DIW Berlin

Deutsches Institut
für Wirtschaftsforschung

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Consultancy to Develop and Implement a
Macroeconomic Model for Lesotho (DIMMoL)

Macro-Econom(etr)ic Modelling

Part 5

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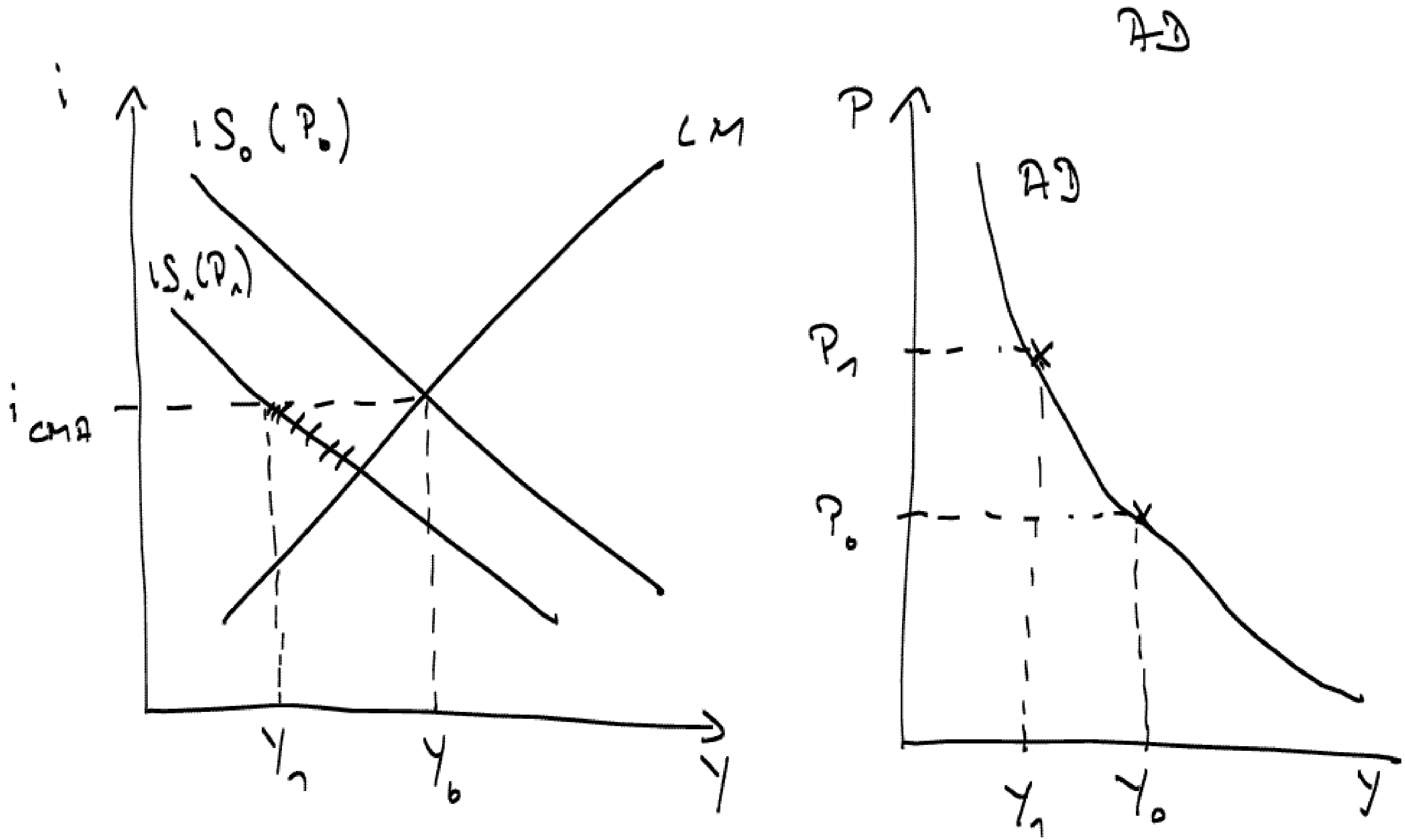
DIW Berlin – Macro Analysis and Forecasting

Course program

- Introduction
- Outline of macroeconom(etr)ic models
- **Macroeconomic framework (cont.)**
- Econometric methodology
- Applied econometrics with EViews
- Lesotho case studies

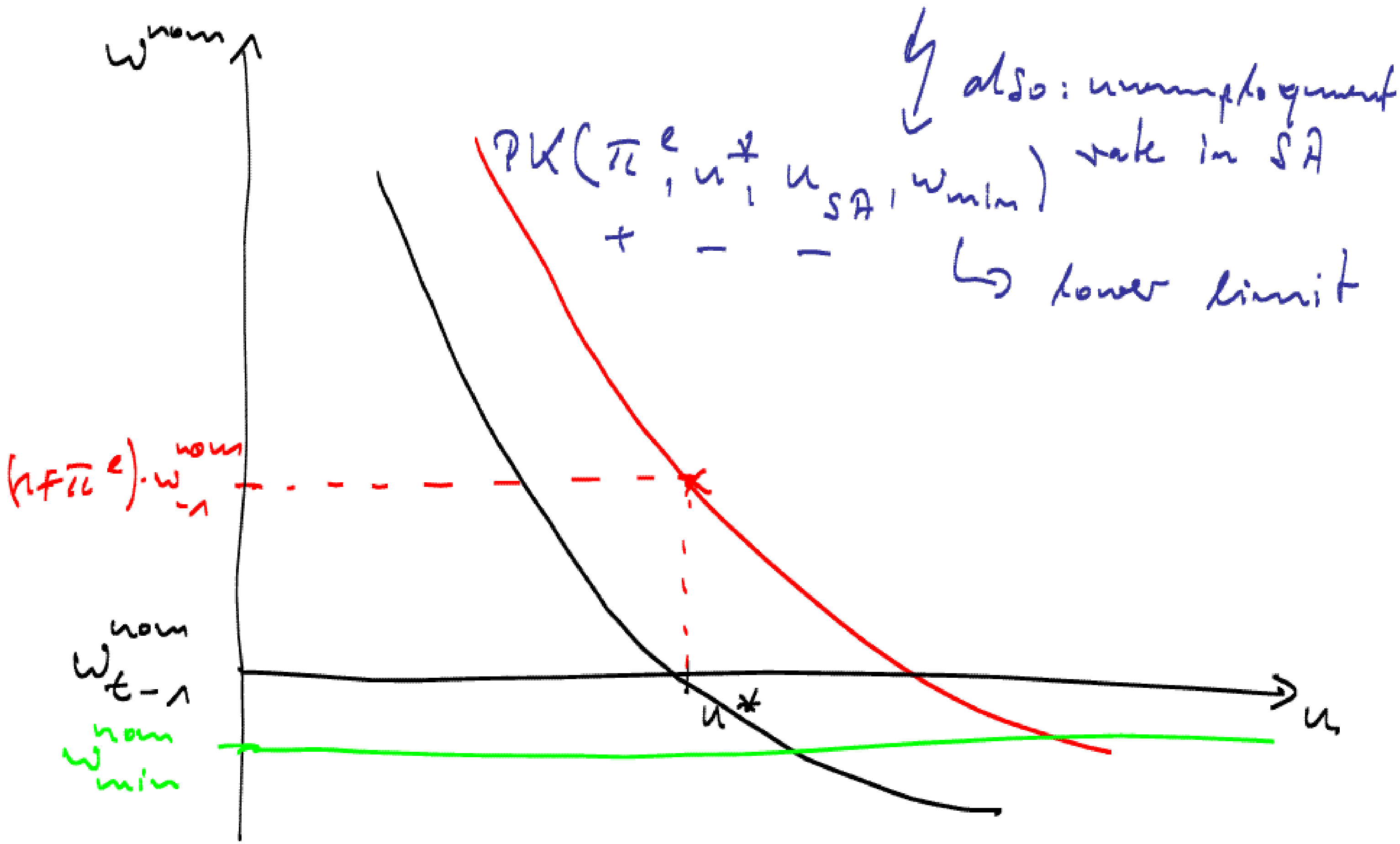
AD-curve: Construction



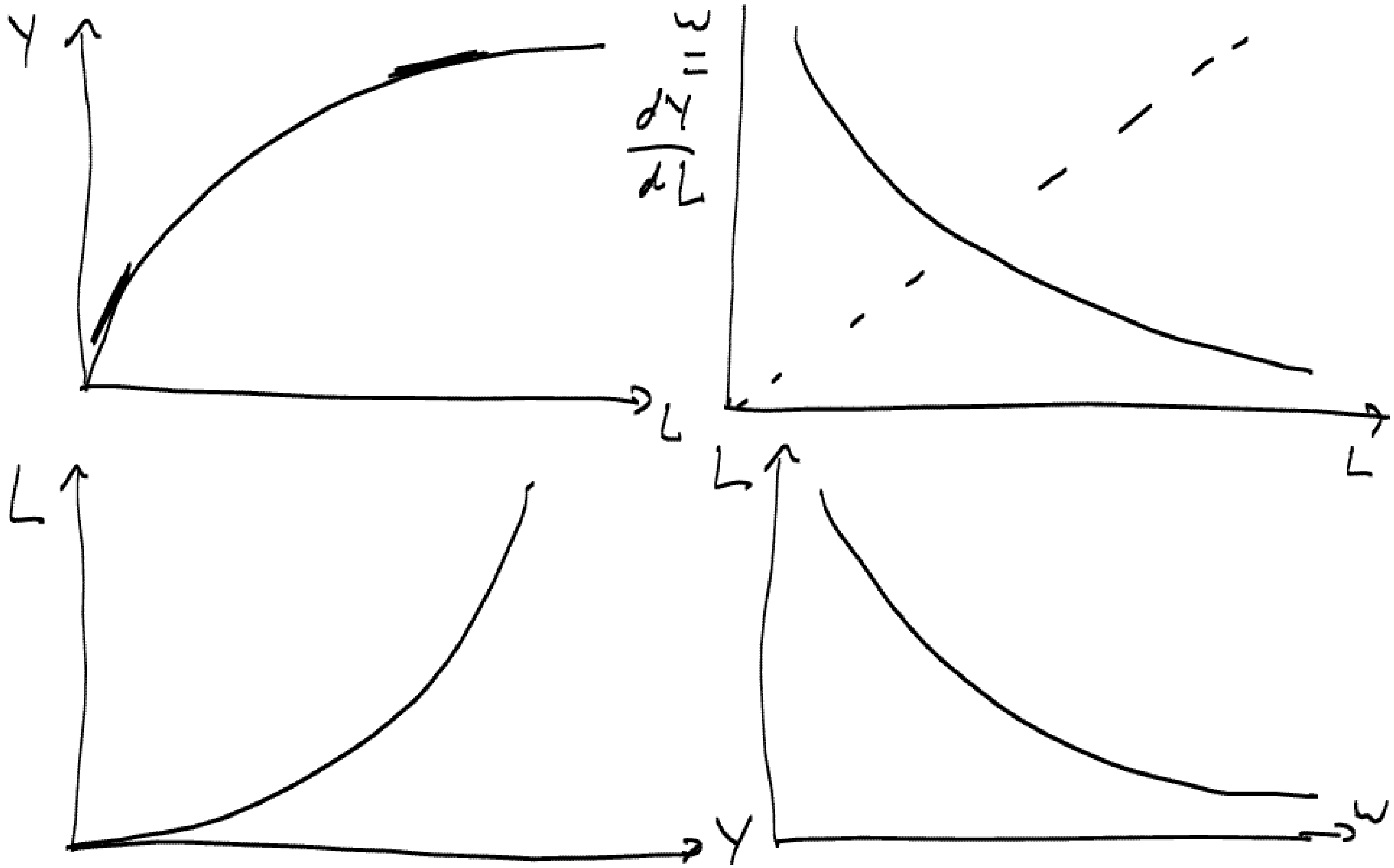
AS-curve: Components

- Production function
  - short-/medium-run: labor as only variable input factor
- Quantity supplied (neocl.) | Price setting (keynes.)
  - real wage rate | unit labor cost
  - marginal productivity | rate of capacity utilization
  - profit maximazition | mark-up pricing
- Labor market model (wage setting equation)
  - rate of unemployment
  - inflation expectations

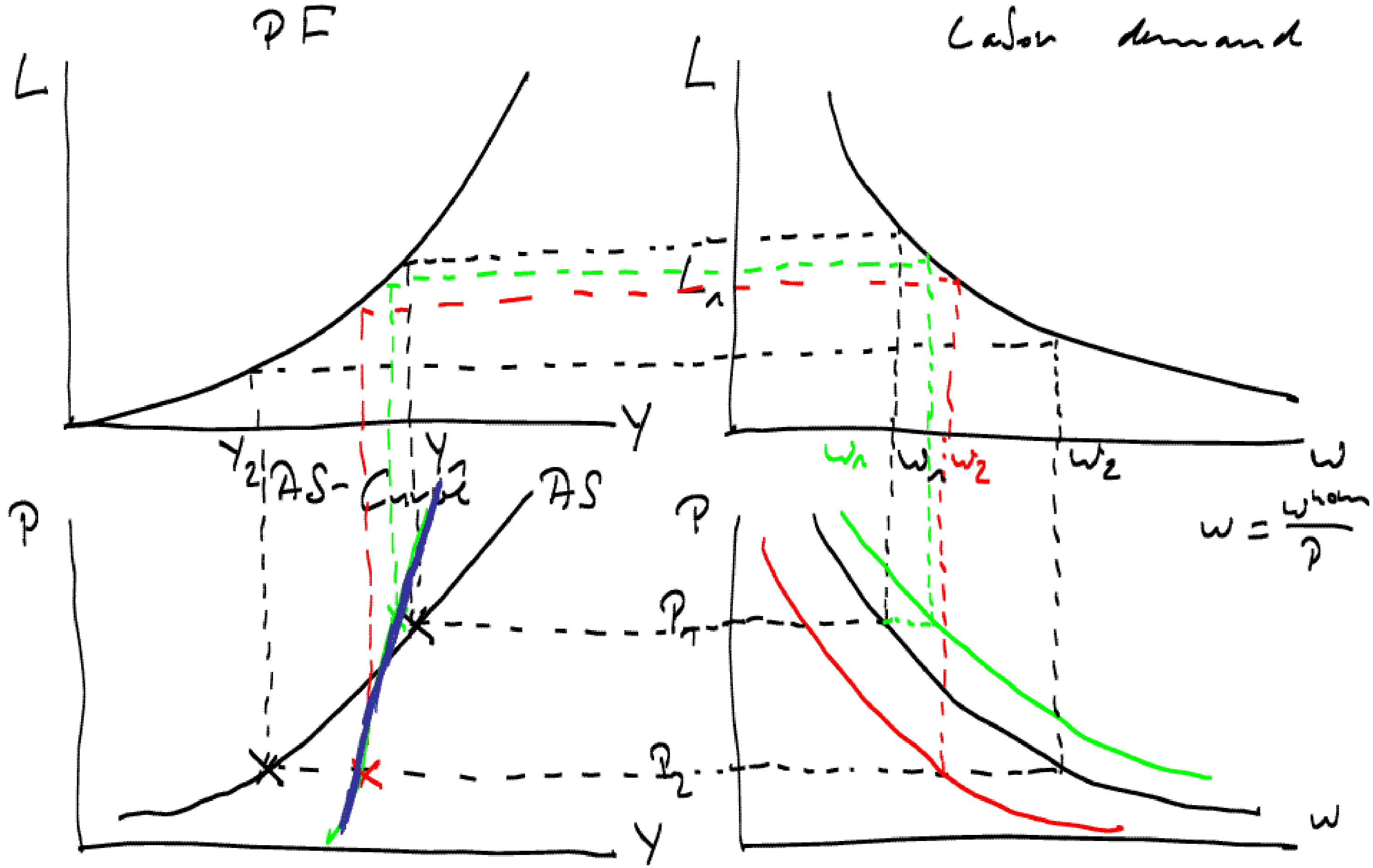
Wage setting:
Expectation-augmented Phillips curve (in levels)



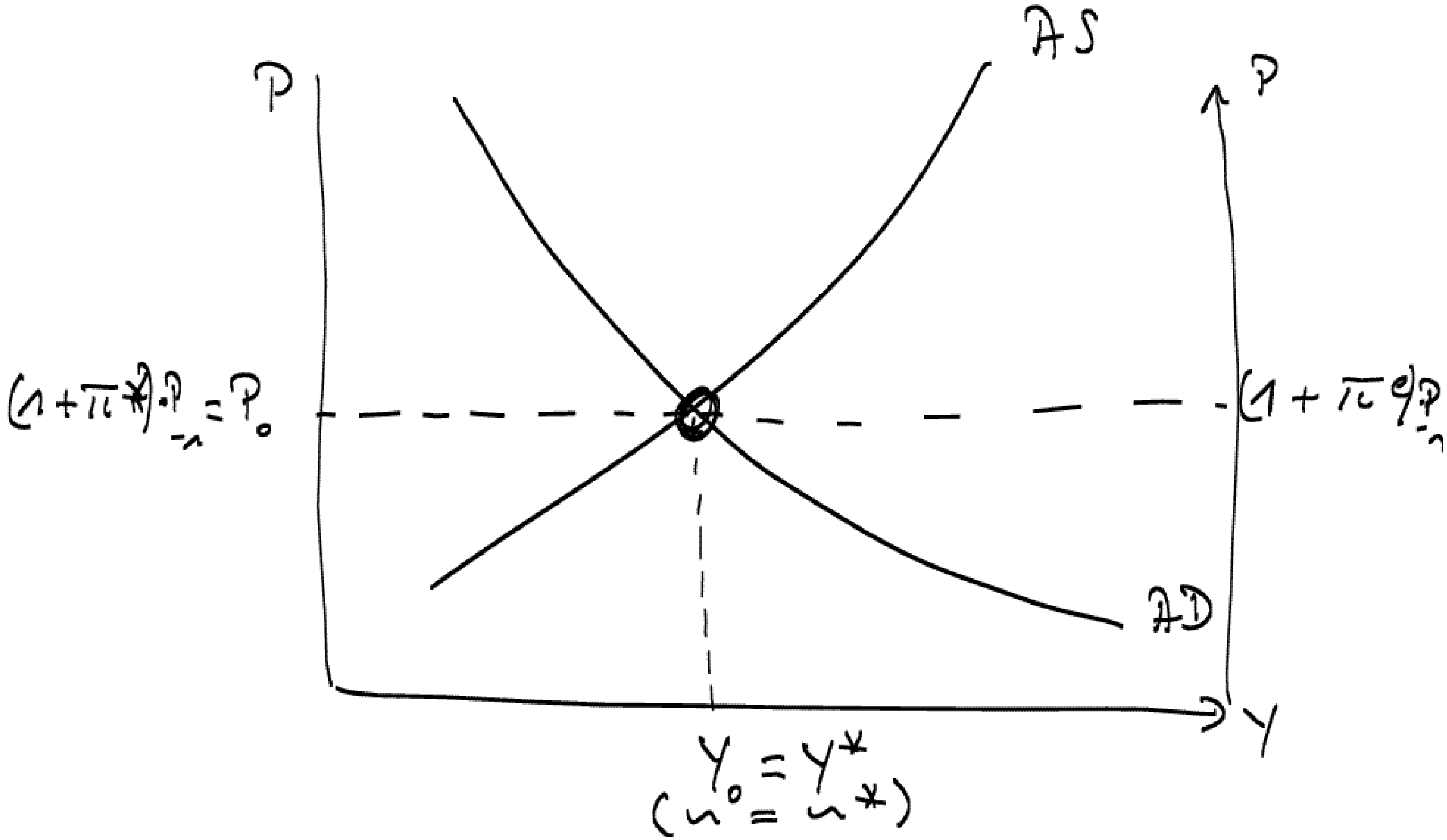
Production function and labor demand



AS-Curve: Construction



AD-AS



Inflation and real exchange rate: Condition for constant demand

PPP

$$e = \frac{e^{nom} \cdot P^{*}}{P} \overset{!}{=} const = a$$

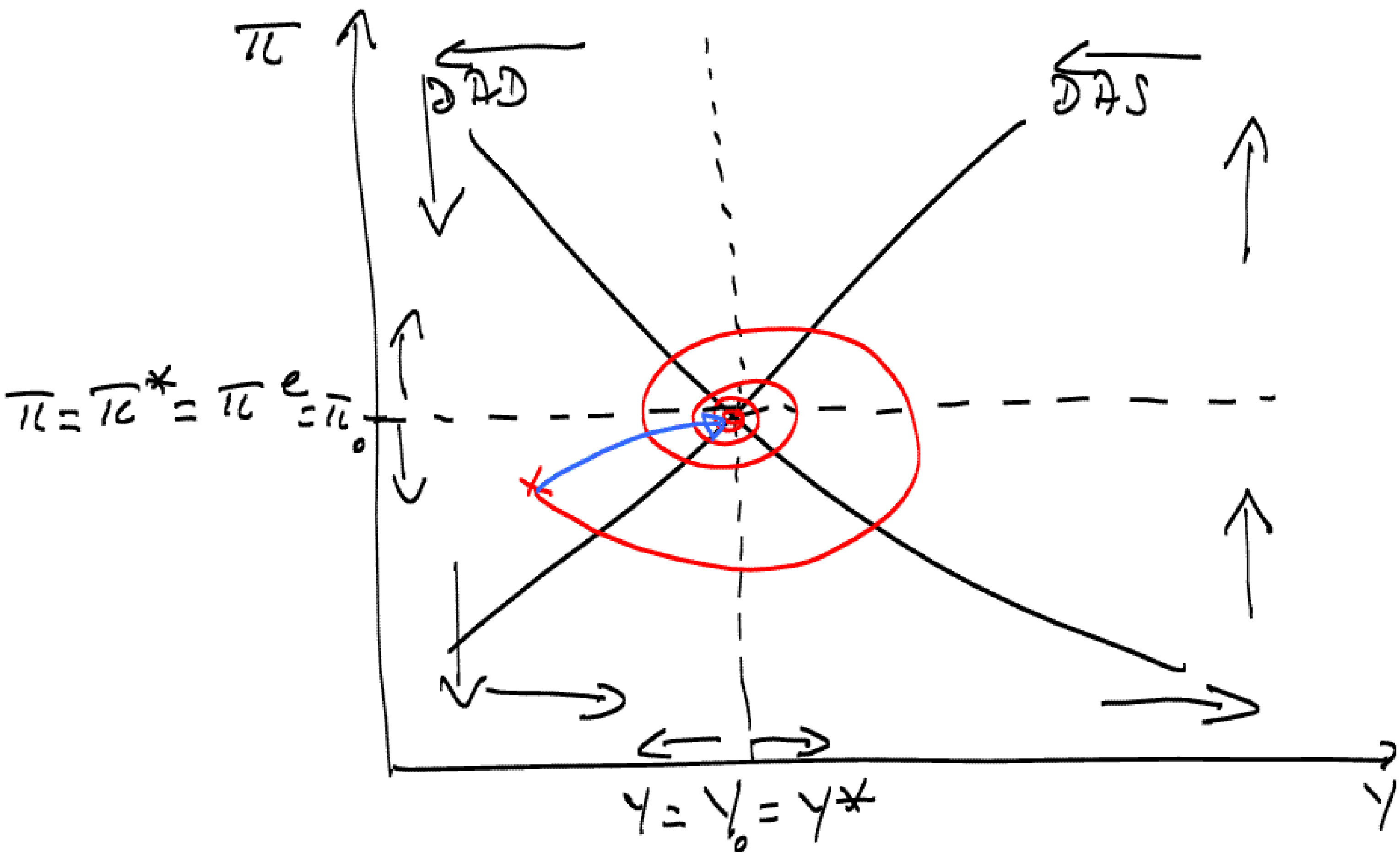
$$\Leftrightarrow \quad P = e^{nom} \cdot P^{*} \cdot a$$

$$\hat{e} = \underbrace{\boxed{\hat{e}^{nom}}}^{=0} + \underbrace{\boxed{\pi^{*}}}^{= const} - \pi \overset{!}{=} 0$$

$$\Leftrightarrow \quad \boxed{\pi = \pi^{*}}$$

$$\boxed{P = (1 + \pi^{*}) \cdot P_{-1}}$$

DAD-DAS: Equilibrium and adjustment drivers



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- **Econometric methodology**
- Applied econometrics with EViews
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Econometric methodology: Overview

- Fundamentals of probability
- Fundamentals of mathematical statistics
- Principles of regression analysis
- Time series regression models

Fundamentals of probability

- Random variables
- Information about probability of possible outcomes
  - Probability density function
  - Cumulative distribution function
- Moments of the probability distribution
  - Measure of central tendency: Expected Value (Mean)
  - Measures of variability: Variance and Standard Deviation
- Measures of association (≠ causation):
  - Covariance
  - Correlation

  linear relationships only

Important probability distributions

- Normal: X ~ Normal(mean, variance)
- Standard Normal: X ~ Normal(0, 1)
- Chi-Square: $X \sim \chi$ (df)
- t: X ~ t(df)
- F: $X \sim F(df_1,df_2)$

tabulated

Populations, parameters and sampling

Statistical inference =
learning something about a well-defined group by means of representatives of this group

- well-defined group = population (unknown)
- something = parameters
- representatives = sample (observed)
- learning = estimation and hypothesis testing

Estimators and estimates

- **Estimator** of a parameter θ = rule, that assigns each possible outcome of the sample a value of θ (which is then the concrete sample specific **estimate**)
- Sampling variance of estimators
- Finite sample properties
  - Unbiasedness
  - Efficiency
- Asymptotic (= large sample) properties
  - Consistency, Law of Large Numbers (LLN)
  - ⇨ arbitrarily exact population mean by sufficiently large sample
  - Asymptotic normality, Central Limit Theorem (CLT)
  - ⇨ mean from a random sample of any population has an asymptotic standard normal distribution

Using the sampling distribution of estimators

- Point estimate
  - ⇨ best crisp guess at the population value (ignoring the sampling distribution)
- Confidence intervals
  - ⇨ information about the estimate accuracy of the estimate
- Hypothesis testing
  - ⇨ answering concrete questions on a population value

Confidence intervals (CI)

- Construction
  - point estimate
  - sampling distribution of the point estimate
    - sampling standard deviation
    - functional form (large samples ⇨ CLT)
  - confidence level (usually 95 %)
- Interpretation
  „There is a 95 % chance that the CI contains θ (before the sample is drawn)."
- Rules of thumb (Standard Normal Distribution)
  - point estimate +/– 1 S.D. ⇨ 66 % confidence interval
  - point estimate +/– 2 S.D. ⇨ 95 % confidence interval

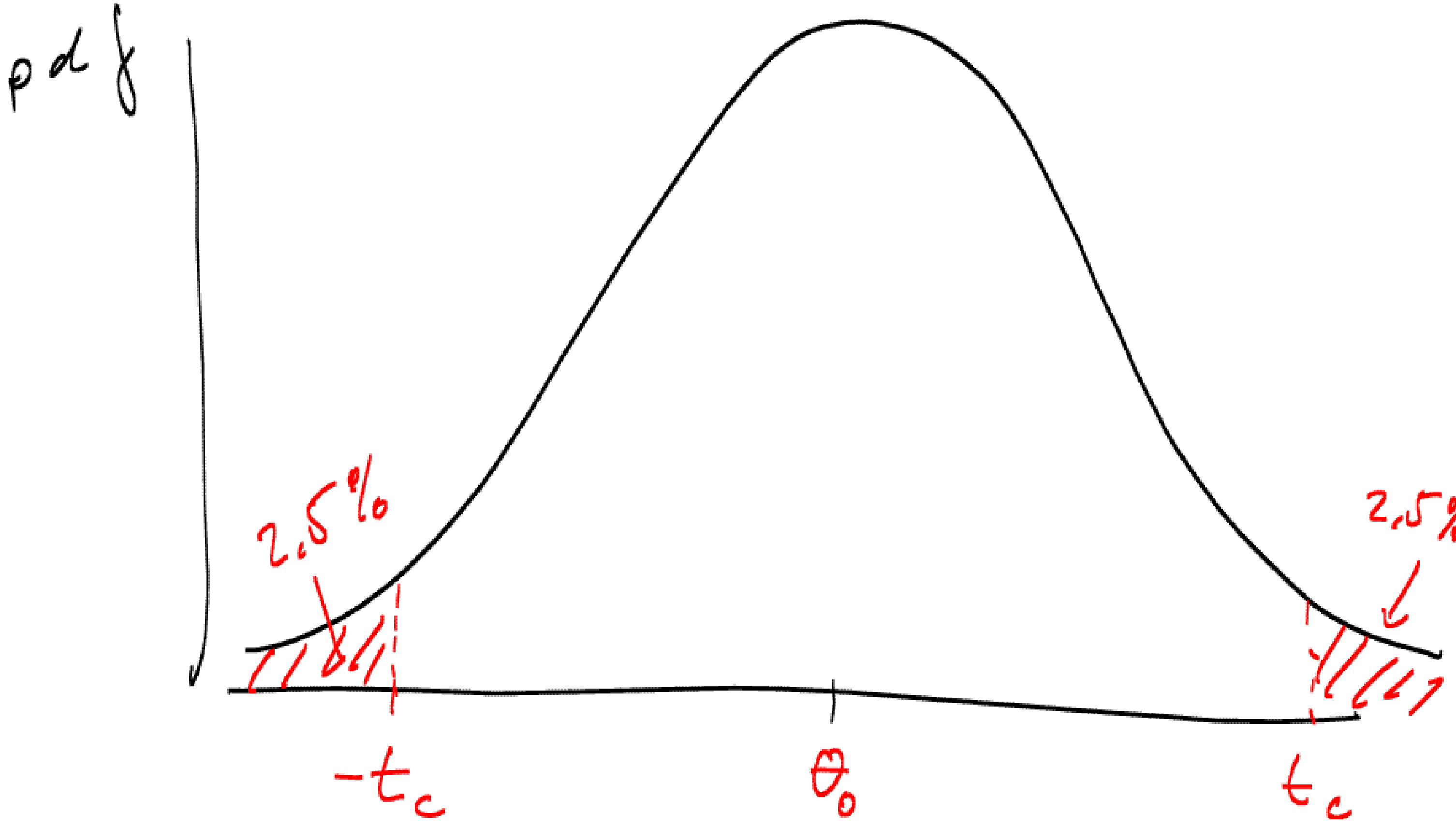
Hypothesis testing: Design

- Null hypothesis: H_0 (particular value of θ)
- Alternative hypothesis: H_1
  - two-sided (one-tailed test)
  - one-sided (two-tailed test)
- Errors types
  - Type 1 error (rejecting the null when it is in fact true)
  - Type 2 error (failing to reject the null when it is actually false)
- Significance level (α) = probability of a type 1 error
  - Given α the power of the test is maximized
  - very small significance levels immunize against H_1
- Interpretation: Rejection vs. non-rejection of H_0
- Strategy: Trying to reject H_0

Hypothesis testing: Test statistic

- Test statistic T (particular outcome denoted t)
  - function of the random sample
  - usually: how many standard deviations is the estimate for θ away from its assumed population mean (if H_0 holds true)
  - note: T might depend on H_0!
- Rejection rule (depending on H_1) that determines when H_0 is rejected in favor of H_1 ⇨ critical value of t
  - H1: $\theta > \theta_0$ ⇨ $t > t_c$
  - H1: $\theta < \theta_0$ ⇨ $t < -t_c$
  - H1: $\theta \neq \theta_0$ ⇨ $t > |t_c|$

Hypothesis testing: Graphical interpretation



Hypothesis testing: p-values (prob-values)

- *What is the largest significance level at which we could carry out the test without rejecting H_0?*
- *What is the probability to observe a value of T as large as t when H_0 is true?*

⇨ small p-values are evidence against H_0

⇨ high p-values are weak evidence against H_0

- Procedure
  - design H_0 and H_1 and choose a test statistic T (possible rejection rules: $t > c$, $t < -c$, or $|t| > c$)
  - use the observed value of t as the critical value and compute the corresponding significance level of the test
  - given a significance level α, reject H_0 if p-value $< \alpha$ (small p-values lead to rejection)

Inference: Final remarks

- Confidence intervals and hypothesis testing are two sides of the same coin
- Consistency
  - confidence intervals
  - hypothesis tests
- Practical versus statistical significance: Magnitudes matter!

Types of data structures

- Cross-sectional data
  - ⇨ random sampling
- Time series data
  - ⇨ chronological ordering of observations conveys potentially important information
  - ⇨ correlation across time (non-random sampling!)
- Pooled cross sections
  - ⇨ combining independent cross sections from different years
- Panel data
  - ⇨ pooling identical cross sections across time