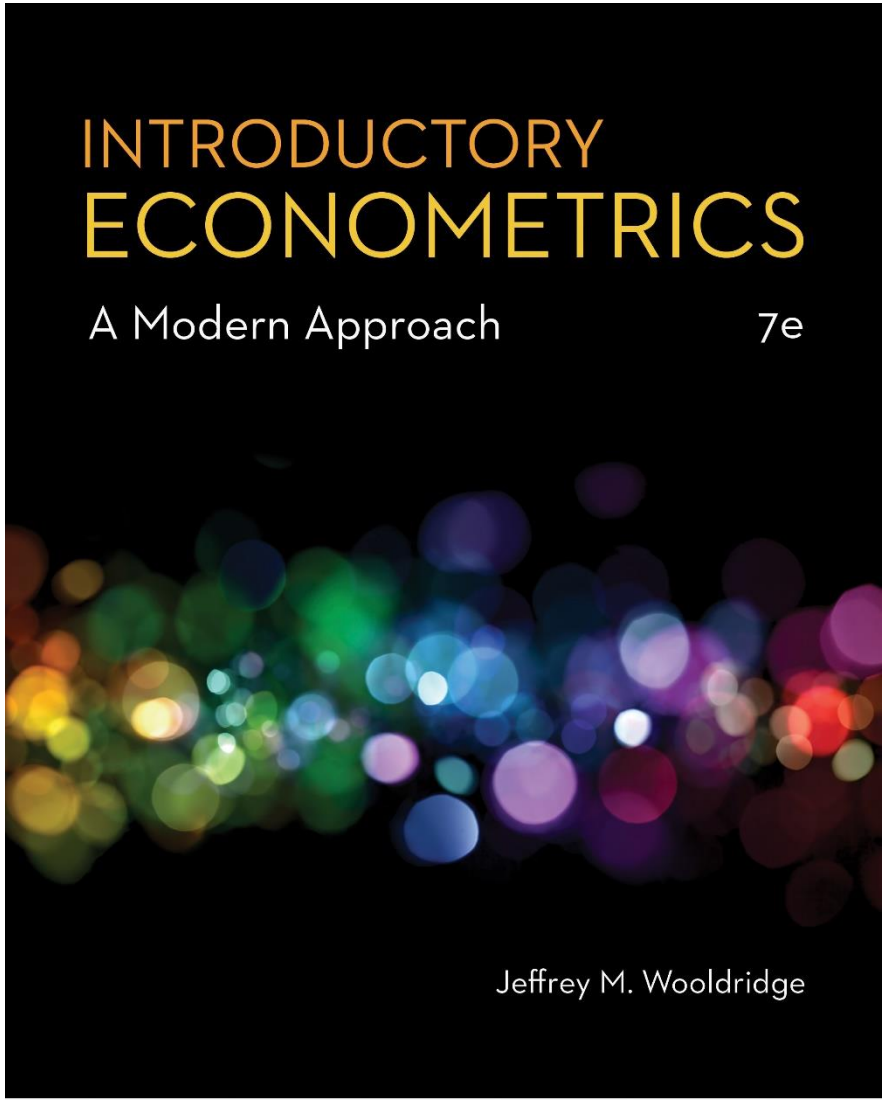
Chapter 1

The Nature of Econometrics and Economic Data



The Nature of Econometrics and Economic Data

- **What is econometrics?**
  - Econometrics is the 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.
  - Evaluating and implementing government and business policy.
- **Common applications**
  - Forecasting macroeconomic variables (interest rates, inflation rates, GDP).
  - Forecasting non-macro variables (less visible).

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- **Steps in econometric analysis**

  1) Economic model (this step is often skipped)

  2) Econometric model

- **Economic models**
  - Maybe micro- or macro models
  - Often use optimizing behaviour, equilibrium modeling, …
  - Establish relationships between economic variables
  - Examples: demand equations, pricing equations, …

Basics of Economic Models

Choice

Every individual\firm\group faces tradeoff:

- Graduate entrance exam?
- Marry or not?
- Buy or manufacture?
- ……

Equilibrium

Aggregation of individuals' behavior:

- Price and quantity: why quantity≠0?
- Impacts of economic stimulus
- Impacts of China's WTO accession
- ……

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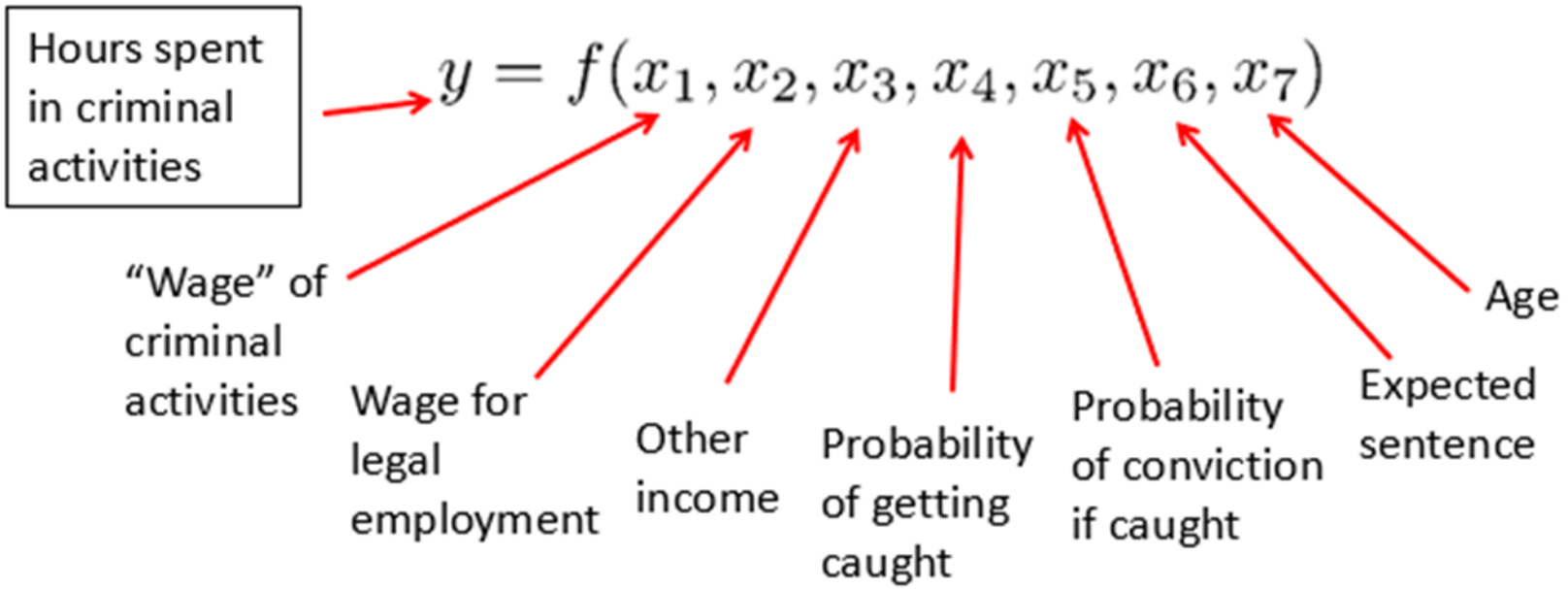
- **Economic model of crime (Becker (1968))**
  - Derives equation for criminal activity based on utility maximization.



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

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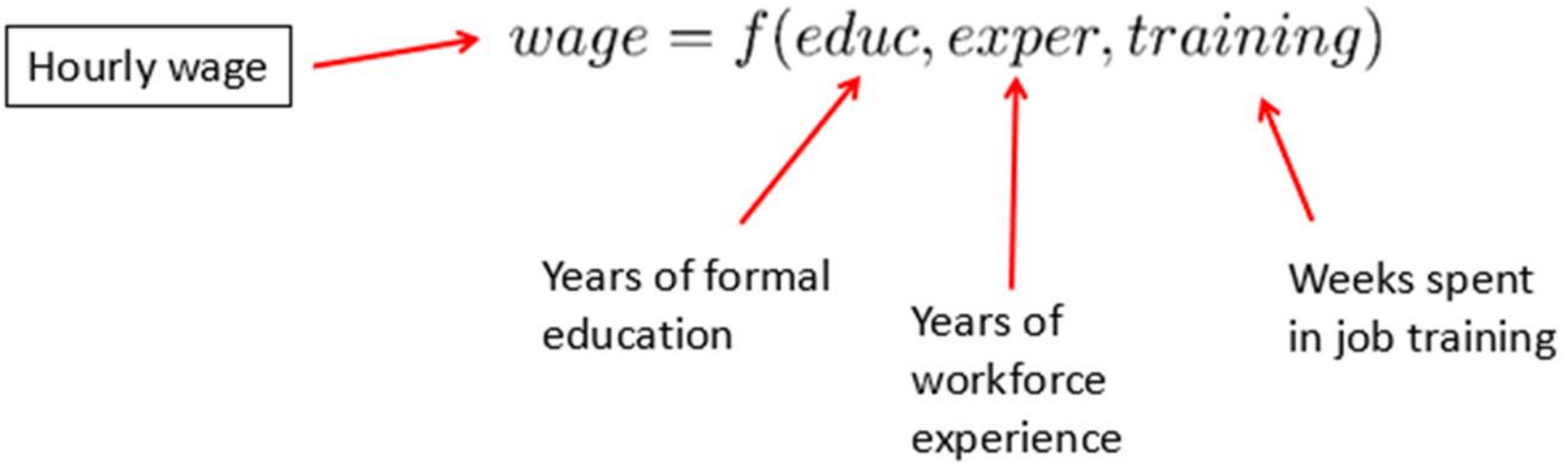
- **Model of job training and worker productivity**
  - What is the effect of additional training on worker productivity?
  - Formal economic theory not really needed to derive equation:



- Other factors may be relevant, but these are the most important.

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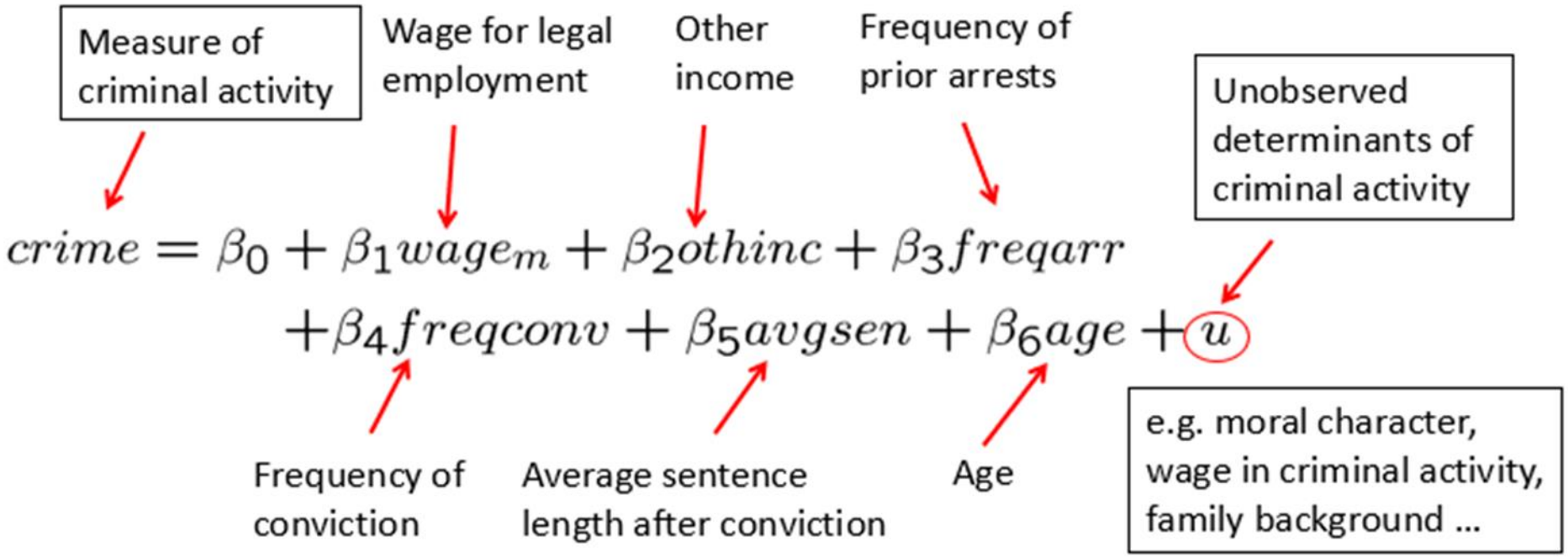
- **Econometric model of criminal activity**
  - The functional form has to be specified.
  - Variables may have to be approximated by other quantities.



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

- 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 the effect of training on wages.
  - How large is this effect? Is it different from zero?

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- **Econometric analysis requires data.**
- There are several 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**
  - These may include samples of individuals, households, firms, cities, states, countries, or other units of interest at a given point of time or in a given period.
  - Cross-sectional observations are more or less independent.
  - An example is pure random sampling from a population.
  - Sometimes pure random sampling is violated, for example, people refuse to respond in surveys, or sampling may be characterized by clustering.
  - Cross-sectional data is typically encountered in applied microeconomics.

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- Table 1.1: Cross-sectional data set on wages and other 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

Years of education

Years of experience

WAGE1.dta

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- Table 1.2: Cross-sectional data on 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

Average growth rate of real per capita GDP

Government consumption as a percentage of GDP

Adult secondary education rates

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

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- Table 1.3: Time series data on 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 the given year

Average coverage rate

Unemployment rate

Gross national product

PRMINWGE.DTA

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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 are often used to evaluate policy changes.
  - Example:
    - Evaluating 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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- Table 1.4: Pooled cross sections on two years of housing prices

Property tax

Size of house in square feet

obsno	year	hprice	proptax	sqrft	bdrms	bthrms
1	1993	85,500	42	1600	3	2.0
2	1993	67,300	36	1440	3	2.5
3	1993	134,000	38	2000	4	2.5
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
250	1993	243,600	41	2600	4	3.0
251	1995	65,000	16	1250	2	1.0
252	1995	182,400	20	2200	4	2.0
253	1995	97,500	15	1540	3	2.0
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
520	1995	57,200	16	1100	2	1.5

Number of bedrooms

Number of bathrooms

Before reform

After reform

HPRICE3.DTA?

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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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- Table 1.5: Two-year panel data set on city crime statistics

obsno	city	year	murders	population	unem	police
1	1	1986	5	350,000	8.7	440
2	1	1990	8	359,200	7.2	471
3	2	1986	2	64,300	5.4	75
4	2	1990	1	65,100	5.5	75
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
297	149	1986	10	260,700	9.6	286
298	149	1990	6	245,000	9.8	334
299	150	1986	25	543,000	4.3	520
300	150	1990	32	546,200	5.2	493

Each city has two time series observations

Number of police in 1986

Number of police in 1990

CRIME3.DTA?

What's the difference between Econometrics and Statistics?

- Stats is the foundation of Econometrics
- But econometrics is not stats, differences:
  1. The important role of economic models in Econometrics:
     - Exogeneous and endogeneous variables
  2. Explain, not only describe
     - E.g. *好男人都结婚了吗？*
  3. The important role of causality
     - How to define causality? The notion of counterfactuals.
       - Example: *Can exposure to celebrities reduce prejudice? The effect of Mohamed Salah on Islamophobic behaviors and attitudes*.
     - Why causality but not correlation?
       - Correlation is useful for prediction
       - Prediction of counterfactuals matters in policy making. E.g. Will you attend the graduate entrance exam?
  4. Prediction is hard in economics
     - Lucas' Critique: why traditional stats fail in predicting economies?

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

Definition of causal effect of x on y :

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

- Ceteris paribus: "other relevant factors being equal."
- 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, and so on are held fixed.

- Experiment = Feasible
  - 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, and so on are held fixed.

- Experiment ≠ Infeasable
  - Choose a group of people; randomly assign different amounts of education 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 than city B, by how much would the two cities' crime rates differ?"
- Experiment ≠ Infeasable
  - Randomly assign number of police officers to a large number of cities (virtually impossible, as no two cities are alike in all respects except size of police force!).
  - More importantly, in reality, the number of police officers occurs contemoraneously with determination of crime rate.

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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 ≠ Infeasable
  - Government randomly chooses minimum wage each year and observes unemployment outcomes.
  - Experiment would theoretically 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 always stated in terms of causal effects.
  - For example, dynamic models of labor supply predict that work hours should respond positively to transitory positive wage changes.
    - Why?
  - How to test this theory?
    - *Labor supply of New York city cabdrivers: one day at a time*
    - Alternative explanation: mental account
  - Another example, how to test Comparative Advantage theory?
    - If a country do not have comparative advantage in some products, then these products will not be produced in this country, so the productivity is not observed.

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

Application: Causality, Counterfactuals and Policy

- Should we protect intellectual property rights?
  - Tradeoff: encourage innovation v.s. protect consumers' welfare
  - Key question: how do we know the counterfactuals?
  - *Estimating the effects of global patent protection in pharmaceuticals: a case study of quinolones in india*