* Approach
  + Applied microeconomics (in the context of macroeconomic conditions
    - What decision should an individual firm take to maximize profits?
  + Demand side of market
    - Elasticities – “single most important concept in life”
      * How quickly does something snap back? E.g., homes are relatively inelastic
  + Supply side of market
    - Production
    - Cost minimization
    - Optimal output

Class 1

* Rules of Differentiation
  + Constant function rule
    - Y = f(x) = k
    - Derivative (dy/dx) = 0
  + Power function rule
    - Y = f(x) = cxn
    - Dy/dx = ncxn-1
    - Ex: 3x16; dy/dx = 48x15
  + Sum (difference) rule
    - Y = f(x) +- g(x)
    - Dy/dx = f’(x) +- g’(x)
    - Ex: y = 3x^16 – 2x^10
    - Dy/dx = 48x^15 – 20x^9
  + Product rule
    - Y = f(x) \* g(x)
    - Dy/dx = f’(x) \*g(x) + g’(x) \* f(x)
    - Ex: y = 3x^6 \* 3x^4
    - Dy/dx = 18x^5 \* 3x^4 + 8x^3 \* 3x^6
  + Composite function (function of a function) or chain rule
    - Y = f(x) where x = g(z)
    - Y = f(g(z))
    - Dy/dz = dy/dx \* dx/dz
    - Ex:
      * y = 3x^4
      * x = 2z^2
      * dy/dz = 12x^3 \* 4z
        + Solve for z (or x)
        + 12(2z^2)^3 \* 4z
  + Quotient rule
    - Y = f(x) / g(x)
    - Dy/dx =

Class 2

* Demand Theory
  + Quantity of goods and services that consumers are willing to pay for (particular amount and time)
    - Willingness to pay
      * Price – y-axis
      * Quantity – x-axis
      * Qd = f(P, …)
        + Quantity demanded is a function of price
      * Negative slope (dQd / dp < 0)
    - Ability to pay
  + Movement vs. shift
    - Movement – shift in price alone
    - Shift – other factors (e.g., taxes, more disposable income, etc.)
      * Income
      * Related products
        + Substitutes

% overlap – only true of good substitutes

Partial derivatives are positive

* + - * + Complements

Goods that get used together

Partial derivatives are negative (because as demand for one good increases, so does the other, and therefore price goes down)

* + - * Advertising
        + Positive partial derivative
      * Expectations
        + Potential future price
        + Futures market
        + Options

Put

If you think it’s going down

Call

If you think it will rise

* + Types of goods
    - Normal vs. inferior goods (superior goods)
      * E.g., people buy more of an inferior good when income decreases
  + Elasticity of demand
    - Measure of response
    - How does demand change in response to change in price (% change in quantity demanded divided by % change in price) **at a given point**
      * Slope and direction
        + Negative

Price goes up, quantity demanded goes down

* + - * + Positive

Price goes up, quantity demanded goes up

* + - * + Neutral

Price goes up, no change in quantity demand

* + - Cross-price elasticity
  + Estimating demand
    - Multiple linear regression
      * Qd = f(P, In, A)
      * Estimating unknown parameters (coefficients, relationships, etc.)
      * Good parameters for explaining the power of the model
      * H0: B2 = dQd/dIn = 0
      * Ha:
      * Df: number of observations minus (the number of variables + constants), n – k – 1
      * Alpha: 1 – 0.95 (t-statistic for normal distribution)
      * T-statistic = B2hat / SEB2
* Some Applications
  + Double-log model (coefficients are elasticities because the log-log model represents the model in terms of percentage changes
    - lnQd = A0 + B1ln(fish\_price) + B2ln(chicken\_price) + B3ln(income)
    - Qd = f(fish\_price, chicken\_price, income)

Class 3

* Dummy Variables
  + Don’t run a t-test and split the data into two groups
  + Multiply by 0 (when dummy variable is set to 0 vs. 1) , effect of that coefficient goes away,
    - So you could have different intercepts even if the same slope
  + Different intercepts and different slopes with dummy variables
    - Slopes – interactions between coefficients
* Problems in Multiple Linear Regression
  + Multicollinearity
    - Features
      * Orthogonal – direction of all the vectors (IVs) is unique; i.e., their impact on y is unique
      * What if your IVs influence one another?
      * When your IVs are not correlated with one another
        + Lose the directionality of y
        + More than one IV is influencing y at a time
    - Diagnostics
      * Wrong sign of the variable
        + Positive vs. negative
        + Low t-statistics (for that variable or others)
        + Variance inflation factor (VIF) > 5

Problem with multicollinearity

* + - * + Correlogram, correlation matrix
    - Corrections
      * Remove one of highly correlated variables and re-estimate
  + Autocorrelation (serial correlation)
    - Features
      * Observations are correlated with the previous observation
      * Mostly affects in time-series data
      * Iteratively minimizes the differences between et and et-1, then et-1 and et-2, and so on
      * t-statistic = coefficient of B1 / SE of B1
      * Type I error – falsely reject null hypothesis
    - Diagnostics
      * Durbin-Watson test statistic between +/- 1.75 and 2.0
    - Corrections
      * Cochrane-Orcutt procedure
  + Heteroscedasticity
    - Features
      * Cross-sectional data
      * Uneven variation (e.g., errors unevenly distributed around the mean)
      * Poor sampling
      * Non-constant variance (of the error term)
        + Standard errors are biased
        + Leads to higher standard errors
        + Type II error – falsely accept null hypothesis
    - Diagnostics
      * Plot the residuals
    - Corrections
      * Minimize the variation
      * Normalize the variables by dividing the variables by the standard error
        + Which standard error? Standard error of the model!
      * Take the log
      * Use dummy variables
  + Specification and measurement errors
    - Features
      * Omission
        + Missing an important variable in the model
      * Inclusion
        + Included a variable that has no impact (and just increases the R2)
      * R2 is artificially high, but t-statistics could be artificially low
    - Diagnostics
    - Corrections
  + Simultaneous equation bias/relationships and the identification problem
    - Features
      * Market structure
        + Price is determined by quantity, supply, and demand

All are interacting to determine price

* + - * Correlated error terms
      * Correlated independent variables
      * Must be solved simultaneously
    - Diagnostics
    - Corrections
      * Reduced form
        + Create non-simultaneous equations
        + Express y1 and y2 in terms only of x’s (independent variables)
        + Two-stage least square

Estimate y1 or y2 based on x’s

Then use fitted values of y1 to predict y2

* + Nonlinearities
    - Features
      * E.g., seasonality, geometric growth
    - Diagnostics
    - Corrections
      * Non-linear regressions
      * Maximum likelihood estimation
        + Do not assume a functional form
      * Linearize the data
        + Natural log (i.e., change of scale)
        + Square root, cube root, etc.
      * Taylor series approximation
      * GLM method – generalized linear model
      * GMM method – generalized moments model

Class 4 – Business Forecasting and Time Series Models

* Time series models
  + Is the budget deficit a problem?
    - As long as you can service the debt on time, then it’s not a problem
    - Otherwise, the interest payments accumulate and you
  + Primarily based on prior data
    - Inherently assumes the underlying causes remains the same
      * Differs from causation
      * So if future doesn’t resemble the past, it threatens predictions
  + Trend line
    - Regression?
      * Y = A + BT + Error
    - Time trend?
    - How much data do you need to get an accurate prediction?
  + Linear time trend
  + Non-linear time trend
  + Moving average model
  + GARCH model?
  + ARIMA model
    - Autoregressive (AR)
    - Integrated (I)
    - Moving average (MA)
    - Let the error structure in the data tell us how far back to go in the data
    - Stochastic model: Let the error determine the model
    - Yt = A0 + B1Yt-1 + B2Yt-2 + … + BpYt-p + Et
      * Lags
    - Three unknowns in this model
      * AR: Length of the lag (i.e., how far do we have to go back to predict?)
        + Value of ‘p’ in equation above
        + Optimal lag length

Akeike information criteria

* + - * Differencing in y
        + d
        + Differences between the time of the IVs vs. the time of the DVs
      * Moving average parameter
        + q
        + Number of periods included in calculated moving average
    - How do you know if the predictions are good?
      * Compare to actual data?
      * What about splitting into a training and test data set?
      * Box Jenkins test
    - What is the difference in calculations of autocorrelation function and partial autocorrelation function?
* Next Steps
  + Feb. 25 – Receive assignment
  + Mar. 4 – Spring break (sample test posted)
  + March 11 – Test

Class 5 – Production and Cost (Supply Side, Chapters 7-9)

* Comments on Test
  + The amount of pollution
  + Should have mentioned t-test and F-test in the hypothesis testing
    - I thought it was self-evident
  + Write out models and calculations
* Production function
  + Describes the functional relationships between inputs and output(s)
    - We’ll talk about only one output in our course
    - Simply an engineering concept
      * Just the combination of inputs
      * Uniquely defined, so two inputs can only equal one output
  + Q(x) = L(x) + K(x)
  + Total product curve of labor holding capital constant
    - Law of diminishing returns
      * Law of diminishing marginal productivity
  + Q = f(K, L)
    - Total production
      * Average product
        + Average productivity of capital

Q/K

* + - * + Average productivity of labor

Q/L

* + - * Marginal product
        + Marginal productivity of capital/labor

DQ/DK

DQ/DL

* Specific production functions
  + Cobb-Douglas total product function (power function)
    - Q = A \* K^a \* L^B
      * Q = output
      * K = capital
      * A = scale
      * Alpha and beta are coefficients
    - Average product function
      * APL = Q / L = A \* K^alpha & L ^(beta – 1)
      * APK =
    - So marginal product functions are multiplied by the exponents
      * So if the exponents are between 0 and positive 1, we know the marginal production function is a fraction of the average production function
    - So if I want to increase production at the margin, I should add resources to the input with the greater the coefficient
  + Elasticity of supply/production
    - Output elasticity of labor
      * DQ/DL \* L / Q
        + Marginal
      * DQ/DK & K / Q
    - Output elasticity of capital
    - Output elasticity of inputs (simply equal to the coefficients [exponents])
  + Log transformation
    - LnQ = lnA + aLnK + BlnL
  + Practically speaking
    - Take the log of all data
    - Run the regression to generate coefficients
    - The coefficients are the elasticities
* Returns to scale
  + Sum of output elasticities of inputs
    - Sum of coefficients
  + Constant returns to scale
    - Sum of output elasticities of inputs is exactly 1
  + Increasing returns to scale
    - Sum of output elasticities of inputs is greater than 1
  + Decreasing returns to scale
    - Sum of output elasticities of inputs is less than 1
* Cost function
  + Cost is the mirror image of production
  + Example: concrete production
    - Costs
      * Raw materials
      * Labor
      * Truck/mixer
  + Total cost function
    - TC = f(Q)
      * Where Q = output
    - C’(Q) > 0
      * Marginal change in cost should be positive
    - Total costs = fixed costs + variable costs
      * Fixed costs are only fixed as long as the underlying conditions remain the same
        + E.g., lawnmower
        + What about the shifts between different fixed costs?
        + How long are the costs fixed?
        + Doesn’t depend on levels of output

What about wear and tear?

* + Average cost function
    - Total divided by quantity
    - Costs divided by output quantity
      * AC = AFC + AVC = FC/Q + VC/Q
  + Marginal cost function
    - MC = MVC = DVC/DQ
      * No such thing as marginal fixed costs
        + Derivative of constant (which fixed costs are) is 0
  + Short-run vs. long-run
    - Long-run is a series (summation) of short-run cost curves
    - Comes from the returns to scale
      * Start with increasing returns to scale, then flattens out, then decreasing returns to scale
      * Insurance and union costs are decreasing returns to scale