCOAL_INDX_*Region*_2YR = AVERAGE(FCCOAL_INDX_*Region*(-12), FCCOAL_INDX_*Region*(-24))

The three-year moving average for the index for a particular month of the year is defined in Index 3.

Index (3)

FCCOAL_INDX_*Region*_3YR = AVERAGE(FCCOAL_INDX_*Region*(-12), FCCOAL_INDX_*Region*(-24), FCCOAL_INDX_*Region*(-36))

Where:

FCCOAL_INDX_*Region*_2YR = Two-year monthly moving average of index for a region
FCCOAL_INDX_*Region*_3YR = Three-year monthly moving average of index for a region
FCCOAL_INDX_*Region*(-12) = Historically calculated index for a region, 1-year ago
FCCOAL_INDX_*Region*(-24) = Historically calculated index for a region, 2-years ago
FCCOAL_INDX_*Region*(-36) = Historically calculated index for a region, 3-years ago

And:

Region = NE (Northeast Region)
= MW (Midwest Region)
= SO (South Region)
= WE (West Region)

Table 1 provides an example, using the indexes calculated for the Midwest Region, of how the monthly moving averages would be calculated for the month of February. Missing values for the index are are omitted from the calculation of the averages; they are not treated as zero.

Table 1. Midwest Region Fuel Index, two-year moving average and three-year moving average, for the month of February

Date	FCCOAL_INDX_MW	FCCOAL_INDX_MW_2YR	FCCOAL_INDX_MW_3YR
February 2012	0.888211	Not Shown	Not Shown
February 2013	0.893718	Not Shown	Not Shown
February 2014	0.90944	0.890964	Not Shown
February 2015	0.909206	0.901579	0.897123
February 2016	0.920211	0.909323	0.904122
February 2017		0.914709	0.912952
February 2018		0.920211	0.914709
February 2019		Not Calculated	0.920211

2. Annual Index

An annual regional index method was also considered that would base the forecast values of the regional adjustment factors on the annual average value of the factors for the last full year for which is data available. Under this method index values for each month would be identical. The regional adjustment factors based on the annual average are calculated in Index 4.

Index 4:

FCCOAL_INDX_*Region*_ANN = AVERAGE(FCCOAL_INDX_*Region*(*JanYR*)
FCCOAL_INDX_*Region*(*FebYR*), …, FCCOAL_INDX_ *Region*(*DecYR*))

Where:

FCCOAL_INDX_*Region*_ANN = Annual average of historically calculated index for a region
FCCOAL_INDX_*Region*(*JanYR*) =January value of historically calculated index for a region
FCCOAL_INDX_*Region*(*FebYR*) =February value of historically calculated index for a region
... FCCOAL_INDX_*Region*(*DecYR*) =December value of historically calculated index for a region

And:

Region = NE (Northeast Region)
= MW (Midwest Region)
= SO (South Region)
= WE (West Region)

YR = Last year in which regional adjustment factor is available for a full year.

Table 2 provides an example, using the indexes calculated for the Midwest Region, of how the fixed, annual average is used to determine the forecasted index values.

Table 2. Midwest Region Fuel Index, Annual average and values assigned to all months

YEAR	Annual Average FCCOAL_INDX_MW	Values Assigned to all months of year for FCCOAL_INDX_MW_ANN
2014	0.89928	0.89928
2015	0.90148	0.90148
2016		0.90148
2017		0.90148
2018		0.90148

2. Application of Index to Determine Regional Coal Prices

Index-based forecasts, whether based on the monthly 2 or 3-year moving average, or the fixed annual average methods, were then generated by applying the forecasted index to the forecasted delivered coal price using Equation 3.

Equation 3:

FCCOAL_*Region*_I*ndex* = (FCCOAL_INDX_*Region_Index* * CLEUDUS) * 100

Where:

FCCOAL_*Region*_I*ndex* = Forecasted regional delivered coal price, cents per million Btu
FCCOAL_INDX_*Region_Index* = Forecasted price index for a region
CLEUDUS = Power sector coal price, dollars per million Btu

And:

Region = NE (Northeast Region)
= MW (Midwest Region)
= SO (South Region)
= WE (West Region)

Index = 2YR (two-year moving average)
= 3YR (three-year moving average)
= ANN (annual average)

C. Econometric Equations for Each Regional Price and a National Level Price Forecast Derived as a Weighted Composite of the Regional Price Forecasts

The other method considered in generating regional delivered coal prices was to develop an econometric equation for each regional price and to subsequently derive a corresponding coal receipts weighted-average national price forecast based on the regional delivered coal prices.

1. Regional Equations

The equations for each region, as shown in Equations 4 through 7, are estimated as a function of the composite spot coal price, the Henry Hub natural gas spot price, the retail diesel fuel price, and regional power sector coal stocks (inventories). Regional delivered natural gas prices would have been considered a substitute for the Henry Hub gas price, but they are currently not forecasted by the STEO model.

Northeast Region

The price of coal delivered to the electric power sector in the Northeast region is estimated as shown in Equation 4.

Equation 4:

FCCOAL_NE = a0 + a1 * (CLSPUUS*100) + a2 * (NGHHUUS*100) + a3 * DSRTUUS + a4 * CLPS_EP_NE + monthly dummy variables

Where:

FCCOAL_NE = Northeast region power sector coal price, cents per million Btu
CLSPUUS = Production-weighted composite spot coal price, dollars per million Btu
NGHHUUS = Henry Hub natural gas spot price, dollars per million Btu
DSRTUUS = Diesel fuel retail price, cents per gallon
CLPS_EP_NE = Northeast region electric power sector coal stocks, million short tons

Midwest Region

The price of coal delivered to the electric power sector in the Midwest region is shown in Equation 5.

Equation 5:

FCCOAL_MW = a0 + a1 * (CLSPUUS*100) + a2 * (NGHHUUS*100) + a3 * DSRTUUS + a4 * CLPS_EP_MW + monthly dummy variables

Where:

FCCOAL_MW = Midwest region power sector coal price, cents per million Btu
CLSPUUS = Production-weighted composite spot coal price, dollars per million Btu
NGHHUUS = Henry Hub natural gas spot price, dollars per million Btu
DSRTUUS = Diesel fuel retail price, cents per gallon
CLPS_EP_MW = Midwest region electric power sector coal stocks, million short tons

South Region

The price of coal delivered to the electric power sector in the South region is shown in Equation 6.

Equation 6:

FCCOAL_SO = a0 + a1 * (CLSPUUS*100) + a2 * (NGHHUUS*100) + a3 * DSRTUUS + a4 * CLPS_EP_SO + monthly dummy variables

Where:

FCCOAL_SO = South region power sector coal price, cents per million Btu
CLSPUUS = Production-weighted composite spot coal price, dollars per million Btu
NGHHUUS = Henry Hub natural gas spot price, dollars per million Btu
DSRTUUS = Diesel fuel retail price, cents per gallon
CLPS_EP_SO = South region electric power sector coal stocks, million short tons

West Region

The price of coal delivered to the electric power sector in the West region is shown in Equation 7.

Equation 7:

FCCOAL_WE = a0 + a1 * (CLSPUUS*100) + a2 * (NGHHUUS*100) + a3 * DSRTUUS + a4 * CLPS_EP_WE + monthly dummy variables

Where:

FCCOAL_WE = West region power sector coal price, cents per million Btu
CLSPUUS = Production-weighted composite spot coal price, dollars per million Btu
NGHHUUS = Henry Hub natural gas spot price, dollars per million Btu
DSRTUUS = Diesel fuel retail price, cents per gallon
CLPS_EP_WE = West region electric power sector coal stocks, million short tons

2. Composite National Price Forecast

The regional fuel costs (prices) that were derived using indexes are developed in a manner similar to the econometrically derived national price forecasts, but the individual, econometrically-produced regional forecasts are not guaranteed to be related to the forecast national price. To ensure consistency between the regional and national price forecasts, the national price forecast should be derived from the regional forecasts. To accomplish this, a coal receipts-weighted average price forecasting equation was developed similar to the method used to derive the current national price.

Although data on coal receipts is available, the STEO model does not currently forecast these volumes, but coal receipt can be projected from projected consumption and inventory values:

Coal Receipts = Coal Consumption - Change in Coal Inventories.

This identity is not guaranteed to hold up if you aggregate at the level of individual plants, but the aggregated value can serve as a useful proxy for calculating receipts. The STEO model does currently forecast coal consumption and coal inventories by region. Below are proxy Equations (8-11) for coal receipts by region.

Equation 8:

CLRC_EP_NE_TON = ((CLEPCON_NE / 1000) * ZSAJQUS) - (CLPS_EP_NE(-1) - CLPS_EP_NE)

Where:

CLRC_EP_NE_TON = Proxy for Northeast region power sector coal receipts, million short tons
CLEPCON_NE = Northeast region power sector coal consumption, thousand tons per day
ZSAJQUS = Number of days in the reference month
CLPS_EP_NE = Northeast region power sector coal stocks, million short tons
CLPS_EP_NE(-1) = Northeast region power sector coal stocks, million short tons, previous month

Equation 9:

CLRC_EP_MW_TON = ((CLEPCON_MW / 1000) * ZSAJQUS) - (CLPS_EP_MW(-1) - CLPS_EP_MW)

Where:

CLRC_EP_MW_TON = Proxy for Midwest region power sector coal receipts, million short tons
CLEPCON_MW = Midwest region power sector coal consumption, thousand tons per day
ZSAJQUS = Number of days in the reference month
CLPS_EP_MW = Midwest region power sector coal stocks, million short tons
CLPS_EP_MW(-1) = Midwest region power sector coal stocks, million short tons, previous month

Equation 10:

CLRC_EP_SO_TON = ((CLEPCON_SO / 1000) * ZSAJQUS) - (CLPS_EP_SO(-1) - CLPS_EP_SO)

Where:

CLRC_EP_SO_TON = Proxy for South region power sector coal receipts, million short tons
CLEPCON_SO = South region power sector coal consumption, thousand tons per day
ZSAJQUS = Number of days in the reference month
CLPS_EP_SO = South region power sector coal stocks, million short tons
CLPS_EP_SO(-1) = South region power sector coal stocks, million short tons, previous month

Equation 11:

CLRC_EP_WE_TON = ((CLEPCON_WE / 1000) * ZSAJQUS) - (CLPS_EP_WE(-1) - CLPS_EP_WE)

Where:

CLRC_EP_WE_TON = Proxy for West region power sector coal receipts, million short tons
CLEPCON_WE = West region power sector coal consumption, thousand tons per day

ZSAJQUS = Number of days in the reference month
CLPS_EP_WE = West region power sector coal stocks, million short tons
CLPS_EP_WE(-1) = West region power sector coal stocks, million short tons, previous month

A proxy for total U.S. power sector coal receipts is calculated in Equation 12.

Equation 12:

CLRC_EP_US_TON = CLRC_EP_NE_TON + CLRC_EP_MW_TON + CLRC_EP_SO_TON + CLRC_EP_WE_TON

Where:

CLRC_EP_US_TON = Proxy for total power sector coal receipts, million short tons;
CLRC_EP_NE_TON = Proxy for Northeast region power sector coal receipts, million short tons;
CLRC_EP_MW_TON = Proxy for Midwest region power sector coal receipts, million short tons;
CLRC_EP_SO_TON = Proxy for South region power sector coal receipts, million short tons;
CLRC_EP_WE_TON = Proxy for West region power sector coal receipts, million short tons.

The (receipt-weighted) price of coal delivered to the electric power sector is estimated as shown in Equation 13.

Equation 13:

FCCOAL_US = ((FCCOAL_NE * CLRC_EP_NE_TON) + (FCCOAL_MW * CLRC_EP_MW_TON) + (FCCOAL_SO * CLRC_EP_SO_TON) + (FCCOAL_WE * CLRC_EP_WE_TON)) / CLRC_EP_US_TON

Where:

FCCOAL_US = power sector coal price, cents per million Btu
FCCOAL_NE = Northeast region power sector coal price, cents per million Btu
CLRC_EP_NE_TON = Proxy for Northeast region power sector coal receipts, million short tons
FCCOAL_MW = Midwest region power sector coal price, cents per million Btu
CLRC_EP_MW_TON = Proxy for Midwest region power sector coal receipts, million short tons
FCCOAL_SO = South region power sector coal price, cents per million Btu
CLRC_EP_SO_TON = Proxy for South region power sector coal receipts, million short tons
FCCOAL_WE = West region power sector coal price, cents per million Btu
CLRC_EP_WE_TON = Proxy for West region power sector coal receipts, million short tons
CLRC_EP_US_TON = Proxy for total power sector coal receipts, million short tons

The forecast is converted to dollars per million Btu, which is the standard STEO unit, in Equation 14.

Equation 14:

CLEUDUS_R = FCCOAL_US / 100

Where:

CLEUDUS_R = power sector coal price, dollars per million Btu
FCCOAL_US = power sector coal price, cents per million Btu

4. Forecast Evaluations

The results of the evaluation indicate that the best method for estimating the regional prices is the development of econometric equations to forecast the prices. Although the index-based forecasts, especially the annual index-based forecasts, were fairly accurate and easy to develop and maintain, they were more susceptible to prices that were significant outliers, such as the December 2014 West region price.

A. Northeast Region Prices

Table 3 provides a comparison of the annual average forecasts and actual Northeast region coal prices for 2012 through 2015. The forecasts for 2012 had the largest difference from actual with the index-based forecasts around 8% larger and the econometric forecast being around 1% higher. Overall, the econometric forecasts were the closest for all years, with the forecast being within one cent or less of the actual price. The moving average forecasts were generally (seven out of eight instances) higher than actual, and did not address price volatility as robustly as the regional regression-based approach.

Table 3. Actual and coal price forecasts, annual totals (cents per million Btu)

	Year			
	2012	**2013**	**2014**	**2015**
Actual Price (FCCOAL_NE)	265.38	269.19	272.14	248.26
Two-year Index Price (FCCOAL_NE_I2YR)	285.95	270.72	266.91	255.25
Three-year Index Price (FCCOAL_NE_I3YR)	284.99	274.27	272.46	252.42
Annual Index Price (FCCOAL_NE_IANN)	286.57	260.70	271.62	255.73
Econometric Equation (FCCOAL_NE)	267.20	268.70	271.98	248.26

Figure 8 through Figure 11 show the monthly actual and forecasted values for the Northeast region coal price.

Figure 8. Northeast region coal price forecast versus actual, January 2012 – December 2015

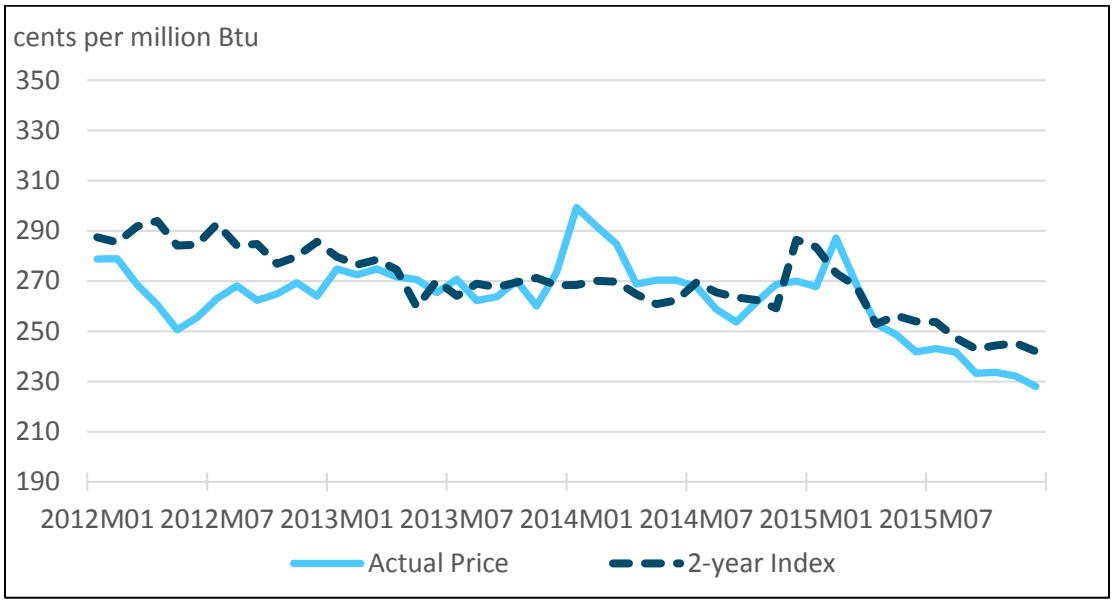


Figure 9. Northeast region coal price forecast versus actual, January 2012 – December 2015

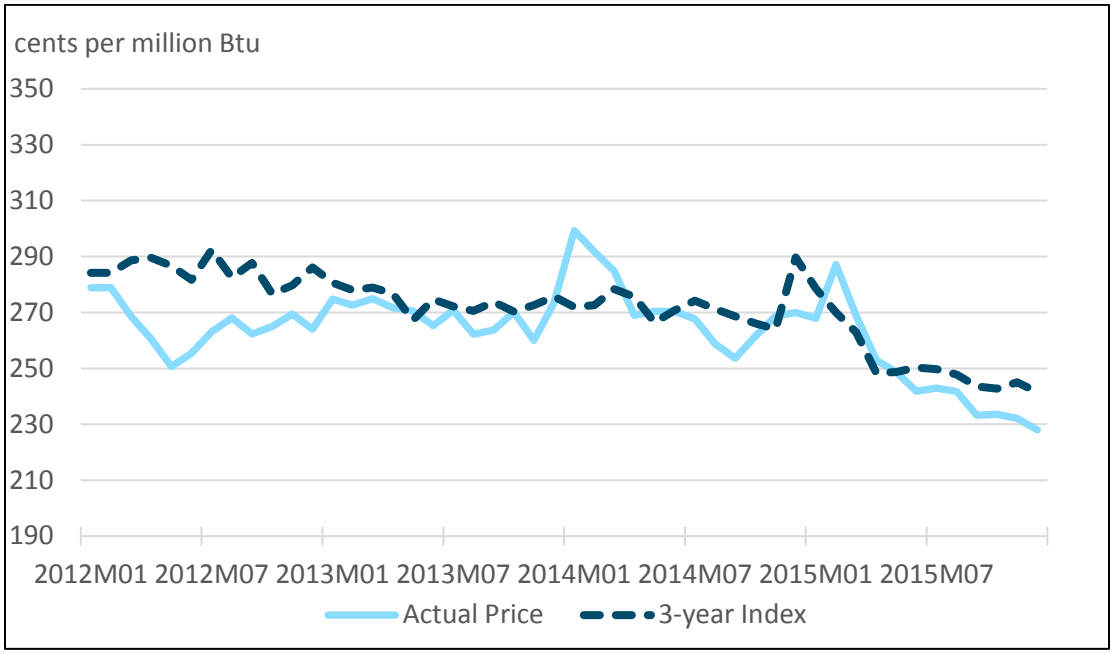


Figure 10. Northeast region coal price forecast versus actual, January 2012 – December 2015

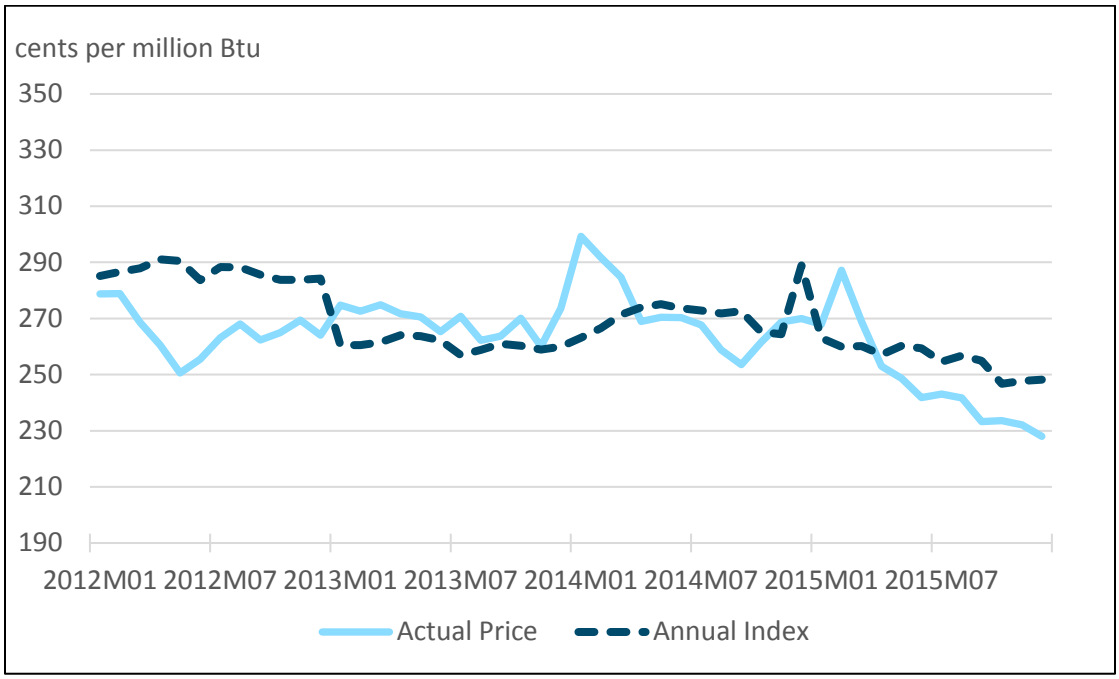
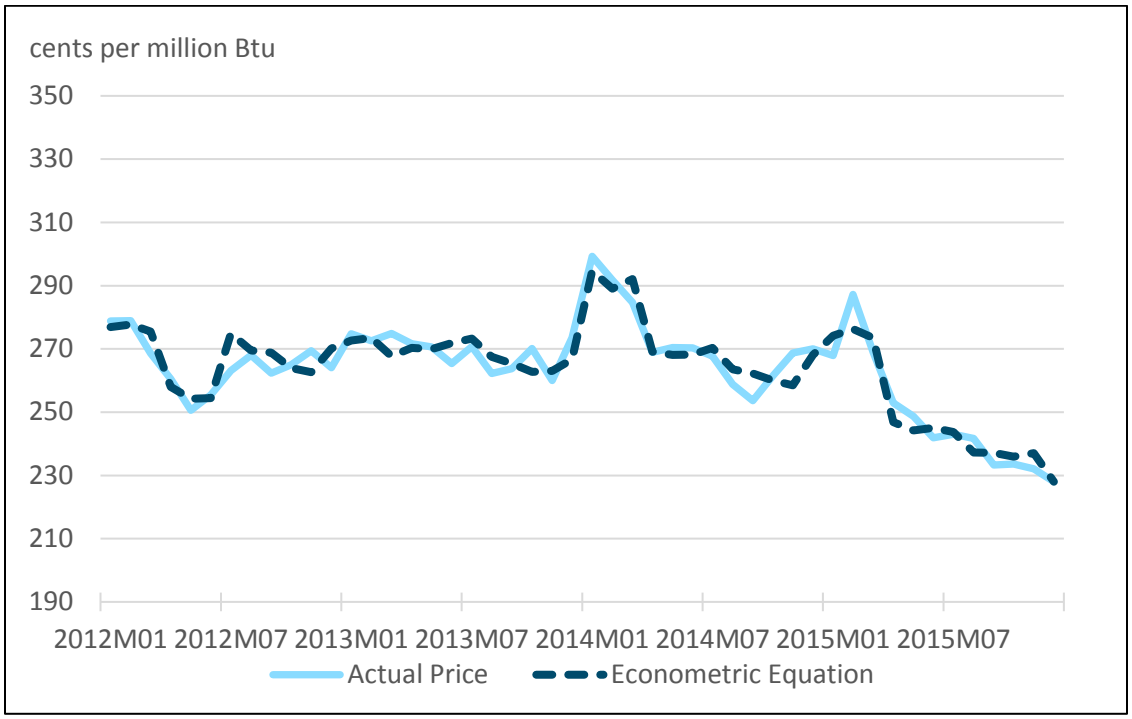


Figure 11. Northeast region coal price forecast versus actual, January 2012 – December 2015



B. Midwest Region Prices

Table 4 provides a comparison of the annual average forecasts and actual Midwest region coal prices for 2012 through 2015. The forecasts for 2012 had the largest difference from actual ranging from 6% (13 cents) for the three-year index to just over 1% (3 cents) for the econometric forecast. Forecast differences for 2015 were less than 1% with the annual index forecast being 0.2% different. Overall, the econometric forecasts and the annual index forecasts were the closest for all years, with each having average differences around 1%, or 1 cent and 2 cents, respectively.

Table 4. Actual and coal price forecasts, annual totals (cents per million Btu)

	Year			
	2012	**2013**	**2014**	**2015**
Actual Price (FCCOAL_MW)	212.71	209.65	212.90	200.42
Two-year Index Price (FCCOAL_MW_I2YR)	200.83	205.53	210.88	199.12
Three-year Index Price (FCCOAL_MW_I3YR)	199.67	201.25	208.66	198.66
Annual Index Price (FCCOAL_MW_IANN)	206.33	208.93	211.53	199.95
Econometric Equation (FCCOAL_MW)	209.70	210.85	211.90	201.04

Figures 12 through Figure 15 show the monthly actual and forecasted values for the Midwest region coal price.

Figure 12. Midwest region coal price forecast versus actual, January 2012 – December 2015

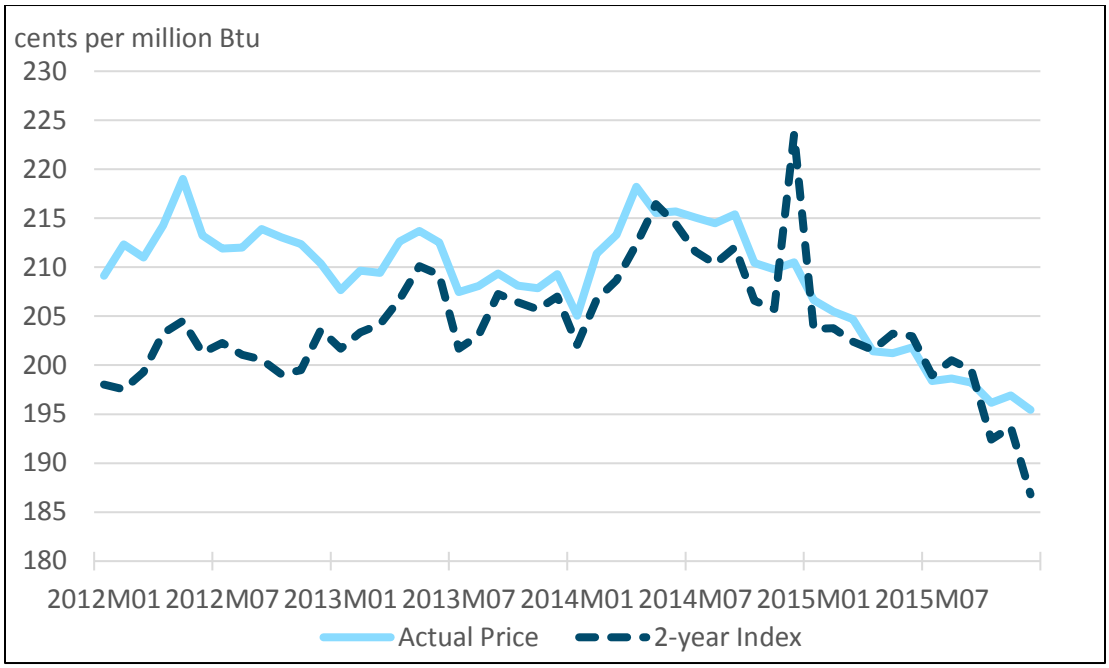


Figure 13. Midwest region coal price forecast versus actual, January 2012 – December 2015

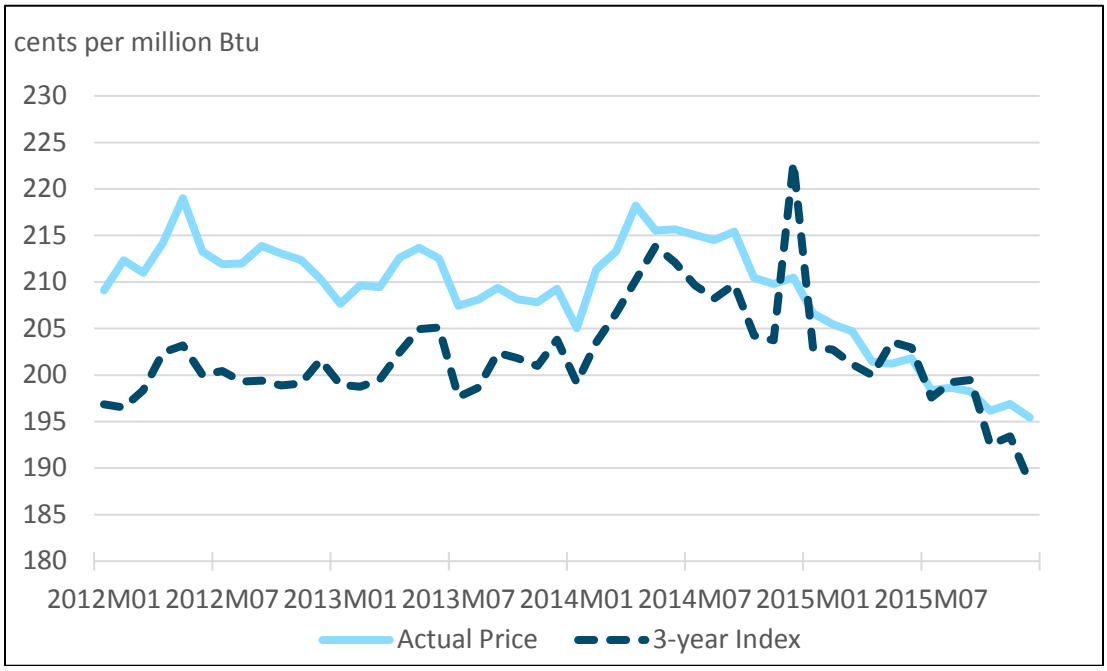


Figure 14. Midwest region coal price forecast versus actual, January 2012 – December 2015

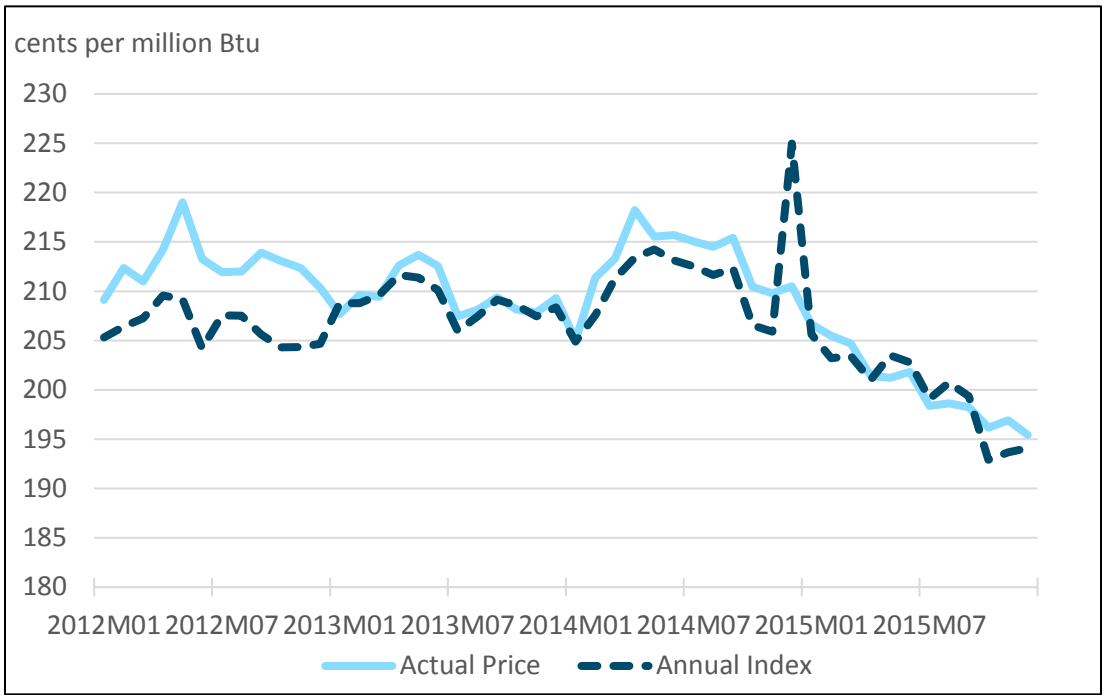
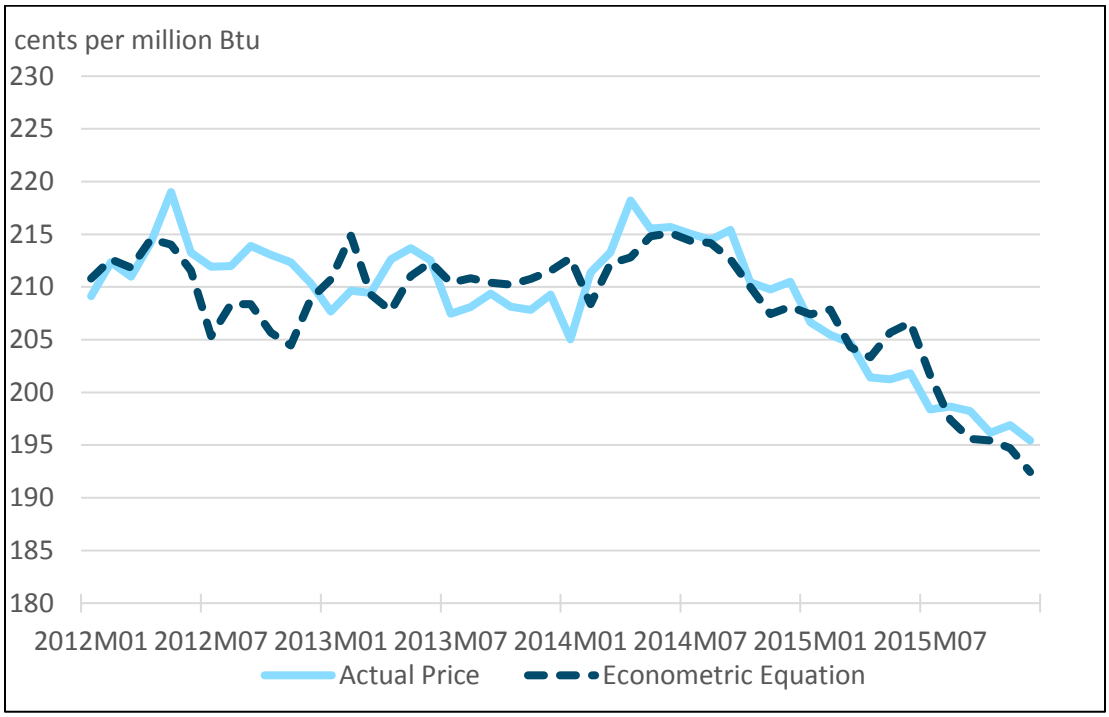


Figure 15. Midwest region coal price forecast versus actual, January 2012 – December 2015



C. South Region Coal Prices

Table 5 provides a comparison of the annual average forecasts and actual South region coal prices for 2012 through 2015. The forecasts for 2014 had the largest difference from actual ranging from 3% (9 cents) for the 3-year index to just over 1% (3 cents) for the econometric forecast. Forecast differences for 2015 were the smallest, with the largest difference (the annual index forecast difference) being 2%. Overall, the econometric forecasts and the annual index forecasts were the closest for all years, with each having average differences of 1% (1 cent) and 2% (4 cents), respectively.

Table 5. Actual and out-of-sample coal price forecasts, annual totals (cents per million Btu)

	Year			
	2012	**2013**	**2014**	**2015**
Actual Price (FCCOAL_SO)	272.87	264.67	260.66	249.09
Two-year Index Price (FCCOAL_SO_I2YR)	278.57	268.70	268.35	247.59
Three-year Index Price (FCCOAL_SO_I3YR)	280.11	271.88	269.61	249.62
Annual Index Price (FCCOAL_SO_IANN)	275.00	268.02	267.06	244.81
Econometric Equation (FCCOAL_SO)	272.56	266.92	263.40	249.09

Figures 16 through Figure 19 show the monthly actual and forecasted values for the South region coal price.

Figure 16. South region coal price forecast versus actual, January 2012 – December 2015

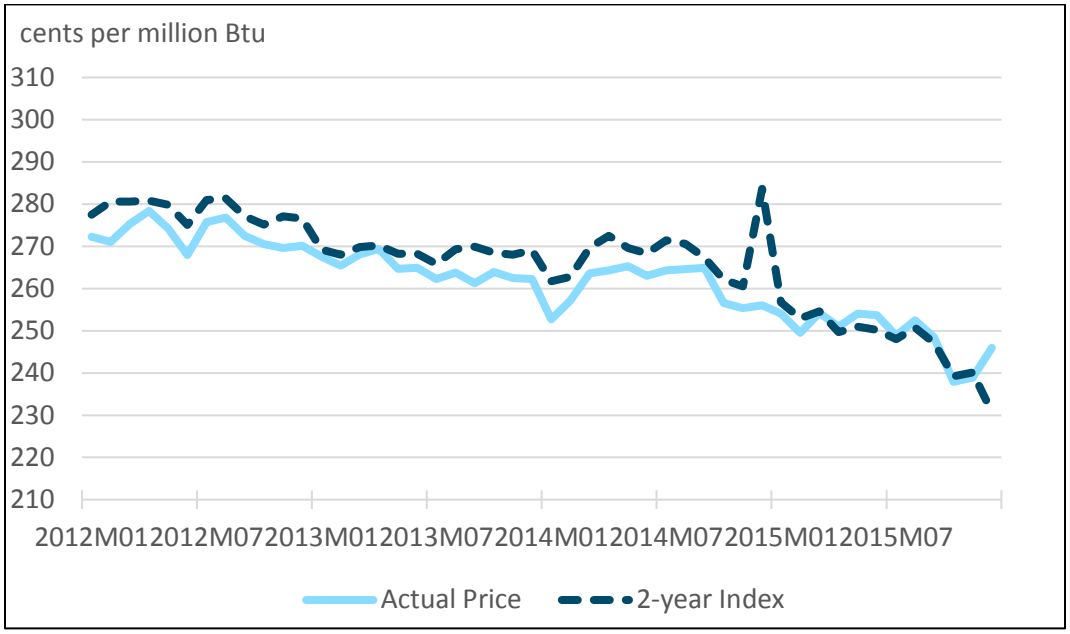


Figure 17. South region coal price forecast versus actual, January 2012 – December 2015

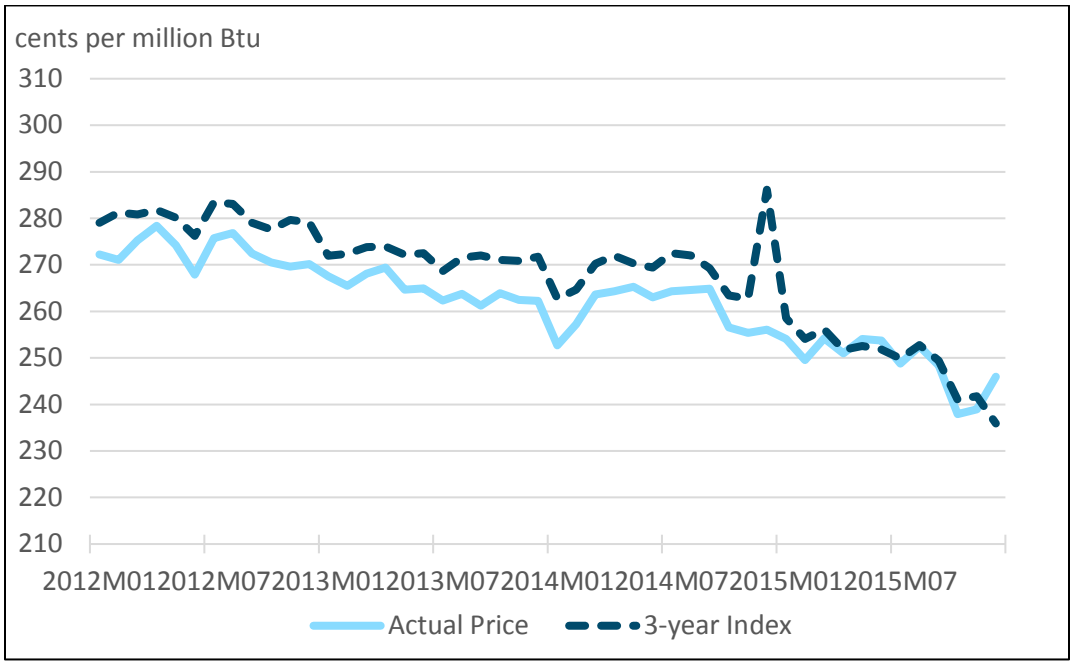


Figure 18. South region coal price forecast versus actual, January 2012 – December 2015

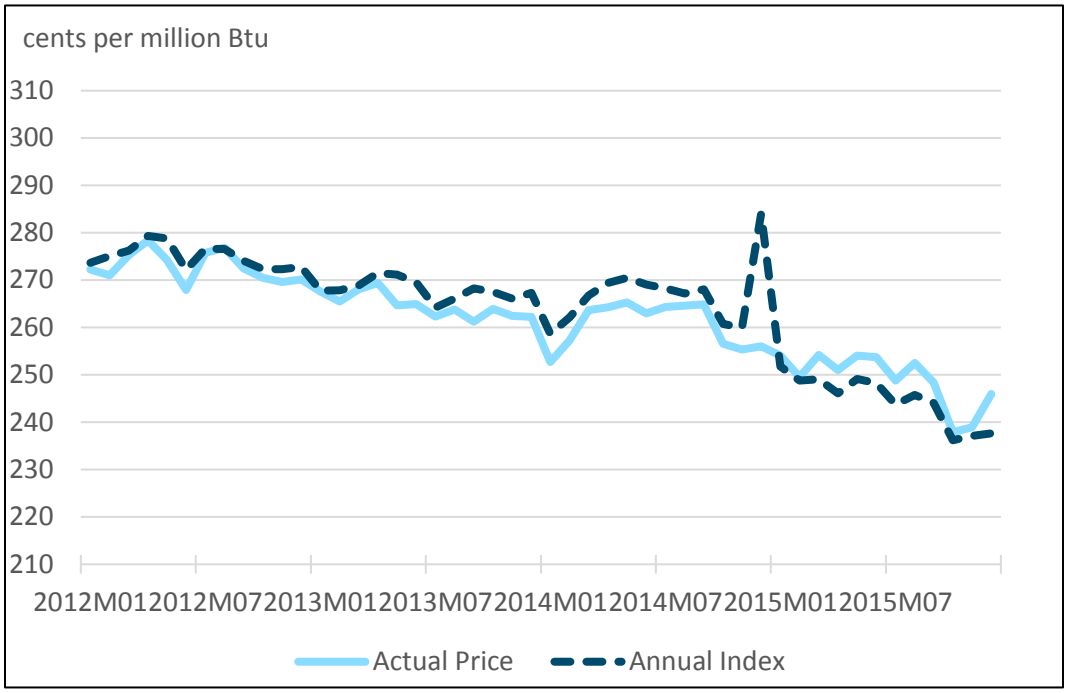
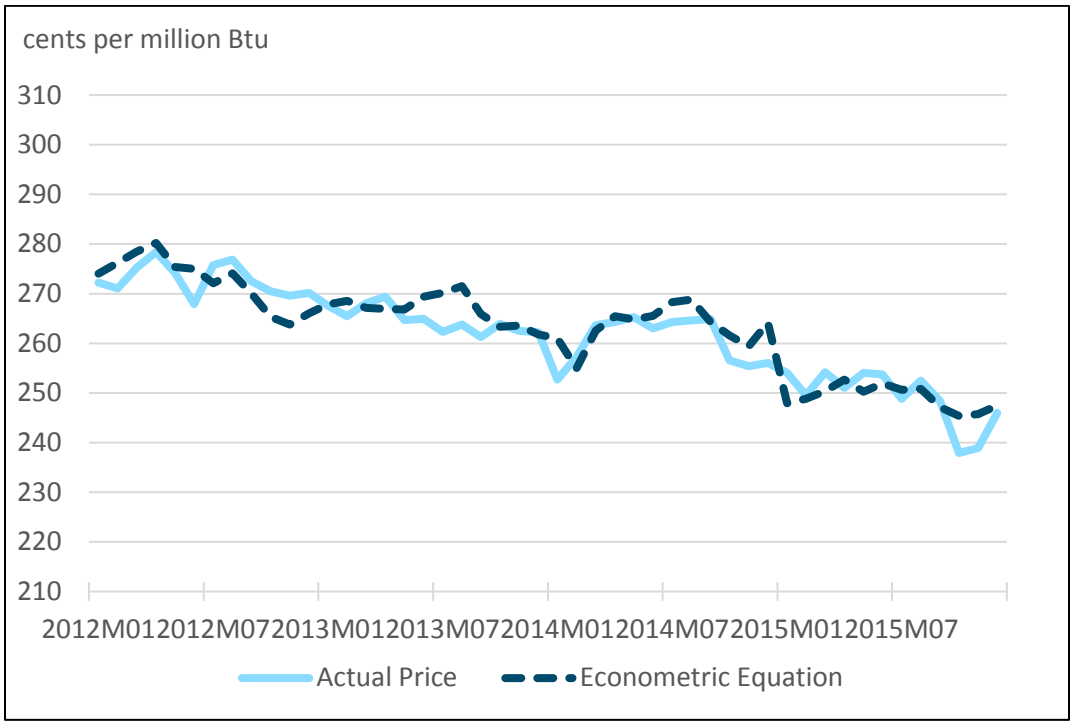


Figure 19. South region coal price forecast versus actual, January 2012 – December 2015



D. West Region Coal Prices

Table 6 provides a comparison of the annual average forecasts and actual West region coal prices for the 2012 through 2015. Excluding the econometric forecast, the forecasts for 2014 had the largest difference from actual ranging from 7% (15 cents) for the annual index to just over 11% (24 cents) for the three-year index forecast. The reason for the large errors is the significant outlier reported in December 2014 for the price of coal delivered to New Mexico. That price, $16.54/MMBtu, was 575% higher than the 2013 price. When the estimated prices were aggregated up to the regional and national levels, the outlier still caused significant estimated year over year growth, with regional (West) prices being 82% higher and national prices being 7% higher than their respective December 2013 prices. Because the indexes are applied to the national prices, the December 2014 price spike is present (to varying degrees) in the index-based forecasts for all regions. Overall, the econometric forecasts and the annual index forecasts were the closest for all years, with each having average differences of 1% (1 cent) and 5% (9 cents), respectively.

Table 6. Actual and out-of-sample coal price forecasts, annual totals (cents per million Btu)

	Year			
	2012	**2013**	**2014**	**2015**
Actual Price (FCCOAL_WE)	187.94	194.82	212.07	191.38
Two-year Index Price (FCCOAL_WE_I2YR)	179.95	182.20	191.16	191.14
Three-year Index Price (FCCOAL_WE_I3YR)	178.60	179.44	187.99	185.68
Annual Index Price (FCCOAL_WE_IANN)	183.55	184.60	196.59	198.41
Econometric Equation (FCCOAL_WE)	189.66	192.32	211.90	191.56

Figure 20 through Figure 23 show the monthly actual and forecasted values for the West region coal price.

Figure 20. West region coal price forecast versus actual, January 2012 – December 2015

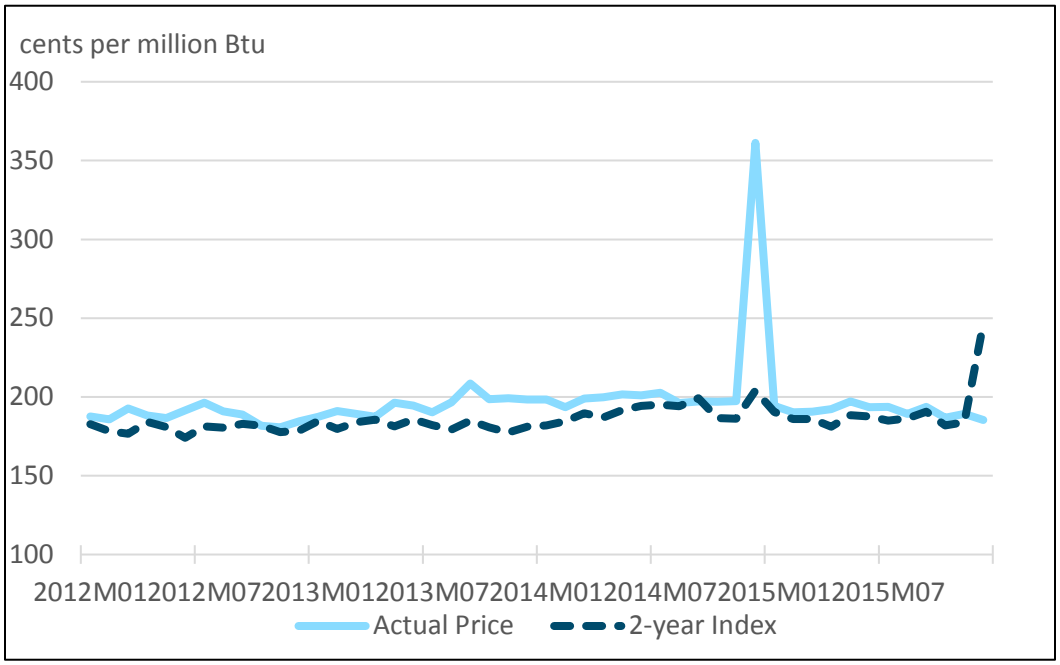


Figure 21. West region coal price forecast versus actual, January 2012 – December 2015

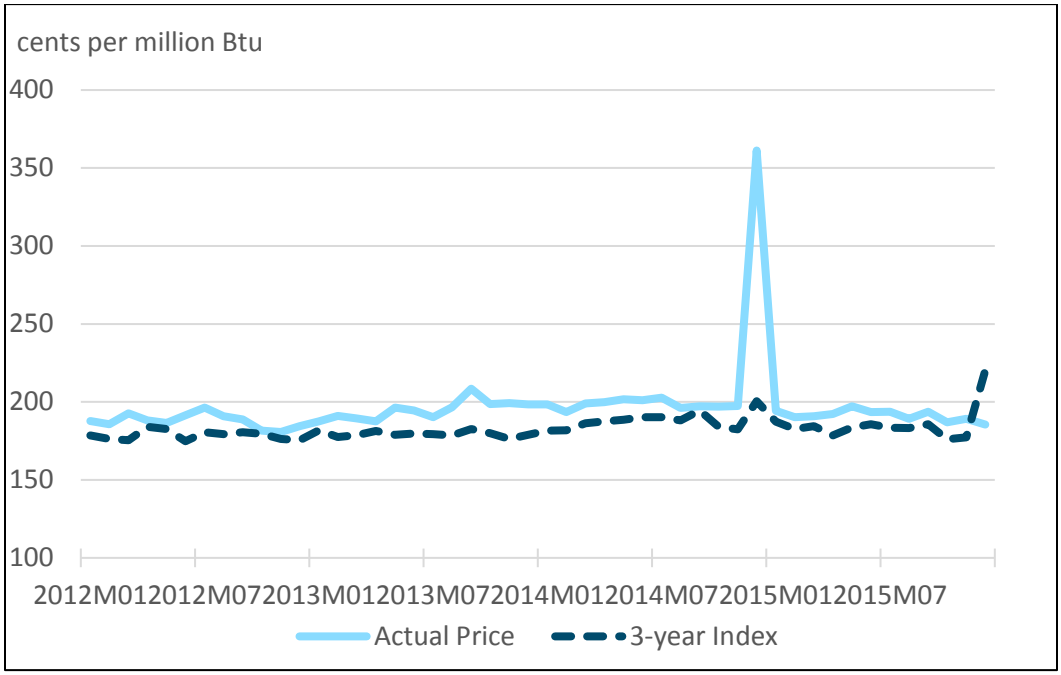


Figure 22. West region coal price forecast versus actual, January 2012 – December 2015

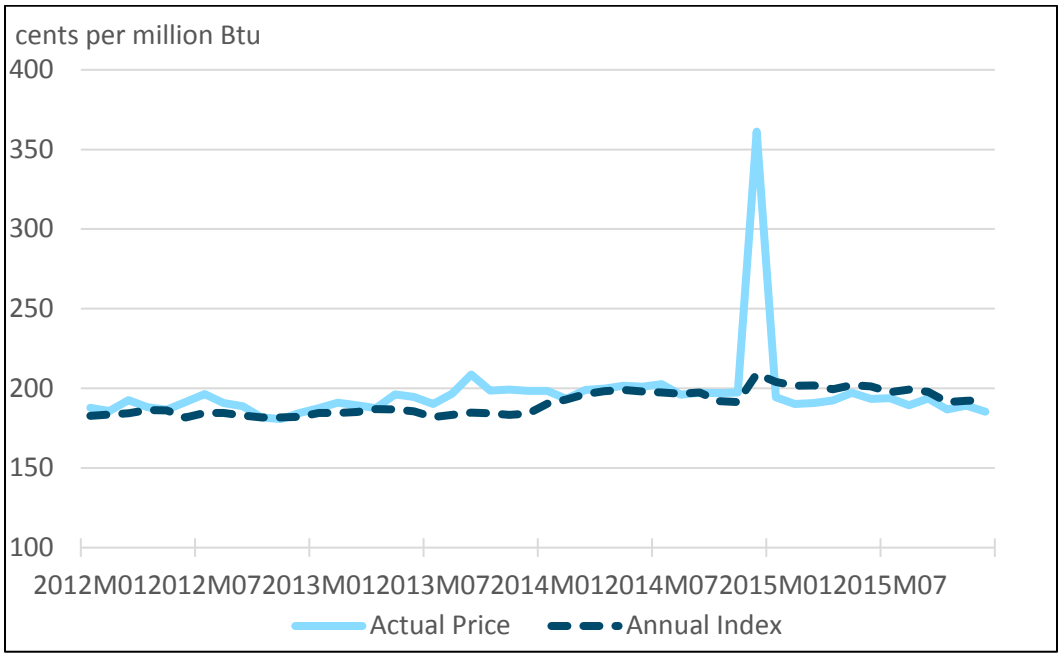
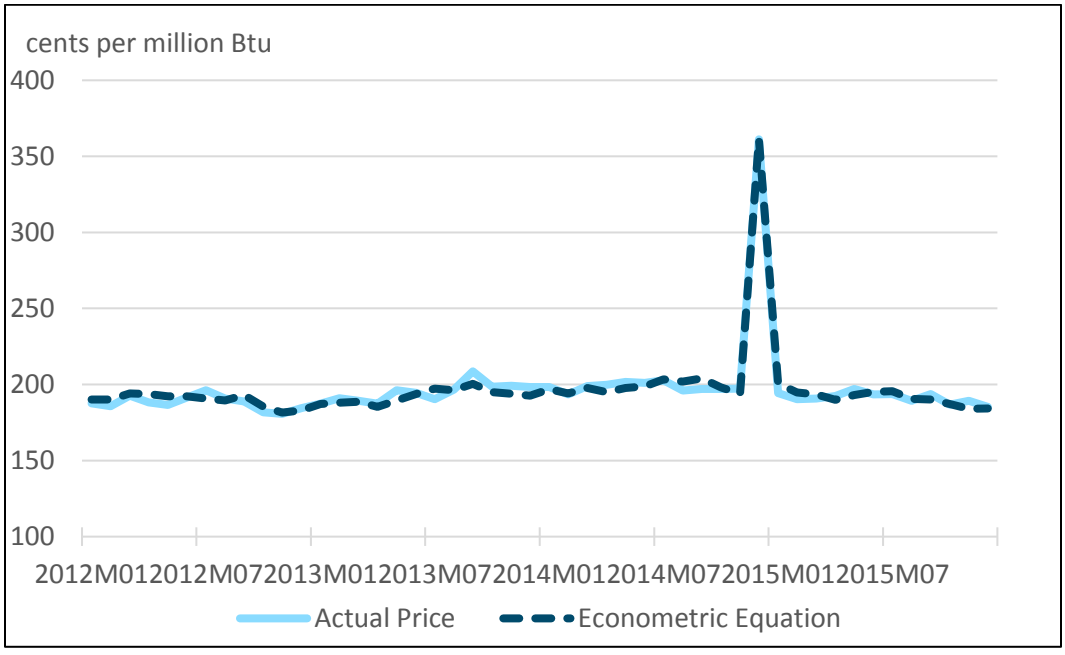


Figure 23. West region coal price forecast versus actual, January 2012 – December 2015



E. U.S. Coal Prices

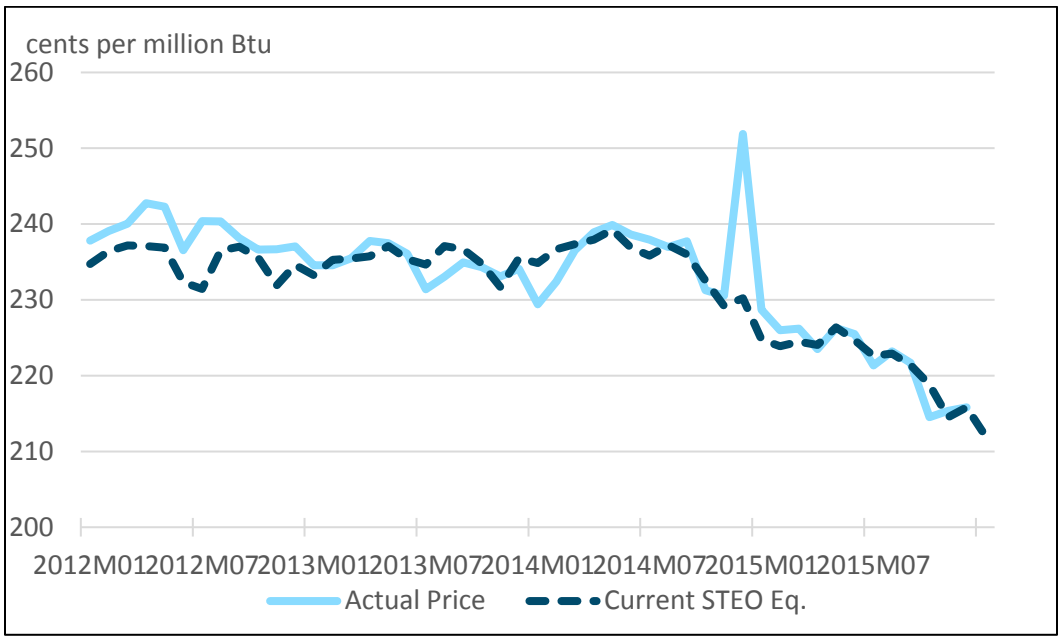
Table 7 provides a comparison of the forecasts and actual United States coal price for 2012 through 2015. The forecasts for 2014 had the largest difference from actual with the current STEO equation being 2% (4 cents) higher and the weighted price forecast 1% (2 cents) higher. On average, the weighted price forecast differences were about one half of the current STEO forecast differences.

Table 7. Actual and out-of-sample coal price forecasts, annual totals (cents per million Btu)

	Year			
	2012	2013	2014	2015
Actual Price (FCCOAL_US)	238.97	234.73	236.84	222.34
Current STEO Equation (CLEUDUS)	235.14	235.21	235.33	222.02
Weighted Price (CLEUDUS_R)	237.13	235.00	237.26	221.78

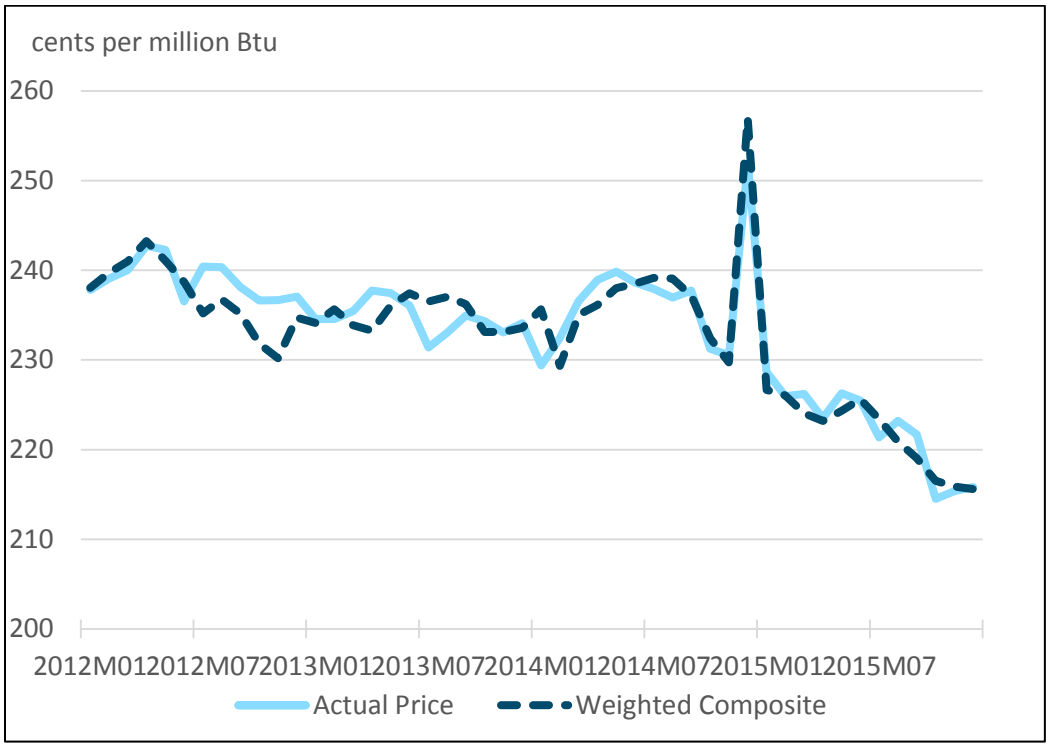
Figures 24 and Figure 25 show the monthly actual and forecasted values for the U.S. coal price.

Figure 24. U.S. coal price forecast versus actual, January 2012 – December 2015



The current STEO Equation did not have a dummy variable for the December 2014 price.

Figure 25. U.S. coal price forecast versus actual, January 2012 – December 2015



Appendix A. Variable Definitions, Units, and Sources

Table A1. Variable Definitions, Units, and Sources

Variable Name	Units	Definition	History	Forecast
APR	Integer	= 1 if April, 0 otherwise	-	-
AUG	Integer	= 1 if August, 0 otherwise	-	-
CLEP_CON_MW	MTD	Power sector coal consumption, Midwest	EPM	STEO
CLEP_CON_NE	MTD	Power sector coal consumption, Northeast	EPM	STEO
CLEP_CON_SO	MTD	Power sector coal consumption, South	EPM	STEO
CLEP_CON_WE	MTD	Power sector coal consumption, West	EPM	STEO
CLEUDUS	DMMBTU	Power sector coal price	EPM	Eq.2
CLEUDUS_R	DMMBTU	Power sector coal price	EPM	Eq.14
CLEXPUS	MMTD	Total coal exports	Census	STEO
CLPRPUS	MMTD	Total coal production	MSHA	STEO
CLPS_EP	MMST	Power sector coal stocks, United States	EPM	STEO
CLPS_EP_MW	MMST	Power sector coal stocks, Midwest	EPM	STEO
CLPS_EP_NE	MMST	Power sector coal stocks, Northeast	EPM	STEO
CLPS_EP_SO	MMST	Power sector coal stocks, South	EPM	STEO
CLPS_EP_US	MMST	Power sector coal stocks, United States	EPM	STEO
CLPS_EP_WE	MMST	Power sector coal stocks, West	EPM	STEO
CLRC_EP_MW_TON	MMST	Implied power sector coal receipts, Midwest	EPM	Eq.9
CLRC_EP_NE_TON	MMST	Implied power sector coal receipts, Northeast	EPM	Eq.8
CLRC_EP_SO_TON	MMST	Implied power sector coal receipts, South	EPM	Eq.10
CLRC_EP_US_TON	MMST	Implied power sector coal receipts, U.S.	EPM	Eq.12
CLRC_EP_WE_TON	MMST	Implied power sector coal receipts, West	EPM	Eq.11
CLSPUUS	DMMBTU	Coal spot price	CNM	Eq.1
DEC	Integer	= 1 if December, 0 otherwise	-	-
DSRTUUS	CPG	Diesel fuel retail price	PMM	STEO
FCCOAL_INDX_MW	Index	Coal price index, Midwest	EPM	Indx.1
FCCOAL_INDX_MW_2YR	Index	Coal price index, Midwest, 2-yr monthly avg.	EPM	Indx.2
FCCOAL_INDX_MW_3YR	Index	Coal price index, Midwest, 3-yr monthly avg.	EPM	Indx.3
FCCOAL_INDX_MW_ANN	Index	Coal price index, Midwest, annual average	EPM	Indx.4
FCCOAL_INDX_NE	Index	Coal price index, Northeast	EPM	Indx.1
FCCOAL_INDX_NE_2YR	Index	Coal price index, Northeast, 2-yr monthly avg.	EPM	Indx.2
FCCOAL_INDX_NE_3YR	Index	Coal price index, Northeast, 3-yr monthly avg.	EPM	Indx.3
FCCOAL_INDX_NE_ANN	Index	Coal price index, Northeast, annual average	EPM	Indx.4
FCCOAL_INDX_SO	Index	Coal price index, South	EPM	Indx.1
FCCOAL_INDX_SO_2YR	Index	Coal price index, South, 2-yr monthly avg.	EPM	Indx.2
FCCOAL_INDX_SO_3YR	Index	Coal price index, South, 3-yr monthly avg.	EPM	Indx.3
FCCOAL_INDX_SO_ANN	Index	Coal price index, South, annual average	EPM	Indx.4
FCCOAL_INDX_WE	Index	Coal price index, West	EPM	Indx.1
FCCOAL_INDX_WE_2YR	Index	Coal price index, West, 2-yr monthly avg.	EPM	Indx.2
FCCOAL_INDX_WE_3YR	Index	Coal price index, West, 3-yr monthly avg.	EPM	Indx.3
FCCOAL_INDX_WE_ANN	Index	Coal price index, West, annual average	EPM	Indx.4
FCCOAL_MW	CMMBTU	Power sector coal price, Midwest	EPM	Eq.5
FCCOAL_MW_I2YR	CMMBTU	Power sector coal price, Midwest	EPM	Eq.3
FCCOAL_MW_I3YR	CMMBTU	Power sector coal price, Midwest	EPM	Eq.3
FCCOAL_MW_IANN	CMMBTU	Power sector coal price, Midwest	EPM	Eq.3
FCCOAL_NE	CMMBTU	Power sector coal price, Northeast	EPM	Eq.4

Variable Name	Units	Definition	History	Forecast
FCCOAL_NE_I2YR	CMMBTU	Power sector coal price, Northeast	EPM	Eq.3
FCCOAL_NE_I3YR	CMMBTU	Power sector coal price, Northeast	EPM	Eq.3
FCCOAL_NE_IANN	CMMBTU	Power sector coal price, Northeast	EPM	Eq.3
FCCOAL_SO	CMMBTU	Power sector coal price, South	EPM	Eq.6
FCCOAL_SO_I2YR	CMMBTU	Power sector coal price, South	EPM	Eq.3
FCCOAL_SO_I3YR	CMMBTU	Power sector coal price, South	EPM	Eq.3
FCCOAL_SO_IANN	CMMBTU	Power sector coal price, South	EPM	Eq.3
FCCOAL_US	CMMBTU	Power sector coal price	EPM	Eq.13
FCCOAL_WE	CMMBTU	Power sector coal price, West	EPM	Eq.7
FCCOAL_WE_I2YR	CMMBTU	Power sector coal price, West	EPM	Eq.3
FCCOAL_WE_I3YR	CMMBTU	Power sector coal price, West	EPM	Eq.3
FCCOAL_WE_IANN	CMMBTU	Power sector coal price, West	EPM	Eq.3
FEB	Integer	= 1 if February, 0 otherwise	-	-
JAN	Integer	= 1 if January, 0 otherwise	-	-
JUL	Integer	= 1 if July, 0 otherwise	-	-
JUN	Integer	= 1 if June, 0 otherwise	-	-
MAR	Integer	= 1 if March, 0 otherwise	-	-
MAY	Integer	= 1 if May, 0 otherwise	-	-
NGHHUUS	DMMBTU	Henry Hub natural gas spot price	NGM	STEO
NOV	Integer	= 1 if November, 0 otherwise	-	-
OCT	Integer	= 1 if October, 0 otherwise	-	-
SEP	Integer	= 1 if September, 0 otherwise	-	-
ZSAJQUS	Integer	Number of days in a month	-	-

Table A2. Units key

CPG	Cents per gallon
CMMBTU	Cents per million BTU
DMMBTU	Dollars per million BTU
Index	Index value
MMTD	Million short tons per day
MTD	Thousand short tons per day

Table A3. Sources key

Census	U.S. Bureau of the Census
CNM	EIA Coal News and Markets
EPM	EIA Electric Power Monthly
MSHA	U.S. Mine Safety and Health Administration
NGM	EIA Natural Gas Monthly
PMM	EIA Petroleum Marketing Monthly

Appendix B. EViews Code and Model Program File

Index-Based Forecasts

```
'-------------------------------------------------------------------------------------------------------
'Calculate fuel cost index for each region
'-------------------------------------------------------------------------------------------------------
FOR %reg mw ne so we us
        smpl @all
            genr fccoal_indx_{%reg} = fccoal_{%reg}/fccoal_us
NEXT

'-------------------------------------------------------------------------------------------------------
'Calculate monthly 2-year moving averages for each region
'-------------------------------------------------------------------------------------------------------
FOR %reg mw ne so we us
    FOR !m = 1 TO 12
        smpl @all
            genr tempindx=NA

        smpl @all if @month = !m
            genr tempindx = fccoal_indx_{%reg} *@SEAS(!m)

        smpl 2008:01 @last if @month = !m
            genr fccoal_indx_{%reg}_2yr = @MSUM(tempindx(-12),13)/@MOBS(tempindx(-12),13)
    NEXT
NEXT

DELETE tempindx

'-------------------------------------------------------------------------------------------------------
'Calculate monthly 3-year moving averages for each region
'-------------------------------------------------------------------------------------------------------
FOR %reg mw ne so we us
    FOR !m = 1 TO 12
        smpl @all
            genr tempindx=NA

        smpl @all if @month = !m
            genr tempindx = fccoal_indx_{%reg} *@SEAS(!m)

        smpl 2008:01 @last if @month = !m
            genr fccoal_indx_{%reg}_3yr = @MSUM(tempindx(-12),26)/@MOBS(tempindx(-12),26)
    NEXT
NEXT

DELETE tempindx

'-------------------------------------------------------------------------------------------------------
'Calculate annual average for each region
'-------------------------------------------------------------------------------------------------------
FOR %reg mw ne so we us
    FOR !y = 2008 TO 2017
        smpl @all
            genr tempindx=NA
```

```
        smpl !Y !Y
            genr tempindx = @mean(fccoal_indx_{%reg})

        smpl 2008:01 @last if @year = !y
            genr fccoal_indx_{%reg}_ann = tempindx
    NEXT
NEXT

DELETE tempindx
FOR %reg mw ne so we us
    FOR !y = 2016 TO 2017
        smpl @all
            genr tempindx=NA

        smpl !Y !Y
            genr tempindx = (fccoal_indx_{%reg}_ann(-12))

        smpl 2008:01 @last if @year = !y
            genr fccoal_indx_{%reg}_ann = tempindx
    NEXT
NEXT

DELETE tempindx


smpl @all
'-------------------------------------------------------------------------------------------------
'Create monthly fuel cost forecasts for each region based on indexes
'-------------------------------------------------------------------------------------------------
FOR %reg mw ne so we us

    smpl 2008:01 @last
        genr fccoal_{%reg}_i2yr = (fccoal_indx_{%reg}_2yr * cleudus) * 100
        genr fccoal_{%reg}_i3yr = (fccoal_indx_{%reg}_3yr * cleudus) * 100
        genr fccoal_{%reg}_iann = (fccoal_indx_{%reg}_ann * cleudus) * 100
NEXT
```

Econometric Equation-Based Forecasts

```
:EQ_FCCOAL_NE

:EQ_FCCOAL_SO

:EQ_FCCOAL_MW

:EQ_FCCOAL_WE

'********** Create U.S. & Regional Coal Receipts Proxy ************************************

@IDENTITY CLRC_EP_NE_TON = ((CLEPCON_NE / 1000) * ZSAJQUS) - (CLPS_EP_NE(-1) - CLPS_EP_NE)

@IDENTITY CLRC_EP_MW_TON = ((CLEPCON_MW / 1000) * ZSAJQUS) - (CLPS_EP_MW(-1) - CLPS_EP_MW)
```

```
@IDENTITY CLRC_EP_SO_TON = ((CLEPCON_SO / 1000) * ZSAJQUS) - (CLPS_EP_SO(-1) - CLPS_EP_SO)

@IDENTITY CLRC_EP_WE_TON = ((CLEPCON_WE / 1000) * ZSAJQUS) - (CLPS_EP_WE(-1) - CLPS_EP_WE)

@IDENTITY CLRC_EP_US_TON = CLRC_EP_NE_TON + CLRC_EP_MW_TON + CLRC_EP_SO_TON + CLRC_EP_WE_TON

'********** U.S. Coal Price Equations **********

@IDENTITY FCCOAL_US = ((FCCOAL_NE * CLRC_EP_NE_TON) + (FCCOAL_MW * CLRC_EP_MW_TON) + (FCCOAL_SO
* CLRC_EP_SO_TON) + (FCCOAL_WE * CLRC_EP_WE_TON)) / CLRC_EP_US_TON

@IDENTITY CLEUDUS_R = FCCOAL_US / 100
```

Appendix C. Regression Results

Table C1. CLSPUUS, Coal spot price, regression results

Dependent Variable: CLSPUUS
Method: Least Squares
Date: 11/18/14 Time: 11:04
Sample: 2004M01 2014M06
Included observations: 126

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.394009	0.300604	-1.310721	0.1928
CLPRPUS	0.681990	0.093387	7.302819	0.0000
CLPS_EP	-0.004582	0.000716	-6.403328	0.0000
CLEXPUS	0.970175	0.220527	4.399349	0.0000
D07	-0.092807	0.046903	-1.978678	0.0505
D0801+D0802+D0803	0.432199	0.081231	5.320626	0.0000
D0804+D0805+D0806	0.986894	0.083729	11.78678	0.0000
D0807+D0808+D0809	1.420654	0.082681	17.18228	0.0000
D0810+D0811+D0812	1.065134	0.087465	12.17784	0.0000
D09ON	0.489861	0.059670	8.209471	0.0000
JAN	-0.062846	0.055272	-1.137037	0.2581
FEB	-0.059518	0.056275	-1.057631	0.2927
MAR	-0.041654	0.055760	-0.747033	0.4567
APR	-0.006501	0.054303	-0.119722	0.9049
MAY	0.076177	0.054399	1.400346	0.1644
JUN	-0.019630	0.054603	-0.359500	0.7199
JUL	-0.035344	0.055423	-0.637715	0.5250
AUG	-0.137050	0.057423	-2.386680	0.0188
SEP	-0.113346	0.056812	-1.995085	0.0486
OCT	0.027862	0.054599	0.510301	0.6109
NOV	-0.013449	0.055044	-0.244332	0.8075

R-squared	0.895742	Mean dependent var	1.475455
Adjusted R-squared	0.875883	S.D. dependent var	0.344700
S.E. of regression	0.121439	Akaike info criterion	-1.227805
Sum squared resid	1.548469	Schwarz criterion	-0.755091
Log likelihood	98.35171	Hannan-Quinn criter.	-1.035756
F-statistic	45.10589	Durbin-Watson stat	1.335732
Prob(F-statistic)	0.000000		

Table C2. CLEUDUS, Electric power sector coal price, regression results

Dependent Variable: CLEUDUS
Method: Least Squares
Date: 03/14/16 Time: 15:52
Sample: 2004M01 2014M06
Included observations: 126

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.230292	0.090535	-2.543681	0.0124
DSRTUUS	0.002165	0.000195	11.11661	0.0000
CLSPUUS	0.393036	0.054468	7.215918	0.0000
CLPS_EP	0.006558	0.000443	14.80736	0.0000
D08	-0.519453	0.058128	-8.936429	0.0000
D0811	0.321703	0.137340	2.342387	0.0210
D0812	0.505169	0.137526	3.673270	0.0004
D1001+D1002+D1003	0.075378	0.075095	1.003763	0.3178
JAN	0.124043	0.055210	2.246759	0.0267
FEB	0.136144	0.055226	2.465209	0.0153
MAR	0.081240	0.055065	1.475351	0.1431
APR	0.021719	0.054593	0.397841	0.6915
MAY	-0.001211	0.054688	-0.022150	0.9824
JUN	0.010215	0.054586	0.187139	0.8519
JUL	0.050391	0.055796	0.903131	0.3685
AUG	0.096429	0.055903	1.724947	0.0874
SEP	0.072355	0.055853	1.295468	0.1979
OCT	0.012128	0.055862	0.217111	0.8285
NOV	-0.038612	0.057113	-0.676060	0.5005

R-squared	0.905674	Mean dependent var	2.020159
Adjusted R-squared	0.889806	S.D. dependent var	0.364757
S.E. of regression	0.121083	Akaike info criterion	-1.246549
Sum squared resid	1.568734	Schwarz criterion	-0.818855
Log likelihood	97.53257	Hannan-Quinn criter.	-1.072790
F-statistic	57.07583	Durbin-Watson stat	0.364402
Prob(F-statistic)	0.000000		

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Table C3. FCCOAL_NE, Electric power sector coal price, Northeast Region, regression results

Dependent Variable: FCCOAL_NE
Method: Least Squares
Date: 08/10/16 Time: 12:35
Sample (adjusted): 2008M01 2016M02
Included observations: 98 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	283.4219	11.15901	25.39850	0.0000
(CLSPUUS*100)	0.100774	0.037852	2.662314	0.0095
(NGHHUUS*100)	-0.056652	0.007328	-7.730311	0.0000
DSRTUUS	-0.003868	0.014384	-0.268893	0.7888
CLPS_EP_NE	-0.829990	0.871351	-0.952532	0.3440
D0801+D0802	-22.43950	6.364308	-3.525835	0.0007
D1001+D1002	12.61763	5.687352	2.218543	0.0296
D11	17.28944	2.381289	7.260535	0.0000
D1204+D1205+D1206	-22.29267	4.816845	-4.628064	0.0000
D1401+D1402+D1403	28.28972	4.758619	5.944943	0.0000
D1501+D1502+D1503	31.67764	5.017913	6.312911	0.0000
D1512	-16.00367	7.625912	-2.098591	0.0393
D15ON	-30.64246	2.867634	-10.68563	0.0000
D16ON	-16.08241	5.895375	-2.727970	0.0080
JAN	1.540467	3.748684	0.410935	0.6823
FEB	2.198404	3.783920	0.580986	0.5630
MAR	-0.999937	3.576685	-0.279571	0.7806
APR	3.214956	3.550674	0.905450	0.3682
MAY	2.647055	3.622285	0.730769	0.4673
JUN	3.329410	3.634874	0.915963	0.3627
JUL	3.082190	3.530392	0.873045	0.3855
AUG	-3.574735	3.562416	-1.003458	0.3190
SEP	-4.172274	3.530118	-1.181908	0.2411
OCT	-6.679193	3.511647	-1.902011	0.0611
NOV	-6.207064	3.511372	-1.767703	0.0813

R-squared	0.886984	Mean dependent var	264.2992
Adjusted R-squared	0.849828	S.D. dependent var	17.29258
S.E. of regression	6.701233	Akaike info criterion	6.858156
Sum squared resid	3278.177	Schwarz criterion	7.517587
Log likelihood	-311.0497	Hannan-Quinn criter.	7.124882
F-statistic	23.87184	Durbin-Watson stat	1.840297
Prob(F-statistic)	0.000000		

Table C4. FCCOAL_MW, Electric power sector coal price, Midwest Region, regression results

Dependent Variable: FCCOAL_MW
Method: Least Squares
Date: 08/10/16 Time: 15:57
Sample (adjusted): 2008M01 2016M02
Included observations: 98 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	217.4888	5.990697	36.30442	0.0000
(CLSPUUS*100)	0.003448	0.021756	0.158503	0.8745
(NGHHUUS*100)	-0.061787	0.003693	-16.73008	0.0000
DSRTUUS	0.129124	0.008783	14.70193	0.0000
CLPS_EP_MW	-0.593593	0.060909	-9.745606	0.0000
D0801+D0802	-13.54731	3.470076	-3.904037	0.0002
D0808	-12.12977	4.816094	-2.518591	0.0138
D15ON	1.925577	1.457018	1.321588	0.1901
JAN	0.492223	2.063157	0.238578	0.8121
FEB	0.527746	2.075871	0.254229	0.8000
MAR	-2.589581	2.099452	-1.233455	0.2211
APR	-0.588144	2.093465	-0.280943	0.7795
MAY	3.906242	2.106073	1.854751	0.0674
JUN	3.744765	2.109913	1.774843	0.0798
JUL	-1.552918	2.104047	-0.738062	0.4627
AUG	-3.660051	2.188296	-1.672558	0.0984
SEP	-3.720879	2.103724	-1.768711	0.0808
OCT	-2.813260	2.095746	-1.342366	0.1833
NOV	-1.455503	2.085009	-0.698080	0.4872

R-squared	0.937252	Mean dependent var	197.9120
Adjusted R-squared	0.922955	S.D. dependent var	14.98941
S.E. of regression	4.160598	Akaike info criterion	5.861430
Sum squared resid	1367.535	Schwarz criterion	6.362597
Log likelihood	-268.2101	Hannan-Quinn criter.	6.064142
F-statistic	65.55611	Durbin-Watson stat	0.969978
Prob(F-statistic)	0.000000		

Table C5. FCCOAL_SO, Electric power sector coal price, South Region, regression results

Dependent Variable: FCCOAL_SO
Method: Least Squares
Date: 08/10/16 Time: 16:00
Sample (adjusted): 2008M01 2016M02
Included observations: 98 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	256.3664	7.825193	32.76167	0.0000
(CLSPUUS*100)	0.190490	0.025433	7.489720	0.0000
(NGHHUUS*100)	-0.056584	0.005170	-10.94419	0.0000
DSRTUUS	0.006959	0.009580	0.726422	0.4698
CLPS_EP_SO	-0.013593	0.062878	-0.216172	0.8294
D0801+D0802+D0803+D0804	-24.61036	3.402369	-7.233301	0.0000
D1001+D1002+D1003	15.36970	3.257135	4.718780	0.0000
D15ON	-19.41569	1.831959	-10.59832	0.0000
D16ON	-10.82944	3.957260	-2.736601	0.0077
JAN	0.911225	2.462348	0.370063	0.7123
FEB	1.843304	2.472349	0.745568	0.4582
MAR	3.485187	2.516913	1.384707	0.1701
APR	4.558920	2.476343	1.840989	0.0694
MAY	3.607940	2.480508	1.454516	0.1498
JUN	4.870245	2.468031	1.973332	0.0520
JUL	5.867953	2.459818	2.385523	0.0195
AUG	6.356804	2.491193	2.551711	0.0127
SEP	2.161688	2.480456	0.871488	0.3862
OCT	-1.205761	2.445944	-0.492963	0.6234
NOV	-1.172447	2.427301	-0.483025	0.6304

R-squared	0.899684	Mean dependent var	261.8322
Adjusted R-squared	0.875248	S.D. dependent var	13.71468
S.E. of regression	4.844065	Akaike info criterion	6.173290
Sum squared resid	1830.267	Schwarz criterion	6.700834
Log likelihood	-282.4912	Hannan-Quinn criter.	6.386671
F-statistic	36.81797	Durbin-Watson stat	1.184986
Prob(F-statistic)	0.000000		

Table C6. FCCOAL_WE, Electric power sector coal price, West Region, regression results

Dependent Variable: FCCOAL_WE
Method: Least Squares
Date: 08/10/16 Time: 11:57
Sample (adjusted): 2008M01 2016M02
Included observations: 98 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	228.7986	7.283656	31.41261	0.0000
(CLSPUUS*100)	-0.179753	0.023819	-7.546748	0.0000
(NGHHUUS*100)	-0.039127	0.004510	-8.676196	0.0000
DSRTUUS	0.135686	0.010313	13.15712	0.0000
CLPS_EP_WE	-2.708311	0.256258	-10.56868	0.0000
D0801+D0802+D0803	-26.78031	3.430663	-7.806161	0.0000
D0906+D0907+D0908+D0909	-11.81356	2.968738	-3.979319	0.0002
D10	-6.107433	1.666392	-3.665064	0.0005
D1412	172.5765	5.062156	34.09150	0.0000
D15ON	11.98188	1.834004	6.533180	0.0000
JAN	4.242636	2.393109	1.772855	0.0802
FEB	2.583631	2.388382	1.081749	0.2827
MAR	3.592422	2.466252	1.456632	0.1493
APR	4.654295	2.442577	1.905486	0.0605
MAY	8.285139	2.462555	3.364448	0.0012
JUN	9.746450	2.519859	3.867855	0.0002
JUL	9.176839	2.493220	3.680718	0.0004
AUG	4.780748	2.485824	1.923204	0.0582
SEP	6.656777	2.485049	2.678731	0.0090
OCT	3.441757	2.436914	1.412342	0.1619
NOV	1.748247	2.425941	0.720647	0.4733

R-squared	0.969274	Mean dependent var	182.3725
Adjusted R-squared	0.961293	S.D. dependent var	23.76750
S.E. of regression	4.676013	Akaike info criterion	6.110178
Sum squared resid	1683.613	Schwarz criterion	6.664100
Log likelihood	-278.3987	Hannan-Quinn criter.	6.334228
F-statistic	121.4518	Durbin-Watson stat	1.293801
Prob(F-statistic)	0.000000		