Sample
Course Slides

This PDF-file contains a composition of slides that were used for courses taught in our MIEPP-program. In total, we present slides from 6 different courses to you. We thus hope to give you a short impression of the diversity of our curriculum with regard to content as well as methods.

Should you require further information on the courses, please consult the MIEPP-webpage and do not hesitate to contact the particular instructors directly with specific requests.

Sample Course Slides No. 1

The following slides are taken from the course:

International Macroeconomics
Subsection: Exchange Rates

The course instructor is:
Prof. Philipp Harms

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6. Exchange Rates

The monetary model of exchange rate determination

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- **Structure and assumptions:**
  - **Small open economy** with **perfect international capital mobility** → Real interest rate determined by world capital markets:

$$r_t^H = r_t^F \qquad (6.8)$$

  - **Flexible exchange rate** (= Central bank does *not* intervene on foreign exchange markets).
  - **Classical dichotomy**: Real output, consumption etc. are exogenous.

The monetary model of exchange rate determination

- **Structure and assumptions:**

  – **Real money demand** is given by

$$m_t^{D,H} - p_t^H = \phi\, y_t^H - \lambda\, i_t^H \qquad (6.9)$$

with

$m^{D,H}_t$:	Log. of domestic nominal money demand
p^H_t:	Log. of domestic price level
y^H_t:	Log. of domestic real income (exogenous!)
i^H_t:	Nominal interest rate paid on assets held in domestic currency between period t and t+1.
	$\phi, \lambda > 0$

  - Permanent **money market equilibrium**: $m_t^{D,H} = m_t^{S,H} = m_t^H$

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- **Structure and assumptions:**
  - Nominal money supply is *exogenous*.
  - **Rational expectations**: $x_{t+j}^{e} = \mathrm{E}_t x_{t+j}$

    Expectations about x = Conditional expected value based on all information available at t (including the model).

***E_t* : nominal exchange rate**
E_t : expectations operator

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- **Structure and assumptions (contd.):**
  - **(Absolute) purchasing power parity (PPP)**:

$$Q_t = \frac{E_t P_t^F}{P_t^H} = 1 \quad \Leftrightarrow \quad P_t^H = E_t P_t^F \tag{6.10}$$

- Interpretation: If measured in the same currency, price levels are identical across countries.
- Rationale: Price indices are based on identical goods baskets and the **law of one price** holds for all goods. (More about this later…)

The monetary model of exchange rate determination

- **Structure and assumptions (contd.):**
  - Absolute Purchasing Power Parity (PPP) (contd.)
    - Writing the PPP condition in logs yields

$$e_t = p_t^H - p_t^F \tag{6.11}$$

    - Differencing (6.11) yields the **relative** version of PPP

$$\mathrm{E}_t e_{t+1} - e_t = \mathrm{E}_t p_{t+1}^H - p_t^H - \left(\mathrm{E}_t p_{t+1}^F - p_t^F\right) \tag{6.12}$$

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- **Structure and assumptions (contd.):**

  – **The Fisher equation**: Nominal interest rate i as sum of real interest rate r and expected inflation:

$$i_t^H = r_t^H + \mathrm{E}_t p_{t+1}^H - p_t^H \qquad (6.13a)$$

$$i_t^F = r_t^F + \mathrm{E}_t p_{t+1}^F - p_t^F \qquad (6.13b)$$

  – Combining (5.8), (5.12) and (5.13) yields the **UIP**

$$i_t^H = i_t^F + \mathrm{E}_t e_{t+1} - e_t \qquad (6.14)$$

The monetary model of exchange rate determination

- **Determining the exchange rate**

  – Using (6.9), (6.11) and (6.14) yields

$$e_t = \frac{1}{1+\lambda}\left[m_t^H - p_t^F - \phi\, y_t^H + \lambda\, i_t^F\right] + \frac{\lambda}{1+\lambda} \mathrm{E}_t e_{t+1} \qquad (6.15)$$

  – Forward-iteration of (6.15) yields

$$e_t = \frac{1}{1+\lambda}\sum_{s=t}^{\infty}\left(\frac{\lambda}{1+\lambda}\right)^{s-t} \mathrm{E}_t\left[m_s^H - p_s^F - \phi\, y_s^H + \lambda\, i_s^F\right] + \lim_{T\to\infty}\left(\frac{\lambda}{1+\lambda}\right)^{T} \mathrm{E}_t e_T \qquad (6.16)$$

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- **Determining the exchange rate (contd.)**

$$e_t = \frac{1}{1+\lambda}\sum_{s=t}^{\infty}\left(\frac{\lambda}{1+\lambda}\right)^{s-t} \mathrm{E}_t\left[m_s^H - p_s^F - \phi y_s^H + \lambda i_s^F\right] + \lim_{T\to\infty}\left(\frac{\lambda}{1+\lambda}\right)^T \mathrm{E}_t e_T$$

Fundamental value of the nominal exchange rate — „**Bubble**" term

– **Note:** The "bubble" term is zero unless the nominal exchange rate explodes/implodes (grows infinitely large in absolute value).

– In case of a **speculative bubble**, this is exactly what happens: Value of asset (here: currency) grows *only* because market participants expect to grow in future.

The monetary model of exchange rate determination

- **Determining the exchange rate (contd.)**

  – Assuming that the nominal exchange rate does *not* explode, we can set the last term on the RHS of (6.16) equal to zero, which yields

$$e_t = \frac{1}{1+\lambda} \sum_{s=t}^{\infty} \left(\frac{\lambda}{1+\lambda} \right)^{s-t} \mathrm{E}_t \left[m_s^H - p_s^F - \phi\, y_s^H + \lambda\, i_s^F \right] \qquad (6.17)$$

The monetary model of exchange rate determination

- **Interpretation**
  - The current nominal exchange rate depends on **current** and **expected future values** of ...
    - ... the money supply (+)
    - ... the level of real income (-)
    - ... the nominal foreign interest rate (+)
    - ... the foreign price level (-)
  - Future values are “discounted” using the factor $\lambda/(1+\lambda)$.

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- **Interpretation (contd.)**
  - Why does the future matter for the current exchange rate?

$$e_t = p_t^H - p_t^F$$

PPP: Nominal exchange rate determined by domestic price level.

$$p_t^H = m_t^H - \phi y_t^H + \lambda i_t^H$$

Price level increases in the nominal interest rate (Effect of interest rate on real money demand).

$$i_t^H = i_t^F - e_t + \mathrm{E}_t e_{t+1}$$

UIP: Nominal interest rate increasing in expected depreciation of domestic currency.

  - Consequence: Expectations about higher nominal exchange rate in future result in higher nominal exchange rate in current period.

The monetary model of exchange rate determination

- **Merits of the monetary model: What have we learned?**
  - Key message: Current nominal exchange rate depending on current and expected future values of exogenous variables (money supply, output, interest rates etc.)

    → Importance of **expectations** in determining exchange rates

  - Exchange rate as the price of an **asset** (domestic currency)

    → Like other asset prices, exchange rate determined by expectations about the future.

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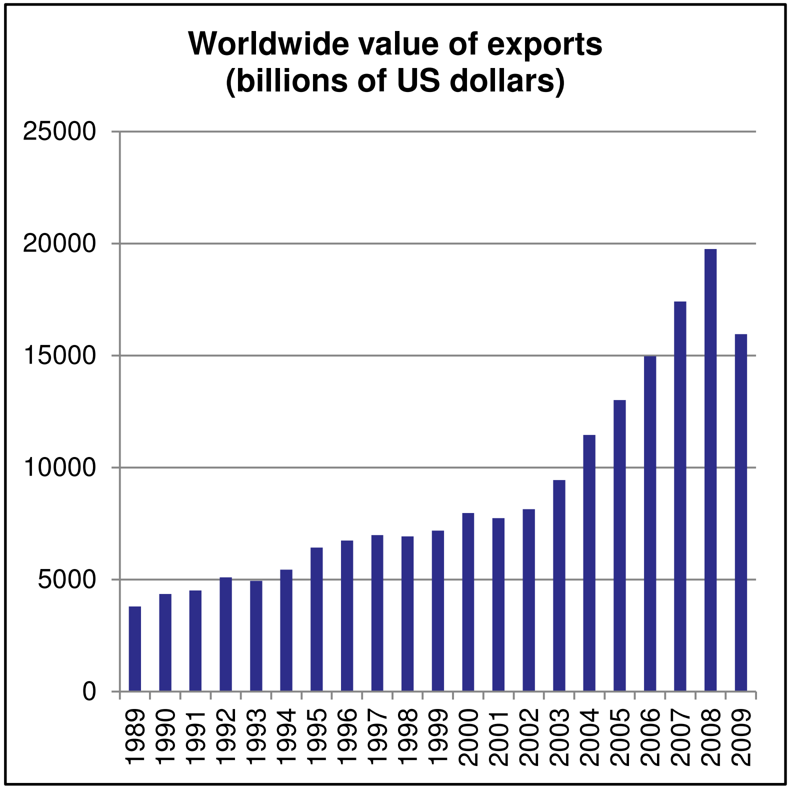
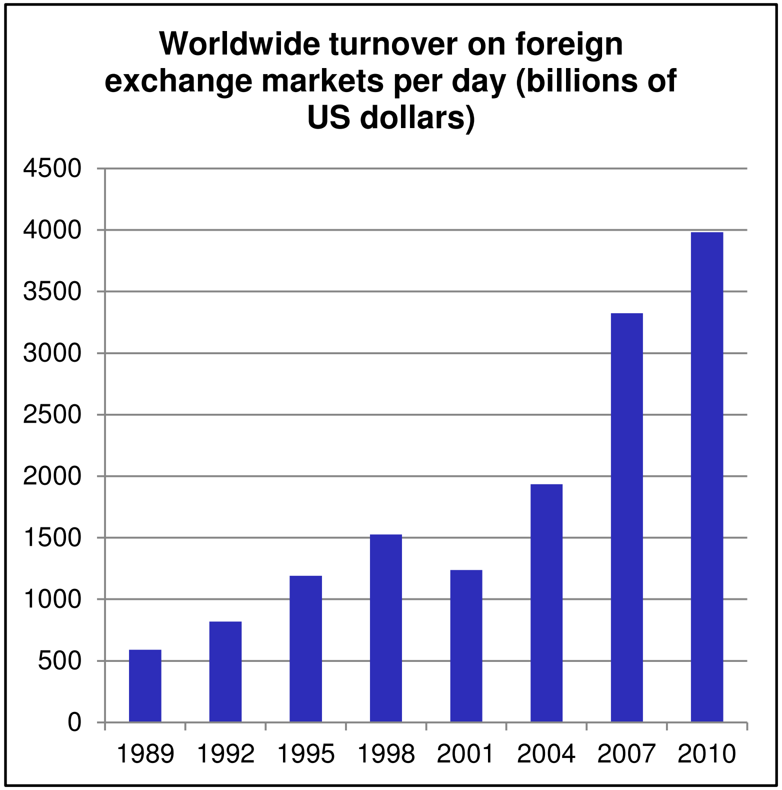
- **Figure 6.10: Worldwide turnover on forex markets and worldwide exports of goods and services**





Source: BIS, World Bank (WDI)

The monetary model of exchange rate determination

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- **Taking the monetary model to the data**
  - With two (structurally identical) countries, the fundamental value of the nominal exchange rate is given by

$$e_t = \frac{1}{1+\lambda}\sum_{j=0}^{\infty}\left(\frac{\lambda}{1+\lambda}\right)^j \mathrm{E}_t\left(m_{t+j} - m^*_{t+j} - \phi y_{t+j} + \phi y^*_{t+j}\right)$$

  - To save notation, we define the **monetary fundamentals**

$$\Phi_{t+j} \equiv m_{t+j} - m^*_{t+j} - \phi y_{t+j} + \phi y^*_{t+j}$$

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- **Taking the monetary model to the data (contd.)**

  - We assume that the monetary fundamentals follow an AR(1):

$$\Phi_{t+1} = \mu + \rho\,\Phi_t + \nu_{t+1}$$

  - It can be shown that in this case

$$e_{t+1} - e_t = \frac{1}{1+\lambda(1-\rho)}\left(\Phi_{t+1} - \Phi_t\right)$$

  - <u>Interpretation</u>:
    - Changes in nominal exchange rate driven by changes in fundamentals.
    - Unless $\rho = 1$: Nominal exchange rate *less volatile* than fundamentals.

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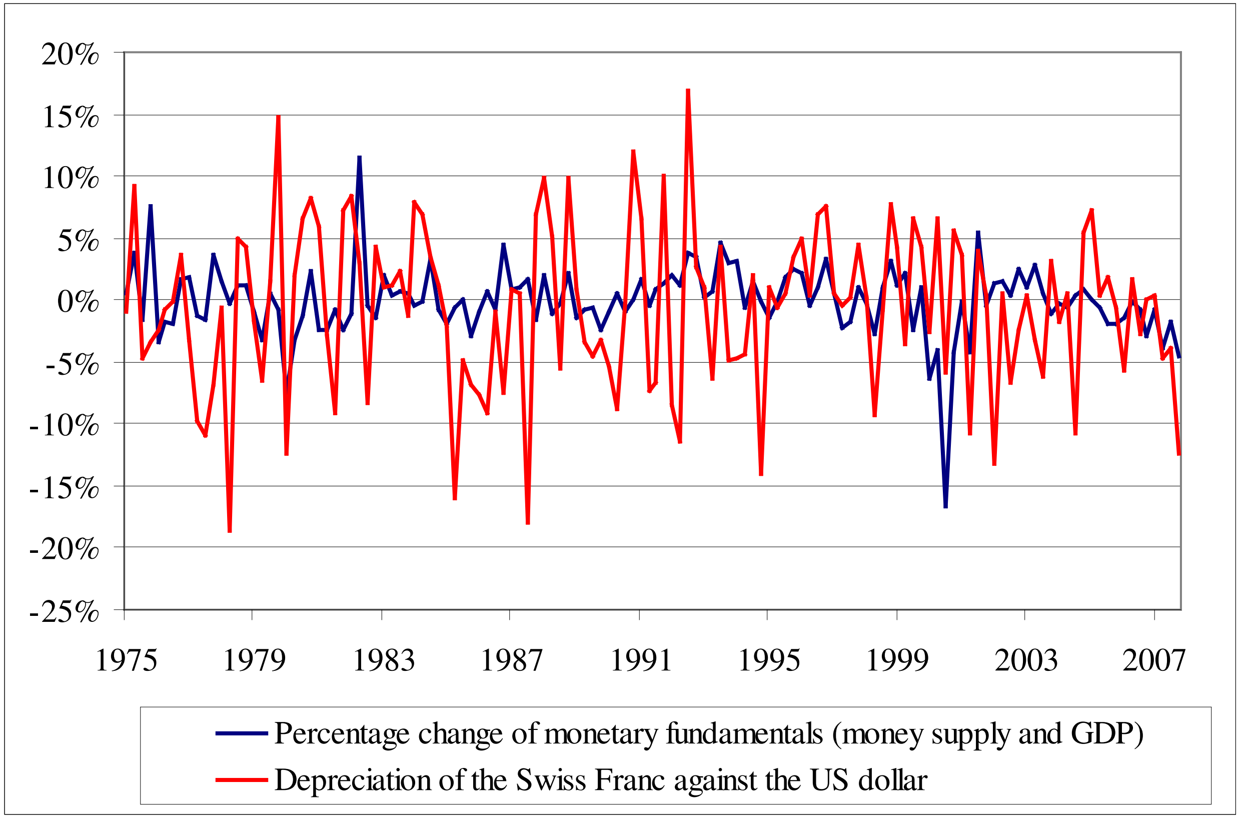
- **Figure 6.11: Monetary Fundamentals and the Nominal Exchange Rate**



Source: IMF (IFS) and own calculations

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- **Shortcomings of the monetary model: What seems wrong and what is missing ?**

  – The monetary model can be interpreted as a nominal extension of the intertemporal model presented in Sections 3 and 4. Taking the real magnitudes determined in the intertemporal model as given, it is used to determine the nominal exchange rate.

  – Hence, it can be accused of making the same (heroic) assumptions as the intertemporal model:

    - Perfect capital mobility and risk-neutrality
    - Permanent PPP
    - Monetary neutrality

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- **Shortcomings of the monetary model: What seems wrong and what is missing ? (contd.)**

  – The monetary model suggests that the exchange rate is *at most* as **volatile** as monetary fundamentals.

    However, observed nominal exchange rates are more volatile than monetary fundamentals („**excess volatility**“)

  – The monetary model is based on the notion that **PPP** holds at every point in time.

    However, we observe persistent *deviations* from PPP.

Sample Course Slides No. 2

The following slides are taken from the course:

Empirical Labor Economics
Subsection: Matching

The course instructor is:
Prof. Thorsten Schank

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Solving the evaluation problem: selecting on observables

- The instrumental variable-method (IV) (see chapter 3) or fixed effects deal directly with the *selection on the unobservables*.
- However, often there are no convincing instruments available and fixed effects are not feasible.
- And controlled experiments are impossible.
- One can still estimate average treatment effects using regression or matching techniques.

- However, one need to make the assumption of selection on observables.
- This is also called unconfoundedness or missing at random or conditional independence assumption (CIA):

$$\{Y_i(0), Y_i(1)\} \perp\!\!\!\perp D | X.$$

- Conditional on X, both $y(1)$ and $y(0)$ are independent of D.
- The selection into treatment is completely determined by variables observed to the researcher
- Conditioning on these variables, the assignment to treatment is random

Regression

- Rewriting (1) yields:

$$\begin{aligned} Y_i &= Y_i(0) + [Y_i(1) - Y_i(0)]D_i \\ &= E\{Y_i(0)\} + (Y_i(1) - Y_i(0))D_i + [Y_i(0) - E\{Y_i(0)\}] \end{aligned}$$

- Assumming a constant treatment effect, this can be expressed as the following regression equation:

$$Y_i = \alpha + \beta D_i + \eta_i$$

- η_i is the random part of $Y_i(0)$.
- Again, there is a selection bias if η and D_i are correlated, which is:

$$E[\eta_i|D_i = 1] - E[\eta_i|D_i = 0] = E[Y_i(0)|D_i = 1] - E[Y_i(0)|D_i = 0].$$

- Suppose that η can be decomposed as:

$$\eta_i = X_i'\gamma + v_i$$

and the residual v_i and X_i are uncorrelated by construction.

- Assuming that the CIA-condition holds, it follows:

$$E[Y_i|X_i, D_i] = E[Y_i|X_i] = \alpha + \beta D_i + X_i'\gamma$$

- Hence, if the covariates X are included into the regression, the coefficient β is the causal effect of interest.

Exact matching

- All matching estimators are weighting estimators.
- All matching estimators for the treatment on the treated can be written in the form

$$ATT^M = \frac{1}{n_1} \sum_{i \in \{D_i=1\}} \left[Y_i(1) - \sum_{j \in \{D_j=0\}} w(i,j) Y_j(0) \right]$$

  where n_1 is the number of treated persons, $w_{(i,j)}$ is the weight placed on the *jth* observations in constructing the counterfactual for the *ith* treated treated observation.
- The weights satisfy $\sum_j w(i,j) = 1$ for all i.
- Different matching estimators differ in how the weights are constructed.

An aside on iterated expectations

- In general, suppose we take expections twice, ie conditioning on 2 vectors that are related to each other. Then:

$$E(y|\mathbf{z}) = E[E(y|\mathbf{w})|\mathbf{z}],$$

  where $\mathbf{z} = f(\mathbf{w})$, eg $\mathbf{x}$ is a subset of $\mathbf{w}$. In words, one ends up conditioning on the vector with the least information.
- In our case:
  - let y be $Y(1) - Y(0)$;
  - let $\mathbf{z}$ be $D = 1$;
  - let $\mathbf{w}$ be $D = 1, X$.
- Making these substitutions:

$$E[Y(1)-Y(0)|D = 1] = E\{E[Y(1)-Y(0)|D = 1, X]|D = 1\}.$$

- Return to the main story ...

- ...taking iterated expectations:

$$\begin{aligned}\delta_{ATT} &= \mathrm{E}\{Y_i(1) - Y_i(0)|D_i = 1\} \\ &= \mathrm{E}\{\mathrm{E}[Y_i(1) - Y_i(0)|D_i = 1, X]|D_i = 1\} \\ &= \mathrm{E}\{\mathrm{E}[Y_i(1)|D_i = 1, X] - \mathrm{E}[Y_i(0)|D_i = 1, X]|D_i = 1\}\end{aligned}$$

- Using the CIA

$$\mathrm{E}[Y_i(0)|D_i = 1, X] = \mathrm{E}[Y_i(0)|D_i = 0, X]$$

now we can substitute out the counterfactual in δ_{ATT} with the observable:

$$\begin{aligned}\delta_{ATT} &= \mathrm{E}\{\mathrm{E}[Y_i(1)|D_i = 1, X] - \mathrm{E}[Y_i(0)|D_i = 0, X]|D_i = 1\} \\ &= \mathrm{E}\{\delta_X|D_i = 1\} \qquad (2)\end{aligned}$$

where

$$\delta_X \equiv \mathrm{E}[Y_i|D_i = 1, X] - \mathrm{E}[Y_i|D_i = 0, X] \qquad (3)$$

- This suggests the following (exact) matching strategy:

  1. Stratify the data into cells defined by each particular value of X.
  2. Within each cell, compute the difference between the average outcomes of the treated and the controls.
  3. average these differences with respect to the distribution of X_i in the population of treated units.

- Suppose X_i is discrete, such that we can write:

$$ATT = \sum_x \delta_X P(X_i = X | D_i = 1) \tag{4}$$

- Suppose that X takes on K discrete values $k = 1, \ldots, K$.
- n_{1k} is the number of treated persons within each cell and n_{0k} is the number of untreated persons in each cell.
- The estimator is then

$$\sum_k \frac{n_{1k}}{\sum n_{1k}} \left[\sum_{i \in k \cap \{D_i = 1\}} \frac{Y_{1i}}{n_{1k}} - \sum_{j \in k \cap \{D_j = 0\}} \frac{Y_{0j}}{n_{1j}} \right]$$

- In other words, calculate the mean difference in each cell and take a weighted average of the mean differences using the fraction of treated observations in each cell as weights.

Sample Course Slides No. 3

The following slides are taken from the course:

Advanced Public Policy: Taxation
Subsection: Welfare States & Tax Competition

The course instructor is:
Prof. Daniel Schunk

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Motivation and Outline

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- **Last lectures:** Reasons for the need of a welfare state, for example
  - protect workers in ‘rich’ countries when trade equalizes factor prices,
  - provide insurance when private markets fail to do so.
- **Today’s lecture:** The welfare state under tax competition
  - Basic argument:
    - Capital and labor are internationally mobile.
    - Migration decisions of people depend (inter alia) on the tax burden and the welfare system.
    - Each country has an incentive to undercut the tax burden.
    - Zero tax rate and underprovision of public goods (e.g. education, infrastructure, …).
    - Race to the bottom.

  - See also: Sinn, H.W. (2003): The new systems competition. Basil Blackwell: Oxford 2003.

A closed economy setting (1)

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(a) A simple formal framework to illustrate this argument:

- Production of a homogeneous output: $f(K,L)$.
- Both factors are paid their marginal products: $f_K(K,L)=r$, $f_L(K,L)=w$
- Individual labor supply in efficiency units: X
- Labor supply X is a random variable with $X=\theta_1 \cdot \theta_2$
  - θ_1 and θ_2 are stochastically independent random variables.
    - Over „time" and across individuals.
  - θ_1 reflects inborn human capital (e.g. cognitive and noncognitive ability). Realized early in life.
  - θ_2 reflects later reasons for wage variation (e.g. promotion risks). Realized later in life.
  - $\theta_1 > 0$, $\theta_2 > 0$, $E(\theta_1)=E(\theta_2)=1=E(X)$

A closed economy setting (2)

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(a) A simple formal framework to illustrate this argument (cont.):

- The individuals are risk averse.
- Neither the risk θ_1 nor θ_2 (associated with labor efficiency) can be insured privately.
  → Proof of non-existence of private insurance market is given in Sinn (2003).
- Individual risk, stochastically independent and identical for all individuals: $C>0$
- C is insured privately.
  - Competitive market: Fair premium $\beta \cdot E(C)$, where β is the degree of coverage.
  - Risk averse individuals choose $\beta=1$.
- Individual has assets A.
- Tax rate on labor τ: Used to finance a lump-sum transfer $T= \tau \cdot w$.

A closed economy setting (3)

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(b) How does the income distribution change with the tax rate τ?

- Individual income before taxation:
  $Y_{BeforeTax} = \theta_1 \cdot \theta_2 \cdot w - E(C) + r \cdot A$
- Individual net income after taxes and redistribution:
  $Y_{Net} = \theta_1 \cdot \theta_2 \cdot w(1 - \tau) - E(C) + r \cdot A + T$
- Expected individual net income after taxes and redistribution:
  $E(Y_{Net}) = w - E(C) + r \cdot A$
- Standard deviation of individual net income after taxes and redistribution:
  $S(Y_{Net}) = S(\theta_1 \cdot \theta_2)\, w(1 - \tau)$
- $\dfrac{\partial E(Y_{Net})}{\partial \tau} = 0$
- $\dfrac{\partial S(Y_{Net})}{\partial \tau} < 0$ ←

By redistributing income, the state makes available a welfare increasing insurance against the risk of unequal inborn capabilities and other unequal exogenous influences on the life income.

An open economy setting (1)

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(a) Additional assumptions:

- N identical countries.
- Labor and capital are mobile, without any migration cost.

(b) Equilibrium in an open economy:

- Factor price equalization implies:
  - $r_i = r_j = r = const. \qquad \forall\, i, j = 1..N$
  - $w_i = w_j = w = const. \qquad \forall\, i, j = 1..N$
- Condition for an equilibrium on the labor market: Equal net incomes

  $\theta_1 \cdot \theta_2 \cdot w(1 - \tau_i) + T_i = \theta_1 \cdot \theta_2 \cdot w(1 - \tau_j) + T_j \qquad \forall\, i, j = 1..N, \theta_1 \cdot \theta_2$
- Government balanced budget: $T_i = \tau_i \cdot w$. Hence:

  $w[\theta_1 \cdot \theta_2 + \tau_i (1 - \theta_1 \cdot \theta_2)] = w[\theta_1 \cdot \theta_2 + \tau_j (1 - \theta_1 \cdot \theta_2)] \qquad \forall\, i, j = 1..N, \theta_1 \cdot \theta_2$

➔ $\tau_i = \tau_j$

An open economy setting (2)

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(c) Race to the bottom:

- Each country has incentives to undercut the tax rate
    - 'Poor' domestic residents with $\theta_1 \cdot \theta_2 < 1$ will leave
    - 'Rich' foreigners with $\theta_1 \cdot \theta_2 > 1$ will come in
- $\tau_i = \tau_j = 0$ is an equilibrium
- Undesirable from a distributional and an efficiency point of view
    - Recall: $S(Y_{Net}) = S(\theta_1 \cdot \theta_2)\, w(1 - \tau)$

(d) Result:

- Although welfare states may be Pareto optimal and may come into existence in a world with closed borders, they cannot survive when the factors of production are free to move across the borders. Each nation will find it Pareto optimal to dismantle its welfare state, given the fiscal situation in others. An equilibrium will not be reached before the welfare states have disappeared.

Policy Examples & Implications (1)

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(a) Policy Example (Details see Glaeser and Kahn, 1999*):

- In the 60s, New York implemented a generous welfare program.

→ Large immigration from other states.

→ New York went almost bankrupt, program canceled in 1975.

(b) Policy Implications:

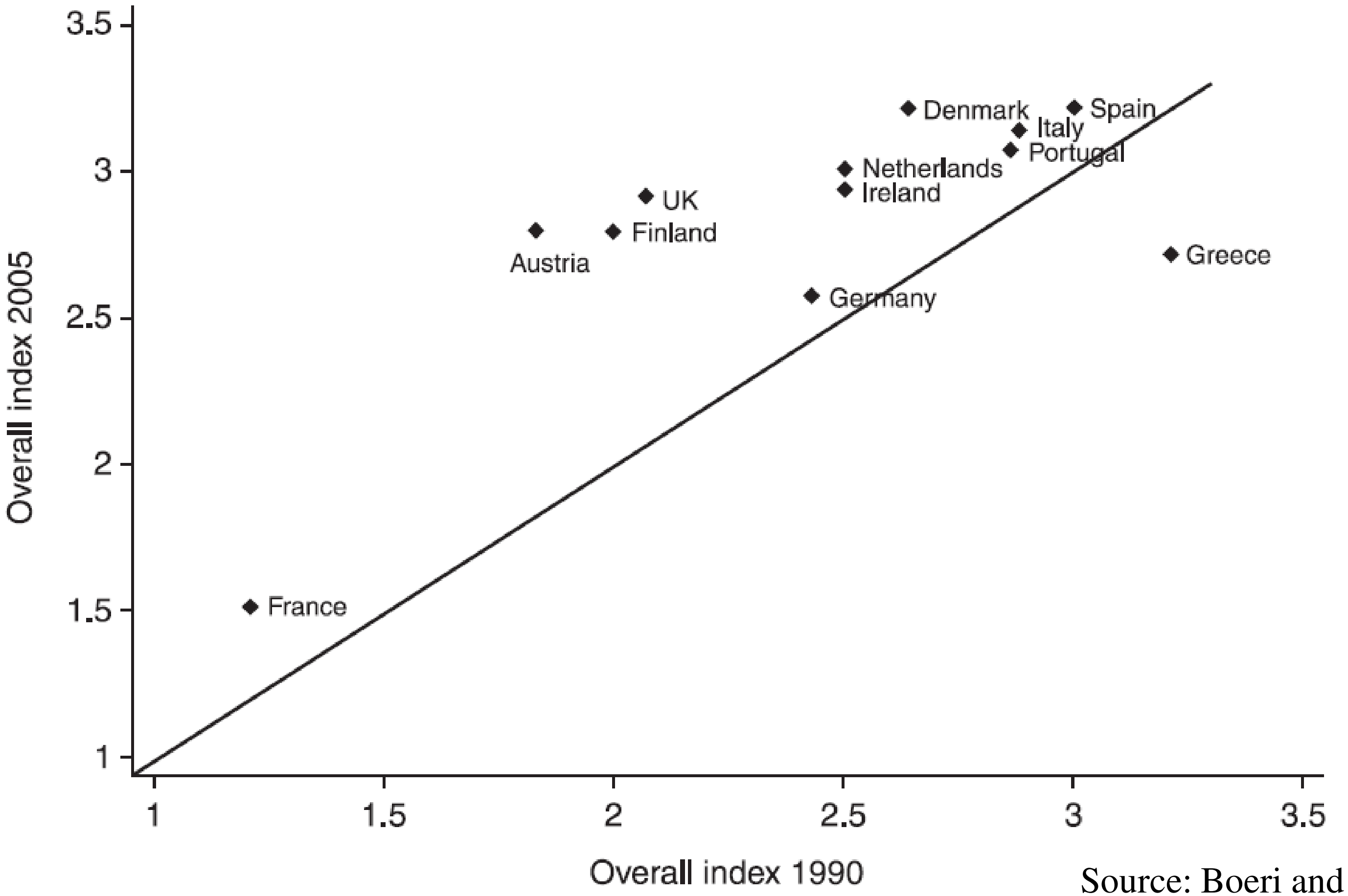
- If national governments are only concerned about the welfare of the domestic population, they may impose migration barriers.
- See next slide: Figure from Boeri and Brücker (2005)**

* Glaeser, E. L., and M. E. Kahn (1999): From Lindsay to Rudy Giuliani: The Decline of the Local Safety Net? *Economic Policy Review 5, 117-32.*

** Boeri, T., and H. Brücker (2005): Why are Europeans so tough on migrants? *Economic Policy, 44, 631-703.*

Policy Examples & Implications (2)

Overall index for the tightness of the immigration policies.



Source: Boeri and Brücker (2005)

Sample Course Slides No. 4

The following slides are taken from the course:

Topics in financial economics: New Keynesian Economics
Subsection: Real Business Cycle vs. New Keynesian Economics

The course instructor is:
Prof. Lena Dräger

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JG|U

Organization of the course

I. Introduction

II. A Classical Monetary Model

III. The Basic New Keynesian Model

IV. Monetary Policy Design

V. Model Simulation using Dynare

VI. Discretion vs. Commitment

VII. The Financial Accelerator Model

The New Keynesian DSGE Model

- Modeling the transmission mechanism of monetary policy to study the relationship between monetary policy, inflation and the business cycle
- Small-scale log-linearized models with intuitive interpretation
- Main workhorse for modern macroeconomists – Dynamic Stochastic General Equilibrium (DSGE) model
- Heavily used for forecasting and the conduct of monetary policy by a wide range of central banks
- Based on the Real Business Cycle (RBC) model, enhanced with "Keynesian" features (like sticky prices and monopolistic competition)
- Can be extended in various ways, introducing additional frictions (sticky wages, credit frictions, hand-to-mouth consumers...) or including additional markets (capital markets, open economy...)

Aim of the course

- Explaining the key concept of the New Keynesian framework and some extensions
- Providing the class with necessary techniques to build and solve a Dynamic Stochastic General Equilibrium (DSGE) model
- Providing an overview of the most recent literature on monetary policy analysis
- Introducing Dynare, a MATLAB-Preprocessor built for solving, simulating, and estimating DSGE models

$\Rightarrow$ At the end of the class, students should be able to understand DSGE models, and know the techniques to build and simulate small-scale models themselves (useful for those aiming at a theoretical macro Master or PhD thesis)

Real Business Cycle vs. New Keynesian Economics – Theory

Real Business Cycle models

- Seminal work: Kydland and Prescott (1982) and Prescott (1986)
- New methodological aspects:
  1. Establishing the use of DSGE models, where behavioral equations are replaced by first-order conditions of intertemporal optimization problems of households and firms
  2. Rational expectations
  3. Importance of quantitative aspects such as calibration, simulation and evaluation – can the model replicate the empirical stylized facts?

Real Business Cycle models

- New conceptual aspects (e.g. Clarida et al., 1999):
  1. Assumption of perfect competition and frictionless markets (fully flexible prices and wages)
     ⇒ Cyclical fluctuations around the equilibrium are **optimal** responses to exogenous real shocks (technology)
     ⇒ Fiscal or monetary stabilization is neither necessary nor desirable, as fluctuations represent efficient allocations
  2. **Technology shocks** (variations in total factor productivity) explain business cycle fluctuations
  3. No reference to monetary factors, since money and monetary policy is neutral
  4. Extension with monetary sector (see ch. 2): Optimal MP should follow the Friedman rule, i.e. keep nominal interest rates always at zero

⇒ Problem: Conflict with empirical evidence showing that there is an effect of monetary policy at least in the short-run (e.g. Friedman and Schwartz, 1963, and Christiano et al., 1999)!

The New Keynesian Model

Core of the model similar to an RBC model:

1. Infinitely-lived representative household maximizes utility subject to an intertemporal budget constraint
2. Large number of firms produces output with identical technology and subject to exogenous shocks
3. Rational expectations
4. Equilibrium is a stochastic process following from optimal intertemporal decisions and market clearing

The New Keynesian Model

The key elements, distinguishing it from an RBC model:

1. Monopolistic competition: Prices are set by private agents having some monopoly power
2. Nominal rigidities: Prices and wages are adjusted only at intervals
3. Short-run non-neutrality of money: Changes in interest rates are not immediately followed by changes in inflation expectations due to the nominal rigidities. This allows central banks to adjust the real interest rate and affect consumption and investment decisions and, thus, also output and employment

$\Rightarrow$ Equilibrium reactions to shocks are inefficient

$\Rightarrow$ Monetary policy can be welfare-enhancing in the short run by minimizing existing distortions

$\Rightarrow$ Models can compare monetary policy regimes, without being subject to the Lucas critique

Real Business Cycle vs. New Keynesian Economics – Empirical Evidence

Empirical Evidence of Nominal Rigidities Using Micro Data

- Early survey: Taylor (1999) suggests an average frequency of individual price adjustments of one year. Also little evidence of synchronized price changes, suggesting staggered price setting
- More recent studies suggest a value below one year: Bils and Klenow (2004) suggest 4-6 months in a study on 350 product categories in the CPI basket
- Nakamura and Steinsson (2008) suggest 8-11 months, excluding price changes due to sales
- Similar evidence for the Euro area

Empirical Evidence of Nominal Rigidities Using Micro Data

- Large heterogeneity in price adjustments across different goods, with service prices most rigid, and food & energy prices most flexible
- Similar evidence of nominal rigidities in wages, where Taylor (1999) also suggests average frequency of changes of one year
- Moreover, some studies find evidence especially for a downward rigidity of nominal wages (and there is also some evidence for downward rigidity of real wages)

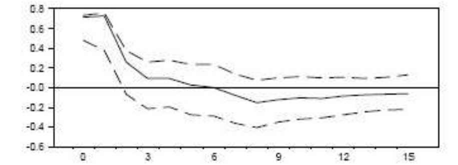
Empirical Evidence of Monetary Policy Non-Neutralities

- Endogeneity problem: Interest rates and money supply react to changes in real variables. Thus, non-monetary forces can be the reasons for movements in the monetary variables and not vice versa, so that the direction of causality is unclear

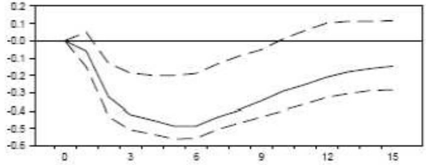
$\Rightarrow$ Several studies used advanced time series econometrics techniques, such as structural VAR models (e.g. Christiano et al., 1999; Bernanke and Mihov, 2004 and Uhlig, 2005, among others)

$\Rightarrow$ For instance, monetary policy shocks can be identified as the residual from an estimated monetary policy rule (Christiano et al.).

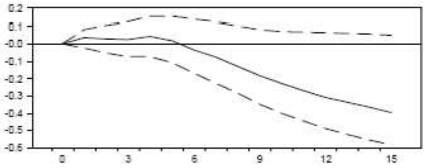
Estimated Dynamic Responses to a Monetary Policy Shock from Christiano et al. (1999)



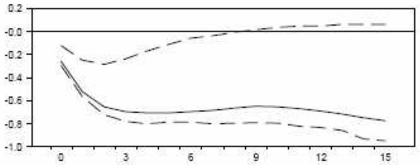
Federal funds rate



GDP



GDP deflator



M2

Estimated Dynamic Responses to a Monetary Policy Shock from Christiano et al. (1999)

Interpretation:

- The graphs show the responses of the GDP, M2 and Prices after an increase in the interest rate of 0.75 percentage points (a monetary policy tightening)

$\Rightarrow$ GDP declines in a humped-shaped pattern reaching a trough after 5 quarters, illustrating a sizable and persistent real effect of the MP shock

$\Rightarrow$ Prices respond very slowly (and insignificantly), indicating a sluggish price adjustment

$\Rightarrow$ In order to yield an increase in the interest rate, the money supply in circulation has to fall (liquidity effect)

Important Tool: Log-Linear Approximation

Why Do We Need Log-Linear Approximations?

- Most non-linear models are difficult to solve exactly. Hence, we approximate the model in a linear form
- In a general equilibrium model, we can use a first-order Taylor-approximation of the model in logs around the steady state, which behaves quite well in the neighborhood of the steady state.
- Bringing models in a standardized linear form allows to solve the model and to use standardized software for estimation and simulation, and the evaluation of different policy regimes. We can now evaluate the contemporary and future responses of all endogenous variables after a change in some exogenous variable (for example an exogenous increase in inflation due to an increase in oil prices).

But: Approximations can be misleading when we leave the neighborhood of the steady state!

Taylor Approximations

A Taylor approximation of order n of a function f around a constant value a is given by:

$$\begin{aligned} T_{n;f;a}(x) &\equiv f(a) + \frac{f'(a)}{1!}(x-a) + \frac{f''(a)}{2!}(x-a)^2 + \cdots + \frac{f^{(n)}(a)}{n!}(x-a)^n \\ &= \sum_{i=0}^{n} \frac{f^{(i)}(a)}{i!}(x-a)^i \end{aligned}$$

Consequently, we get for a first-order Taylor approximation:

$$T_{1;f;a}(x) \equiv f(a) + f'(a)(x-a)$$

Log-Linearization Around the Steady State

Assume a non-linear function of the form

$$x_t = \frac{g_t}{h_t}$$

1. Take logarithms of both sides of the equation:

$$\ln x_t = \ln g_t - \ln h_t$$

2. Take a first-order Taylor series expansion around the steady state:

$$\begin{aligned}\ln(\overline{x}) + \frac{1}{\overline{x}}(x_t - \overline{x}) \quad &\approx \quad \ln(\overline{g}) + \frac{1}{\overline{g}}(g_t - \overline{g}) \\ &- \quad \ln(\overline{h}) - \frac{1}{\overline{h}}(h_t - \overline{h})\end{aligned}$$

$\Rightarrow$ Now the equation is linear in x_t, g_t and h_t!

Log-Linearization Around the Steady State

Further simplification:

3. In the steady state, $\ln(\overline{x}) = \ln(\overline{g}) - \ln(\overline{h})$. Hence, we can eliminate the constant terms:

$$\frac{1}{\overline{x}}(x_t - \overline{x}) \approx \frac{1}{\overline{g}}(g_t - \overline{g}) - \frac{1}{\overline{h}}(h_t - \overline{h})$$

Example Log-Linearization

Let's log-linearize the non-linear Cobb-Douglas production function $Y_t = A_t K_t^{\alpha} N_t^{(1-\alpha)}$ around the steady state:

1. Taking logs: $\ln Y_t = \ln A_t + \alpha \ln K_t + (1-\alpha) \ln N_t$
2. First-order Taylor approximation around the steady-state:

$$\begin{aligned} \ln \overline{Y} + \frac{1}{\overline{Y}}(Y_t - \overline{Y}) &\approx \ln \overline{A} + \frac{1}{\overline{A}}(A_t - \overline{A}) + \alpha \ln \overline{K} + \frac{\alpha}{\overline{K}}(K_t - \overline{K}) \\ &+ (1-\alpha) \ln \overline{N} + \frac{1-\alpha}{\overline{N}}(N_t - \overline{N}) \end{aligned}$$

3. Eliminate the zero-order terms:

$$\frac{1}{\overline{Y}}(Y_t - \overline{Y}) \approx \frac{1}{\overline{A}}(A_t - \overline{A}) + \frac{\alpha}{\overline{K}}(K_t - \overline{K}) + \frac{1-\alpha}{\overline{N}}(N_t - \overline{N})$$

4. Simplify further:

$$\frac{Y_t}{\overline{Y}} + 1 \approx \frac{A_t}{\overline{A}} + \frac{\alpha K_t}{\overline{K}} + \frac{(1-\alpha)N_t}{\overline{N}}$$

Sample Course Slides No. 5

The following slides are taken from the course:

Topics in Statistics and Econometrics: Health Economics

Subsection: Instrumental Variables

The course instructor is:

Prof. Reyn van Ewijk

JOHANNES GUTENBERG UNIVERSITÄT MAINZ

Outline: Instrumental Variables

1. What is the problem that we need to solve?
2. What is it?
3. How does it work? (Estimation)
4. Do note… 4 important issues
5. Examples
6. The relevance condition: a closer look
7. 2 SLS & multiple regression: a natural extension
8. A final example

Introduction

- Wanted: causal effect of X on Y

$$Y_i = \beta_0 + \beta_1 X_i + u_i \quad , \qquad i = 1, \ldots, n$$

- Example: Levitt (AER, 1997) – simplified
  - Do policemen reduce crime?
  - Observational unit = cities (i)/ years (t)
  - Effect of [number of policemen/1,000 citizens] on [criminality/1,000]

$$Crime_{it} = \beta_0 + \beta_1 Police_{it} + u_{it}$$

Types of bias

- Wanted: causal effect of X on Y

$$Y_i = \beta_0 + \beta_1 X_i + u_i \quad , \qquad i = 1, \dots, n$$

$$Crime_{it} = \beta_0 + \beta_1 Police_{it} + u_{it}$$

- Problem when X, u correlated: OLS estimator biased, inconsistent
  - Simultaneity
  - Omitted variables
  - Sample selection
  - Measurement error

Types of bias

- Wanted: causal effect of X on Y

$$Y_i = \beta_0 + \beta_1 X_i + u_i \quad , \qquad i = 1, \ldots, n$$

$$Crime_{it} = \beta_0 + \beta_1 Police_{it} + u_{it}$$

- Problem when X, u correlated: OLS estimator biased, inconsistent
  - Simultaneity
    - Recall: u contains all other components of $Crime$ (not due to number of policemen)
    - Much crime for exogenous reason (i.e. a high u) may cause city to hire many policemen → X and u correlated
  - Omitted variables
  - Sample selection
  - Measurement error

Types of bias

- Wanted: causal effect of X on Y

$$Y_i = \beta_0 + \beta_1 X_i + u_i \quad , \qquad i = 1, \ldots, n$$

$$Crime_{it} = \beta_0 + \beta_1 Police_{it} + u_{it}$$

- Problem when X, u correlated: OLS estimator biased, inconsistent
  - Simultaneity
  - Omitted variables
    - „Law & Order“ (L&O)-mentality in state/city
    - Gun possession allowed → Crime → $Cor(L\&O, Crime)$; $L\&O$ is part of u
    - Many policemen (preference) → $Cor(L\&O, Police)$
    - Without adjusting: $Cor(u, Police)$
  - Sample selection
  - Measurement error

Types of bias

- Wanted: causal effect of X on Y

$$Y_i = \beta_0 + \beta_1 X_i + u_i \quad , \qquad i = 1, \ldots, n$$

$$Crime_{it} = \beta_0 + \beta_1 Police_{it} + u_{it}$$

- Problem when X, u correlated: OLS estimator biased, inconsistent
  - Simultaneity
  - Omitted variables
  - Sample selection
    - IV won't help
  - Measurement error

Types of bias

- Wanted: causal effect of X on Y

$$Y_i = \beta_0 + \beta_1 X_i + u_i \quad , \qquad i = 1, \dots, n$$

$$Crime_{it} = \beta_0 + \beta_1 Police_{it} + u_{it}$$

- Problem when X, u correlated: OLS estimator biased, inconsistent
  - Simultaneity
  - Omitted variables
  - Sample selection
  - Measurement error
    - Classical in X → $\hat{\beta}$ biased toward 0
    - Nonclassical in X → $\hat{\beta}$ biased. Direction: depends.
    - Classical in Y → $\hat{\beta}$ not biased. SE's get larger.
    - Nonclassical in Y → $\hat{\beta}$ biased
  - IV can help for measurement error in X (not in Y)

Types of bias & IV terminology

$$Crime_{it} = \beta_0 + \beta_1 Police_{it} + u_{it}$$

- Problem when X, u correlated: OLS estimator biased, inconsistent
  - Simultaneity
  - Omitted variables
  - (Sample selection)
  - Measurement error

- In most regressions, several regressors
  - Because of research question or to get rid of some bias

$$Crime_{it} = \beta_0 + \beta_1 Police_{it} + \beta_2 CityRevenue_{it} + \beta_3 Year_{it} + u_{it}$$

- Not all variables problematic = correlated with u
  - E.g. effect of time ($year$) on crime reliably estimated

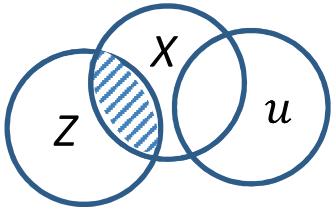
- IV terminology:
- Variable(s) correlated with error term = **endogenous** variables
- Variable(s) *not* correlated with error term = **exogenous** variables
- Correlation X, u = **endogeneity**

Instrumental Variables

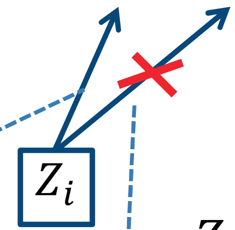
1. What is the problem that we need to solve?
2. What is it?
3. How does it work? (Estimation)
4. Do note… 4 important issues
5. Examples
6. The relevance condition: a closer look
7. 2 SLS & multiple regression: a natural extension
8. A final example

Solution: Instrumental variables estimation (IV)

- Find variable Z: correlated with X, but not with u
- Use <u>only</u> a part of X that's not correlated with u



$$Y_i = \beta_0 + \beta_1 X_i + u_i$$



Z = <u>Instrumental variable</u>

Assumptions:

1. <u>Relevance:</u> $Cov(Z_i, X_i) \neq 0$
   Z should correlate (strongly) with X
2. <u>Exogeneity:</u> $Cov(Z_i, u_i) = 0$

Levitt: Variable Z, correlated with X, but not with u

Instrumental variable: elections!

- Pre election year: more policemen hired

$$Crime_{it} = \beta_0 + \beta_1 Police_{it} + u_{it}$$

$Pre\_election\_year_{it}$

- Relevance: $Pre\_election\_year$ has effect on $Police$
- Exogeneity:

Intuitively: no effect $Pre\_election\_year - Crime$, except via $Police$

- Use only the variation in $Police$, due to $Pre\_election\_year$

  = Exogeneous part of X (not correlated with u)

Instrumental Variables

1. What is the problem that we need to solve?
2. What is it?
3. How does it work? (Estimation)
4. Do note… 4 important issues
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8. A final example

Estimation: Two Stage Least Squares (2SLS)

1. Regress X on Z: $X_i = \pi_0 + \pi_1 Z_i + \eta_i$ N.B. η = "eta"
   - Gives $\hat{X}$ = part of X, not correlated with u (Assumption: exogeneity $Cov(Z_i, u_i) = 0$)
   - $Police_{it} = \pi_0 + \pi_1 Pre\_election\_year_{it} + \eta_{it}$

2. Regress Y on $\hat{X}$: $Y_i = \beta_0 + \beta_1 \hat{X}_i + u_i$
   - $Crime_{it} = \beta_0 + \beta_1 \widehat{Police}_{it} + u_{it}$
   - Z itself not allowed in 2nd stage regression! ("Exclusion restriction")

     → Only allowed to affect Y through X

     → No other (direct) effect allowed!
   - β_1 = unbiased & consistent estimator of effect X on Y
     - Since $\hat{X}_i$ and u uncorrelated
     - N.B. Only when instrument relevant and sample size sufficient

Estimation: 2SLS

1. Regress X on Z: $X_i = \pi_0 + \pi_1 Z_i + \eta_i$
2. Regress Y on $\hat{X}$: $Y_i = \beta_0 + \beta_1 \hat{X}_i + u_i$

$$\hat{\beta}_1^{2SLS} = \frac{s_{\hat{X}Y}}{s_{\hat{X}}^2} \quad , \qquad \text{in which}$$

- $s_{\hat{X}Y} \quad = s_{(\hat{\pi}_0 + \hat{\pi}_1 Z),Y} \quad = \hat{\pi}_1 s_{ZY}$

- $s_{\hat{X}}^2 \quad = s_{\hat{\pi}_0 + \hat{\pi}_1 Z}^2 \quad = \hat{\pi}_1^2 s_Z^2$

- $\hat{\beta}_1^{2SLS} \quad = \dfrac{\hat{\pi}_1 s_{ZY}}{\hat{\pi}_1^2 \, s_Z^2} \quad = \dfrac{s_{ZY}}{\hat{\pi}_1 s_Z^2}$ ← $\hat{\pi}_1 = \dfrac{s_{ZX}}{s_Z^2}$

$$= \frac{s_{ZY}}{\frac{s_{ZX}}{s_Z^2} s_Z^2} \qquad = \frac{s_{ZY}}{s_{ZX}}$$

- I.e. 2SLS-estimator = sample covariance(Z, Y) : sample covariance(Z, X)

Sample Course Slides No. 6

The following slides are taken from the course:

Multinational Firms and Foreign Direct Investment in the World Economy

Subsection: (How) Does FDI Promote Growth?

The course instructor is:

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JG|U

(How) Does FDI Promote Growth?

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Multinational Firms and Foreign Direct Investment in the World Economy

Overview: Does FDI promote growth?

- Generally: early literature very optimistic, later findings more nuanced/sceptic
- So: it depends. We will investigate on what:
  - human capital (HK) in host economy
  - financial development in host economy
  - type of FDI (greenfield vs. M&A)
- Key insights:
  - FDI *can* promote growth
  - effect through productivity/technology overall seems more important than through capital accumulation
  - role of host economy's absorptive capacity matters
  - greenfield FDI more beneficial than M&A

A conceptual note

Let output Y be produced by the production function:

$$Y = AH^{\alpha}K^{1-\alpha} \quad (1)$$

- So, FDI might influence output growth through:
  1. improvements in productivity $A \uparrow$
  2. capital accumulation $K \uparrow$
  3. HK accumulation $H \uparrow$

also possible: scale economies (neglected here, but potentially relevant)

- We will especially focus on the first channel
  - second channel seems to be less relevant; positive effect of free capital flows seem limited in general (unless country is far away from steady state)
  - some evidence for third channel (next lecture; see also Wacker, Cooray, and Gaddis, forthcoming, for female workers)

Note: not straightforward to seperate those channels

Human capital, FDI, and growth: overview
(Borensztein et al., 1998 JIE)

- based on endogenous growth model (e.g. Romer, 1990 JPE)
- MNCs as a key channel for technology transmission to developing countries
- but applicability depends on local 'absorptive capacity'
- empirical paper with theoretical motivation
- also investigates relative role of A compared to K, stressing the role of the former

Human capital, FDI, and growth: theoretical motivation

(Borensztein et al., 1998 JIE)

- single consumption good produced with $Y = AH^{\alpha}K^{1-\alpha}$
- technological progress (as a key growth driver) is result of 'capital deepening' (new varieties of capital goods)
- domestic capital stock is given by:

$$K = \left\{ \int_0^N x(j)^{1-\alpha} \, \mathrm{d}\, j \right\}^{\frac{1}{(1-\alpha)}} \qquad (2)$$

  - domestic firms produce n varieties,
  - foreign firms n^* out of total N varieties

  → $N = n + n^*$
  - N^* as the 'global technology frontier'

Human capital, FDI, and growth: capital setup

(Borensztein et al., 1998 JIE)

- setup costs F before a new type of capital can be produced, depending on:
  - difference to the frontier: N/N^* ('catch up')
  - technology transmission through MNCs: n^*/n (= 'FDI')

$$F = F(n^*/N, N/N^*), \text{ where:}$$

$$\frac{\partial F}{\partial(n^*/N)} < 0 \quad (3)$$

$$\frac{\partial F}{\partial(N/N^*)} > 0 \quad (4)$$

Human capital, FDI, and growth: equilibrium growth

(Borensztein et al., 1998 JIE)

- in equilibrium, the growth rate g of the economy is given by:

$$g = \frac{1}{\sigma}\left[A^{1/\alpha}\phi F(n^*/N, N/N^*)^{-1}H - \rho\right], \text{ where:} \qquad (5)$$

  - $(1/\sigma)$ ... intertemporal elasticity of substitution
  - ρ ... time preference rate
  - $\phi = \alpha(1-\alpha)^{(2-\alpha)/\alpha}$
- and, in view of equations (3) and (4):
  - positive effect of FDI n^*/n on growth g
  - convergence through technological 'catch up' N/N^*
  - both accelerated at higher H
- estimated in the reduced form equation:

$$g = c_0 + c_1 FDI + c_2 FDI \times H + c_3 H + c_4 Y_0 + c_5 A \qquad (6)$$

Human capital, FDI, and growth: economic interpretation
(Borensztein et al., 1998 JIE)

- the effect of FDI on growth is derived by the partial derivative of equation (6) w.r.t. FDI:

$$\frac{\partial g}{\partial FDI} = c_1 + c_2 H \quad (7)$$

- so the effect depends on the level of HK
- What parameters would we expect?
  - $c_1 > 0, \; c_2 > 0$ if FDI promotes growth throughout and the effect is reinforced by HK
  - $c_1 < 0, \; c_2 > 0$ if FDI requires a certain 'threshold level' to have positive effects on growth
- So let's look at the data

Human capital, FDI, and growth: data
(Borensztein et al., 1998 JIE)

- FDI: gross flow data (OECD) from industrialized to devleloping (to reflect 'technological gap')
- HK: initial-year average years of male secondary schooling (Barro and Lee, 1993)
- National accounts (PWT 5.5) and other explanatory variables (Barro and Lee, 1994)
- data for two 'decade spells': 1970-1979, 1980-1989
- estimated using SUR (with different intercepts for each decade)

Human capital, FDI, and growth: key results

(Borensztein et al., 1998 JIE), dependent variable: growth

Independent variable	1.1 Coefficient (standard error)	1.2	1.3
Log (initial GDP)	−0.0124	−0.0126	−0.0122
	(0.0040)	(0.0043)	(0.0039)
Schooling	0.0162	0.0142	0.0128
	(0.0044)	(0.0043)	(0.0045)
Government consumption	−0.0969	−0.0870	−0.0811
	(0.0339)	(0.0330)	(0.0333)
Log (1+black market premium)	−0.0183	−0.0180	−0.0185
	(0.0055)	(0.0054)	(0.0054)
FDI	0.6590		−0.8489
	(0.4689)		(0.7203)
FDI*schooling		1.0659	1.6231
		(0.3850)	(0.6086)
R^2-adjusted, individual	0.28(69)	0.32(69)	0.33(69)
periods (No. of obs.)	0.08(69)	0.10(69)	0.08(69)
Education threshold			0.52
(No. countries>threshold)			(46)

Human capital, FDI, and growth: transmission channels

(Borensztein et al., 1998 JIE)

- positive effect of FDI on growth, depending on level of HK
- but how does this effect opperate?
  - K: Does have FDI an (equilibrium) effect on total invesment? That is, does it substitute/crowd out or complement/crowd in domestic investment?
  - A: Does FDI have a higher TFP effect than domestic investment?
- to investigate the channel, Borensztein et al. (1998) look at the effect of FDI on total investment and on 'productivity' (growth conditional on K)
- does the effect, respectively, depend on HK?

Human capital, FDI, and growth: investment results

(Borensztein et al., 1998 JIE), dependent variable: investment/GDP

Independent variable	2.1 Coefficient (standard error)	2.2	2.3	2.4	2.5	2.6
Log(initial GDP)	0.0346	0.0344	0.0356	0.0361	0.0324	0.0291
	(0.0102)	(0.0101)	(0.0105)	(0.0108)	(0.0115)	(0.0128)
Schooling	0.0197	0.0210	0.0045	0.0042	0.0007	0.0043
	(0.0109)	(0.0113)	(0.0105)	(0.0106)	(0.0106)	(0.0114)
Government	−0.1217	−0.1283	−0.1367	−0.1276	−0.1256	−0.1224
consumption	(0.0876)	(0.0887)	(0.0843)	(0.0869)	(0.0902)	(0.0905)
Log(1 + black	−0.0078	−0.0080	−0.0071	−0.0072	−0.0129	−0.0083
market premium)	(0.0118)	(0.0117)	(0.0105)	(0.0010)	(0.0116)	(0.01155)
FDI	2.2944	2.8230	1.5257	1.5477	1.2641	0.7833
	(0.9919)	(1.6257)	(0.9367)	(0.9456)	(0.9367)	(0.9442)
FDI*schooling		−0.5165	Region	R-dummies	R-dummies	R-dummies
		(1.2926)	Dummies	+ 3 controls	+ 5controls	+ 6 controls
R^2-adj, individual	0.23(69)	0.22(69)	0.26(69)	0.21(69)	0.17(64)	0.17(58)
periods (No. of obs.)	0.44(69)	0.43(69)	0.55(69)	0.53(69)	0.51(67)	0.55(60)

Human capital, FDI, and growth: productivity results

(Borensztein et al., 1998 JIE), dependent variable: growth

Independent variable	3.1 Coefficient (standard error)	3.2	3.3	3.4
Investment rate	0.1403	0.1279	0.1415	0.1422
	(0.0320)	(0.0309)	(0.0307)	(0.0425)
Log (initial GDP)	−0.0167	−0.0169	−0.0165	−0.0165
	(0.0038)	(0.0037)	(0.0036)	(0.0037)
Schooling	0.0133	0.0124	0.0098	0.0100
	(0.0041)	(0.0040)	(0.0041)	(0.0087)
Government consumption	−0.0840	−0.0781	−0.0663	−0.0664
	(0.0306)	(0.0301)	(0.0299)	(0.0300)
Log(1 + black market premium)	−0.0169	−0.0160	−0.0165	−0.0166
	(0.0051)	(0.0050)	(0.0049)	(0.0050)
FDI	0.0605		−1.4607	−1.4639
	(0.4535)		(0.6728)	(0.6796)
FDI*schooling		0.7324	1.6473	1.6520
		(0.3658)	(0.5555)	(0.5818)
Investment rate* schooling				−0.0010
				(0.0411)
*R*2-adj, individual	0.41(69)	0.41(69)	0.44(69)	0.43(69)
periods (no. of obs.)	0.13(69)	0.17(69)	0.16(69)	0.15(69)
Education threshold			0.76	0.76
(No. countries > threshold)			(36)	(36)

Human capital, FDI, and growth: summary
(Borensztein et al., 1998 JIE)

- FDI itself might have a negative effect on growth ($c_1 < 0$)...
- ...if the host country does not posess a necessary threshold level of education/human capital ($c_2 > 0$).
- This threshold level is reached for most of the developing countries in the sample.
- FDI is different to domestic investment
- overall, no sign of FDI crowding out domestic investment (but cannot reject the latter!)
- suggests that technological aspect (A) is more important than capital accumulation (K)