The Nature of Econometrics and Economic Data

Chapter 1

Wooldridge: Introductory Econometrics:
A Modern Approach, 5e

The Nature of Econometrics and Economic Data

- **What is econometrics?**
  - Econometrics = use of statistical methods to analyze economic data
  - Econometricians typically analyze *nonexperimental* data
- **Typical goals of econometric analysis**
  - Estimating relationships between economic variables
  - Testing economic theories and hypotheses
  - Forecasting economic variables
  - Evaluating and implementing government and business policy

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- **Steps in econometric analysis**
  - 1) Economic model (this step is often skipped)
  - 2) Econometric model
- **Economic models**
  - Maybe micro- or macromodels
  - Often use optimizing behaviour, equilibrium modeling, …
  - Establish relationships between economic variables
  - Examples: demand equations, pricing equations, …

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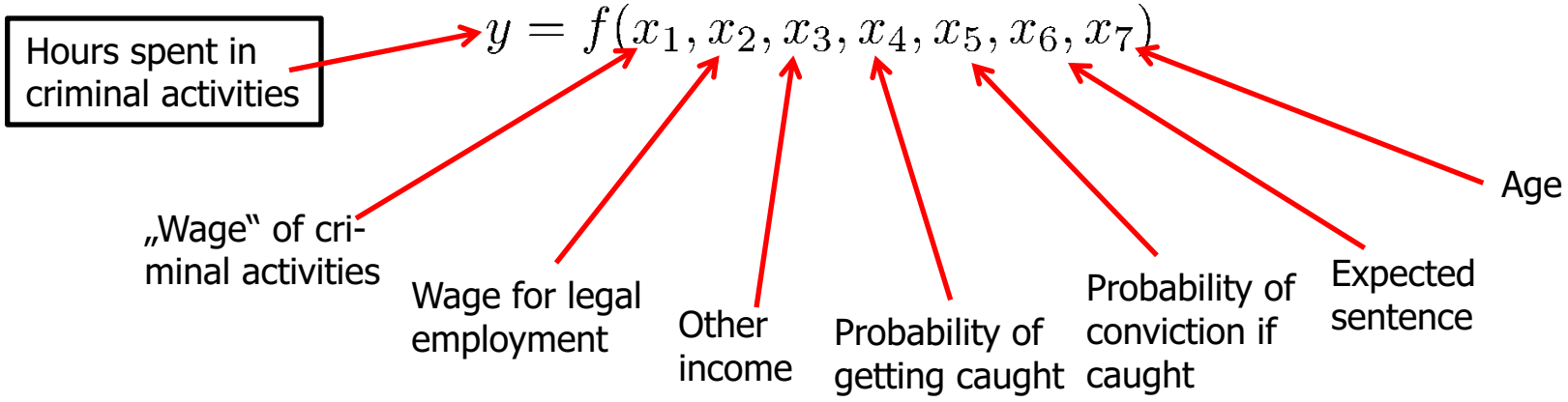
- **Economic model of crime (Becker (1968))**
  - Derives equation for criminal activity based on utility maximization



  - Functional form of relationship not specified
  - Equation could have been postulated without economic modeling

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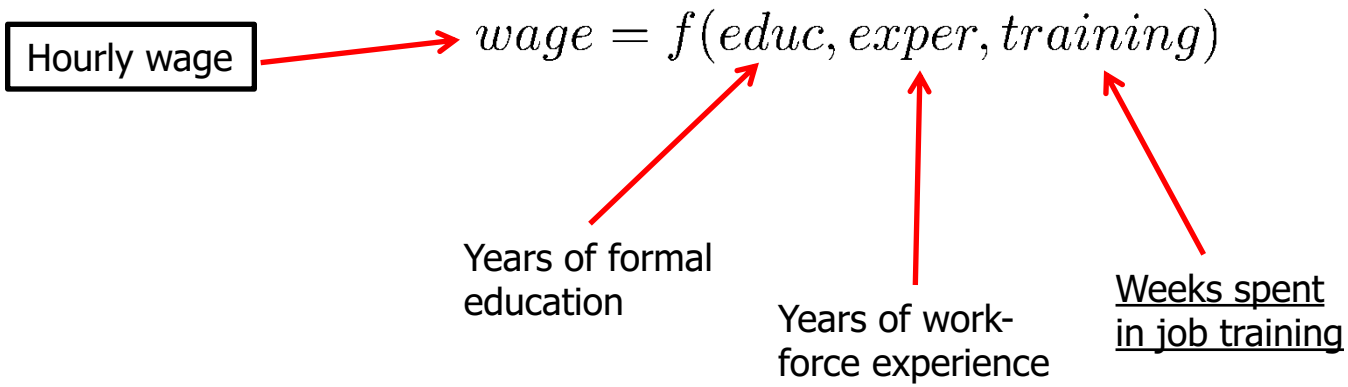
- **Model of job training and worker productivity**
  - What is effect of additional training on worker productivity?
  - Formal economic theory not really needed to derive equation:



  - Other factors may be relevant, but these are the most important (?)

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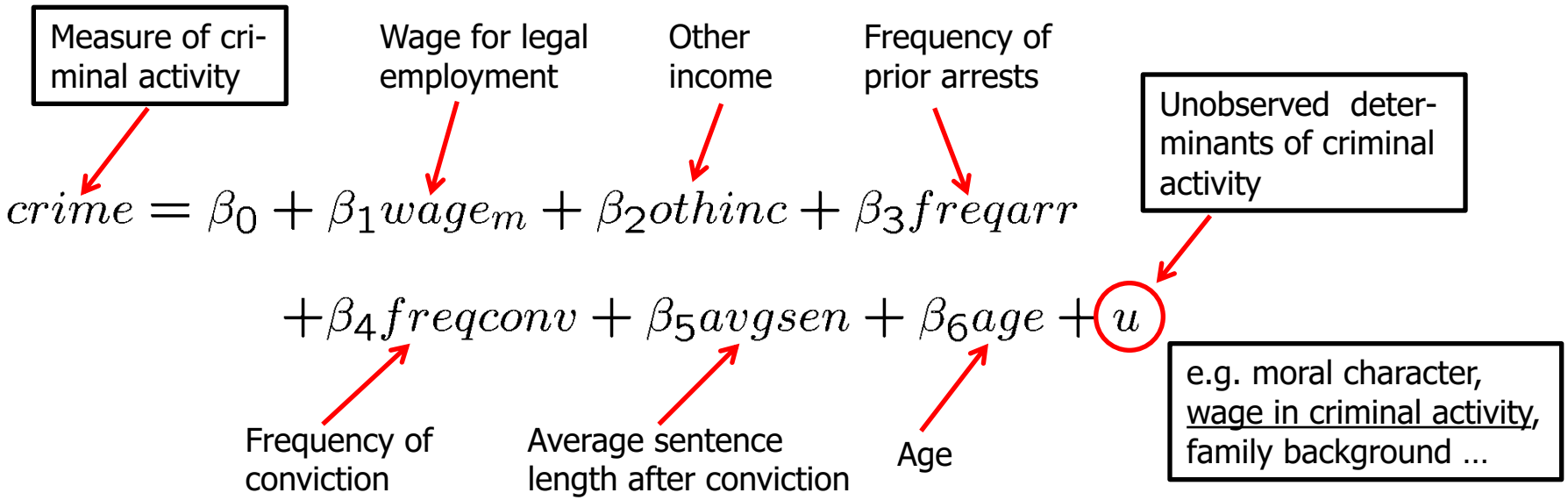
- **Econometric model of criminal activity**
  - The functional form has to be specified
  - Variables may have to be approximated by other quantities



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- **Econometric model of job training and worker productivity**

$$wage = \beta_0 + \beta_1 educ + \beta_2 exper + \beta_3 training + u$$

Unobserved determinants of the wage

Hourly wage

Years of formal education

Years of work-force experience

Weeks spent in job training

e.g. innate ability, quality of education, family background …

- **Most of econometrics deals with the specification of the error u**
- **Econometric models may be used for hypothesis testing**
  - For example, the parameter β_3 represents effect of training on wage
  - How large is this effect? Is it different from zero?

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- **Econometric analysis requires data**
- **Different kinds of economic data sets**
  - Cross-sectional data
  - Time series data
  - Pooled cross sections
  - Panel/Longitudinal data
- **Econometric methods depend on the nature of the data used**
  - Use of inappropriate methods may lead to misleading results

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- **Cross-sectional data sets**
  - Sample of individuals, households, firms, cities, states, countries, or other units of interest at a given point of time/in a given period
  - Cross-sectional observations are more or less **independent**
  - For example, **pure random sampling** from a population
  - Sometimes pure random sampling is violated, e.g. units refuse to respond in surveys, or if sampling is characterized by clustering
  - Cross-sectional data typically encountered in applied microeconomics

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- **Cross-sectional data set on wages and other characteristics**

TABLE 1.1 A Cross-Sectional Data Set on Wages and Other Individual Characteristics

obsno	wage	educ	exper	female	married
1	3.10	11	2	1	0
2	3.24	12	22	1	1
3	3.00	11	2	0	0
4	6.00	8	44	0	1
5	5.30	12	7	0	1
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
525	11.56	16	5	0	1
526	3.50	14	5	1	0

Indicator variables (1=yes, 0=no)

Observation number

Hourly wage

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- **Cross-sectional data on growth rates and country characteristics**

TABLE 1.2 A Data Set on Economic Growth Rates and Country Characteristics

obsno	country	gpcrgdp	govcons60	second60
1	Argentina	0.89	9	32
2	Austria	3.32	16	50
3	Belgium	2.56	13	69
4	Bolivia	1.24	18	12
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
61	Zimbabwe	2.30	17	6

Growth rate of real per capita GDP

Government consumtion as percentage of GDP

Adult secondary education rates

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- **Time series data**
  - Observations of a variable or several variables over time
  - For example, stock prices, money supply, consumer price index, gross domestic product, annual homicide rates, automobile sales, …
  - Time series observations are typically **serially correlated**
  - Ordering of observations conveys important information
  - Data frequency: daily, weekly, monthly, quarterly, annually, …
  - Typical features of time series: **trends and seasonality**
  - Typical applications: applied macroeconomics and finance

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- **Time series data on minimum wages and related variables**

TABLE 1.3 Minimum Wage, Unemployment, and Related Data for Puerto Rico

obsno	year	avgmin	avgcov	prunemp	prgnp
1	1950	0.20	20.1	15.4	878.7
2	1951	0.21	20.7	16.0	925.0
3	1952	0.23	22.6	14.8	1015.9
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
37	1986	3.35	58.1	18.9	4281.6
38	1987	3.35	58.2	16.8	4496.7

Average minimum wage for given year

Average coverage rate

Unemployment rate

Gross national product

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- **Pooled cross sections**
  - Two or more cross sections are combined in one data set
  - Cross sections are drawn independently of each other
  - Pooled cross sections often used to evaluate policy changes
  - Example:
    - Evaluate effect of change in property taxes on house prices
    - Random sample of house prices for the year 1993
    - A **new** random sample of house prices for the year 1995
    - Compare before/after (1993: before reform, 1995: after reform)

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- **Pooled cross sections on housing prices**

TABLE 1.4 Pooled Cross Sections: Two Years of Housing Prices

obsno	year	hprice	proptax	sqrft	bdrms	bthrms
1	1993	85500	42	1600	3	2.0
2	1993	67300	36	1440	3	2.5
3	1993	134000	38	2000	4	2.5
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
250	1993	243600	41	2600	4	3.0
251	1995	65000	16	1250	2	1.0
252	1995	182400	20	2200	4	2.0
253	1995	97500	15	1540	3	2.0
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
520	1995	57200	16	1100	2	1.5

Property tax

Size of house in square feet

Number of bathrooms

Before reform

After reform

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- **Panel or longitudinal data**
  - The **same** cross-sectional units are followed over time
  - Panel data have a **cross-sectional and a time series dimension**
  - Panel data can be used to account for time-invariant unobservables
  - Panel data can be used to model lagged responses
  - Example:
    - City crime statistics; each city is observed in two years
    - Time-invariant unobserved city characteristics may be modeled
    - Effect of police on crime rates may exhibit time lag

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- **Two-year panel data on city crime statistics**

TABLE 1.5 A Two-Year Panel Data Set on City Crime Statistics

obsno	city	year	murders	population	unem	police
1	1	1986	5	350000	8.7	440
2	1	1990	8	359200	7.2	471
3	2	1986	2	64300	5.4	75
4	2	1990	1	65100	5.5	75
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
297	149	1986	10	260700	9.6	286
298	149	1990	6	245000	9.8	334
299	150	1986	25	543000	4.3	520
300	150	1990	32	546200	5.2	493

Each city has two time series observations

Number of police in 1986

Number of police in 1990

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- **Causality and the notion of ceteris paribus**

  Definition of causal effect of x on y:

  > "How does variable y change if variable x is changed but all other relevant factors are held constant"

- **Most economic questions are ceteris paribus questions**
- **It is important to define which causal effect one is interested in**
- **It is useful to describe how an experiment would have to be designed to infer the causal effect in question**

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- **Causal effect of fertilizer on crop yield**
  - "By how much will the production of soybeans increase if one increases the amount of fertilizer applied to the ground"
  - Implicit assumption: all other factors that influence crop yield such as quality of land, rainfall, presence of parasites etc. are held fixed
- **Experiment:**
  - Choose several one-acre plots of land; randomly assign different amounts of fertilizer to the different plots; compare yields
  - Experiment works because amount of fertilizer applied is unrelated to other factors influencing crop yields

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- **Measuring the return to education**
  - "If a person is chosen from the population and given another year of education, by how much will his or her wage increase? "
  - Implicit assumption: all other factors that influence wages such as experience, family background, intelligence etc. are held fixed
- **Experiment:**
  - Choose a group of people; randomly assign different amounts of eduction to them (infeasable!); compare wage outcomes
  - Problem without random assignment: amount of education is related to other factors that influence wages (e.g. intelligence)

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- **Effect of law enforcement on city crime level**
  - "If a city is randomly chosen and given ten additional police officers, by how much would its crime rate fall? "
  - Alternatively: "If two cities are the same in all respects, except that city A has ten more police officers, by how much would the two cities crime rates differ? "
- **Experiment:**
  - Randomly assign number of police officers to a large number of cities
  - In reality, number of police officers will be determined by crime rate (simultaneous determination of crime and number of police)

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- **Effect of the minimum wage on unemployment**
  - "By how much (if at all) will unemployment increase if the minimum wage is increased by a certain amount (holding other things fixed)? "
- **Experiment:**
  - Government randomly chooses minimum wage each year and observes unemployment outcomes
  - Experiment will work because level of minimum wage is unrelated to other factors determining unemployment
  - In reality, the level of the minimum wage will depend on political and economic factors that also influence unemployment

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- **Testing predictions of economic theories**
  - Economic theories are not always stated in terms of causal effects
  - For example, **the expectations hypothesis** states that long term interest rates equal compounded expected short term interest rates

$$(1+r_{lt})^n = (1+r^e_{year1})(1+r^e_{year2})\cdot\ldots\cdot(1+r^e_{yearn})$$

  - An implicaton is that the interest rate of a three-months T-bill should be equal to the expected interest rate for the first three months of a six-months T-bill; this can be tested using econometric methods