MACROECONOMETRIC MODELS III

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Q & A

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1. Introduction: History, purpose and types of macro-econometric models

2. Single-equation econometrics – a reminder

3. Multi-equation econometrics: methods and problems

4. Structure of macro-econometric models

5. **Forecasting with macro-econometric models**

6. **Policy simulation with macro-econometric models**

7. **Practical problems: data collection, up-dating, staffing of project team**

SINGLE-EQUATION ESTIMATION- EXAMPLES

Summary

A SIMPLE EXAMPLE: NATIONAL ECONOMY

Definition Y: Gross Domestic Product	$Y(t) = C(t) + I(t) + G(t) + X(t) - M(t)$
Consumption function of private households C	$C(t) = \alpha 0 + \alpha 1 * Y(t-1)$
Private Investment function I	$I(t) = \lambda * (Y(t) - Y(t-1))$
Government spending G	G (t): exogenous
Exports X	X(t): exogenous
Imports M	$M(t) = \gamma 0 + y1 * Y(t)$

MODIFIED EXAMPLE: NATIONAL ECONOMY (1)

Definition Y: Gross Domestic Product	$Y(t) = C(t) + I(t) + G(t) + X(t) - M(t)$
Consumption function of private households C	$C(t) = \alpha 0 + \alpha 1 * Y(t-1) + \alpha 2 * Dummy + \alpha 3 * Trend$
Private Investment function I	$I(t) = \lambda 1 * r(t) * \lambda 2 * Trend + \lambda 3 * Dummy1 + \lambda 4 * Dummy2$
Imports M	$M(t) = \gamma 0 + y1 * Y(t)$

A MODIFIED EXAMPLE: NATIONAL ECONOMY (2)

Government spending G	$G\ (t): exogenous$
Exports X	$X(t): exogenous$
Interest rate of long term bonds (duration of 9 to 10 years)	$r(r): exogenous$

SUMMARY OF SINGLE EQUATION ESTIMATORS

Theoretical Model	$Y = \beta 1 + \beta 2 * X + u$
Statistical model: Fitted values	$\hat{Y} = b_1 + b_2 X$
OLS Estimator of b1 (Intercept)	$b_1 = \bar{Y} - b_2 \bar{X}$
OLS Estimator of b2 (slope)	$b_2 = \dfrac{\sum (X_i - \bar{X})(Y_i - \bar{Y})}{\sum (X_i - \bar{X})^2}$
Goodness of fit:	$R^2 = \dfrac{ESS}{TSS} = \dfrac{\sum (\hat{Y}_i - \bar{Y})^2}{\sum (Y_i - \bar{Y})^2}$

MODEL SOFTWARE: *gretl*

- **gretl: Gnu Regression, Econometrics and Time-series Library**

- Source in Internet for a free download
- http://gretl.sourceforge.net/
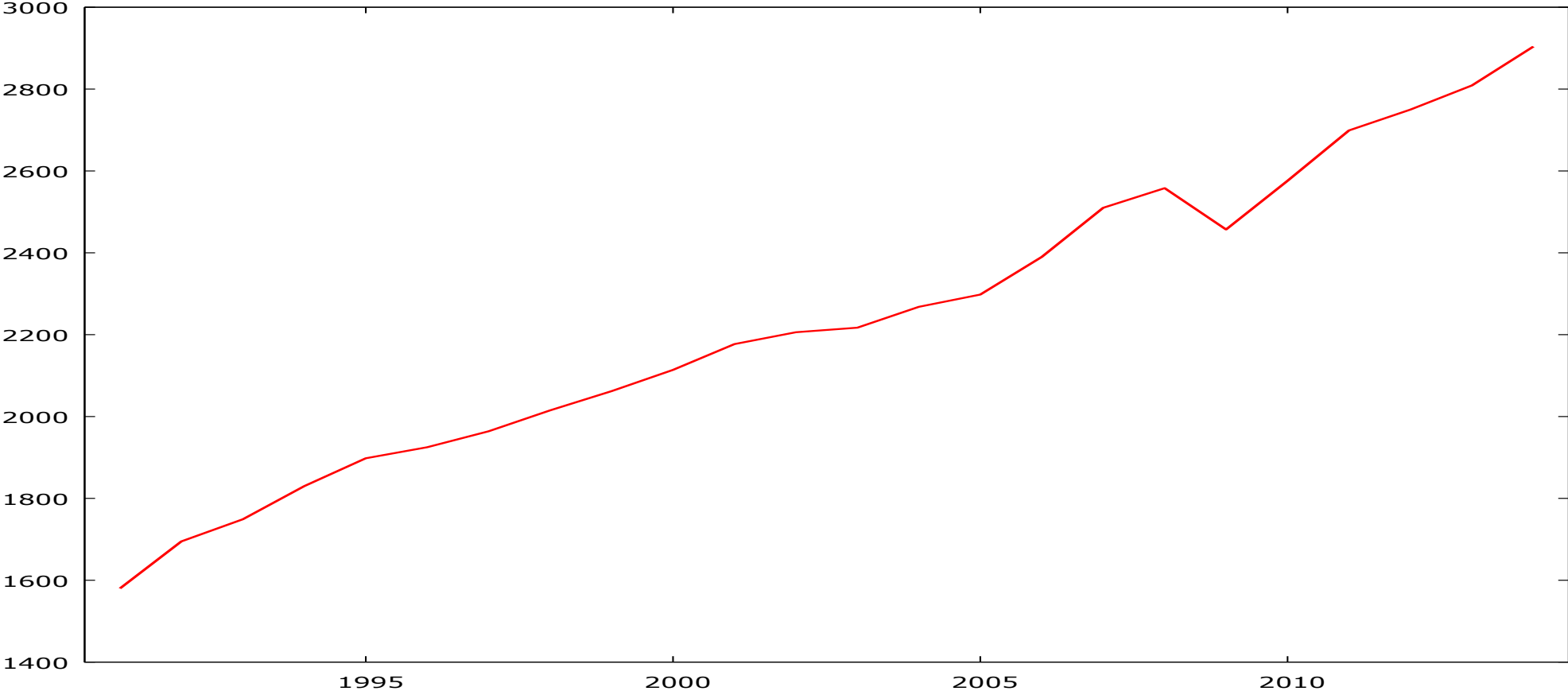
SINGLE EQUATION ESTIMATION SECOND EXERCISE

Please note: The dataset underlying the following exercises is in current euro (nominal terms) the Interpretation of the results must not be straightforward.
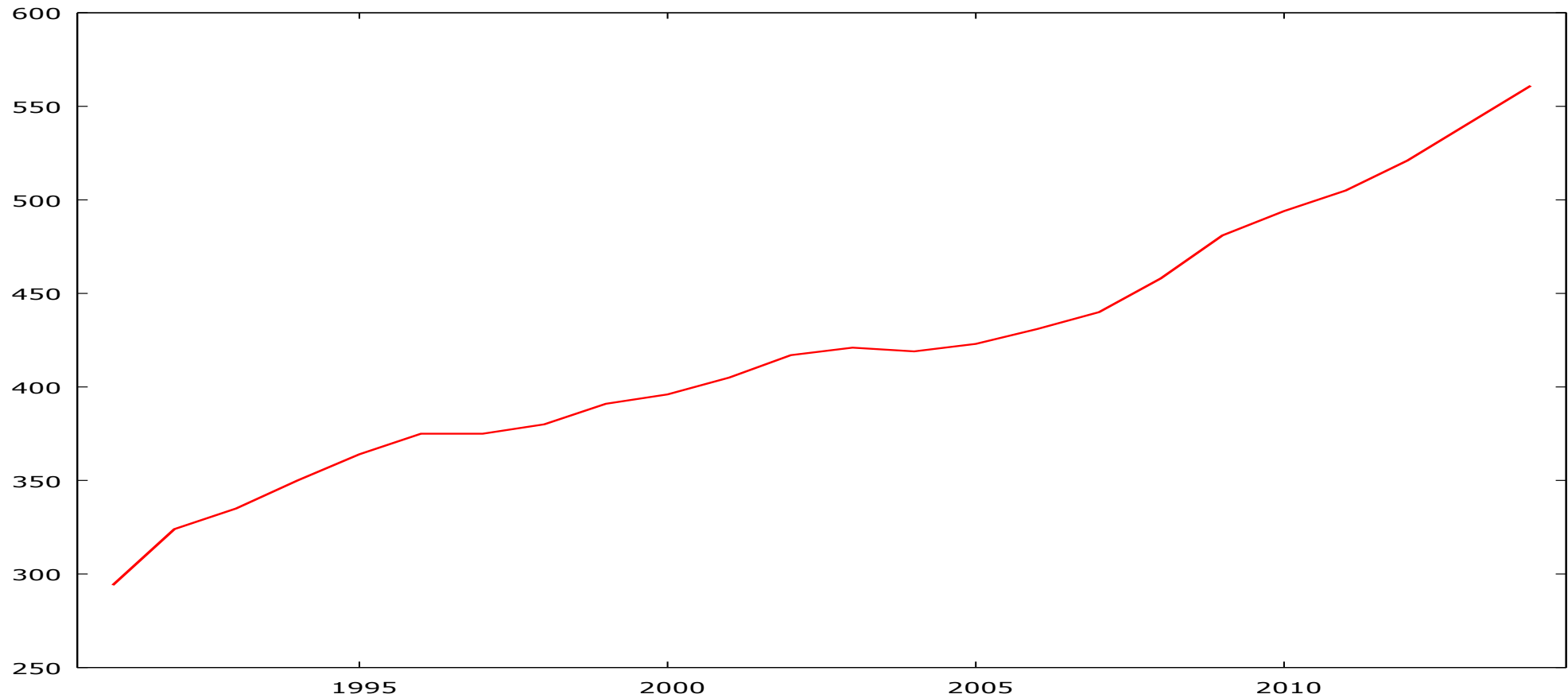
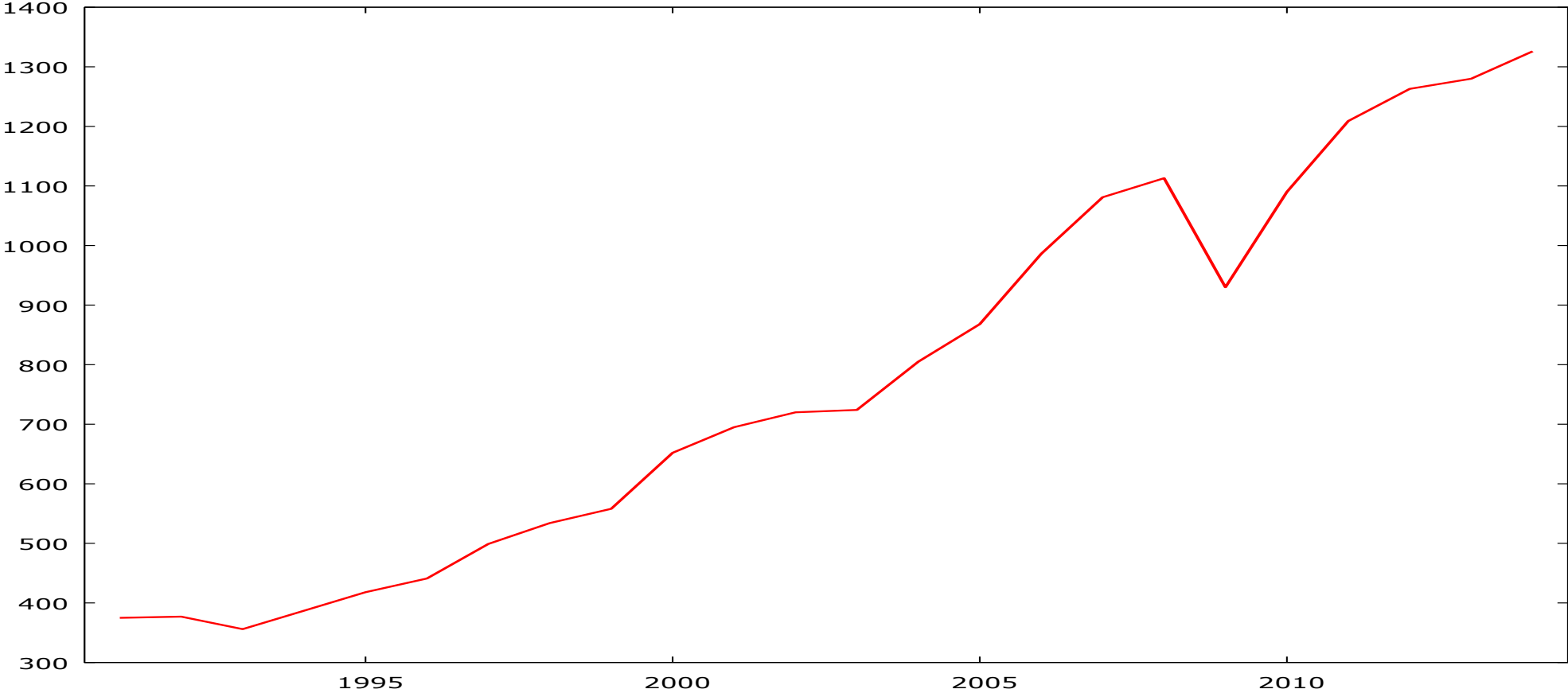The estimates are made for illustrative reasons only.

EXOGENOUS VARIABLES

Gross Domestic Product, Germany, Time Series, in current Euro

Government Consumption, Germany, Time Series, in current Euro
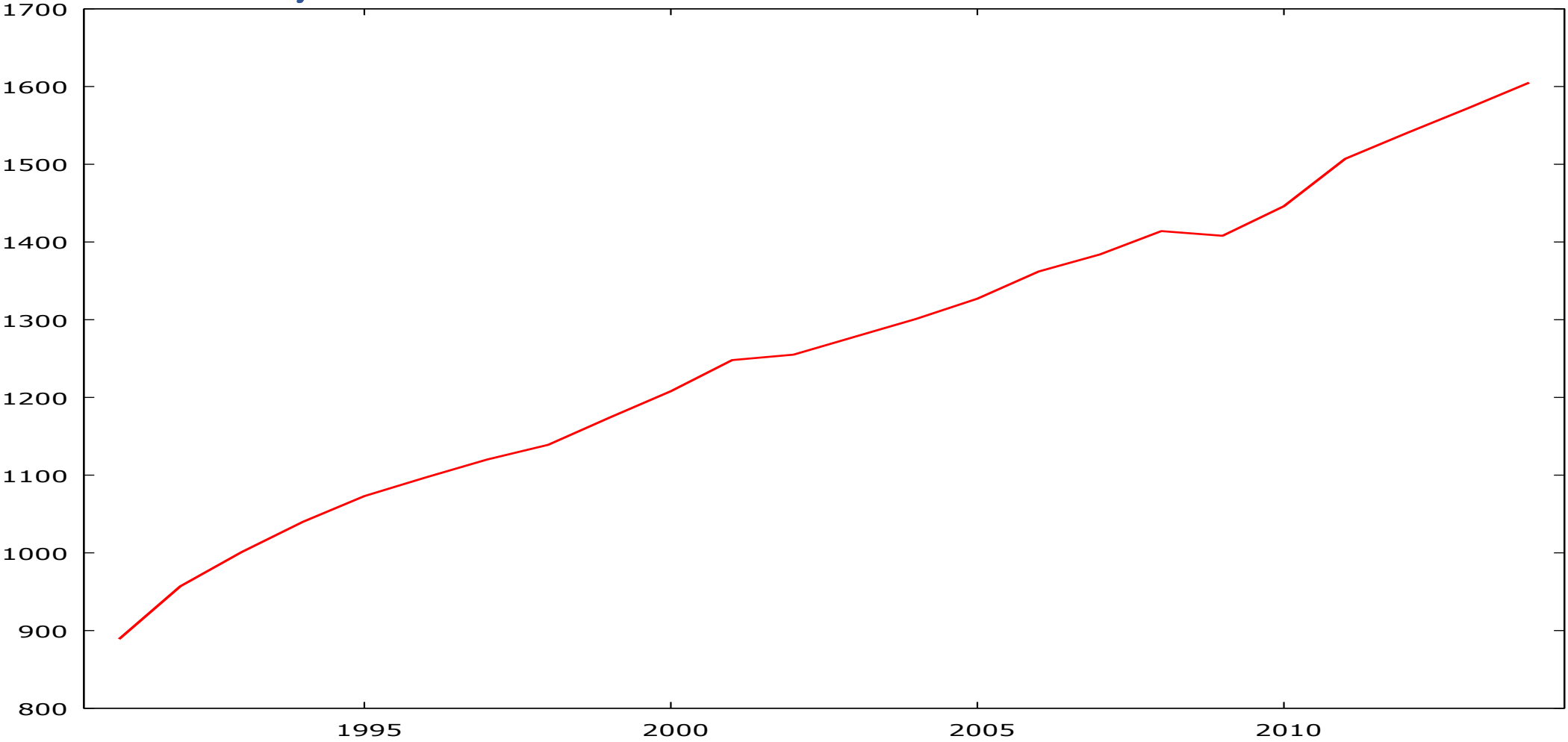
Exports, Germany, Time Series, in current Euro

Long term Interest Rates, Germany, Time Series

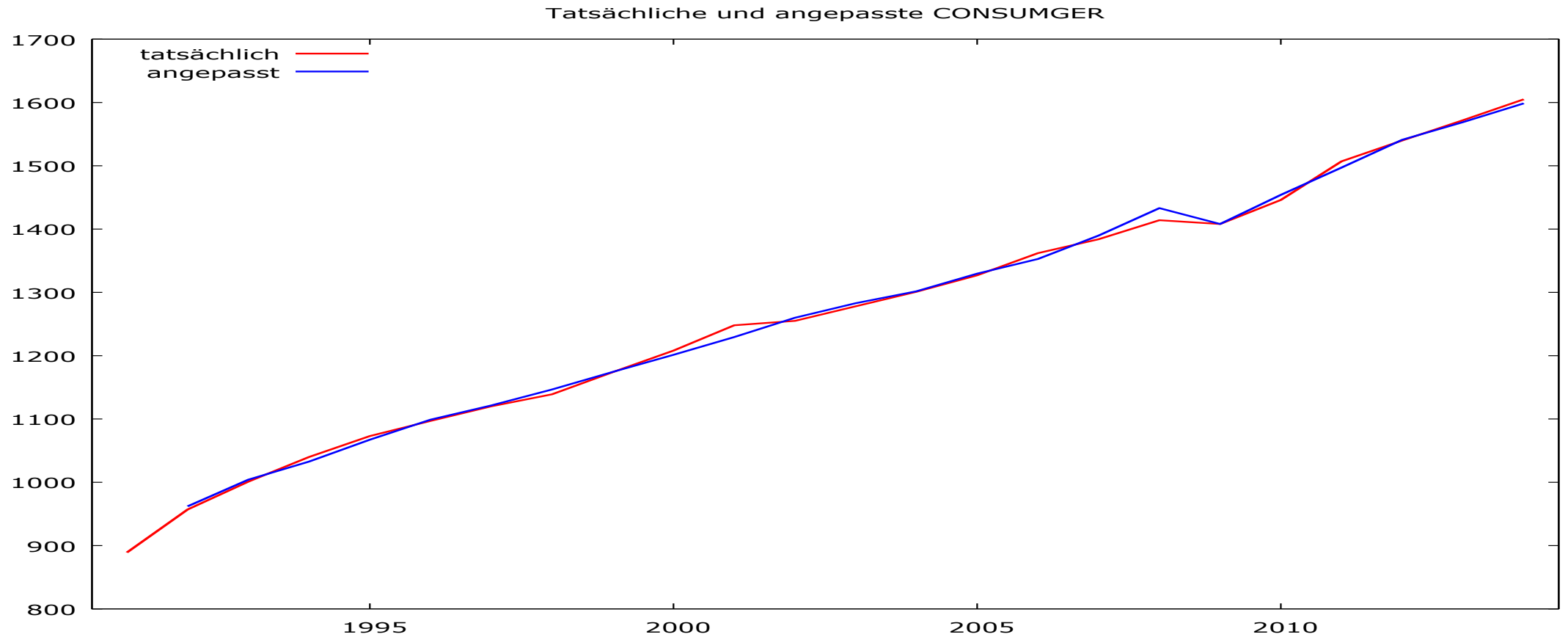# CONSUMPTION FUNCTION

Consumption, Germany,
Time Series, in current Euro

Consumption Function: Estimation

OLS, Sample 1992-2014 (T = 23)
Dependent Variable: CONSUMGER

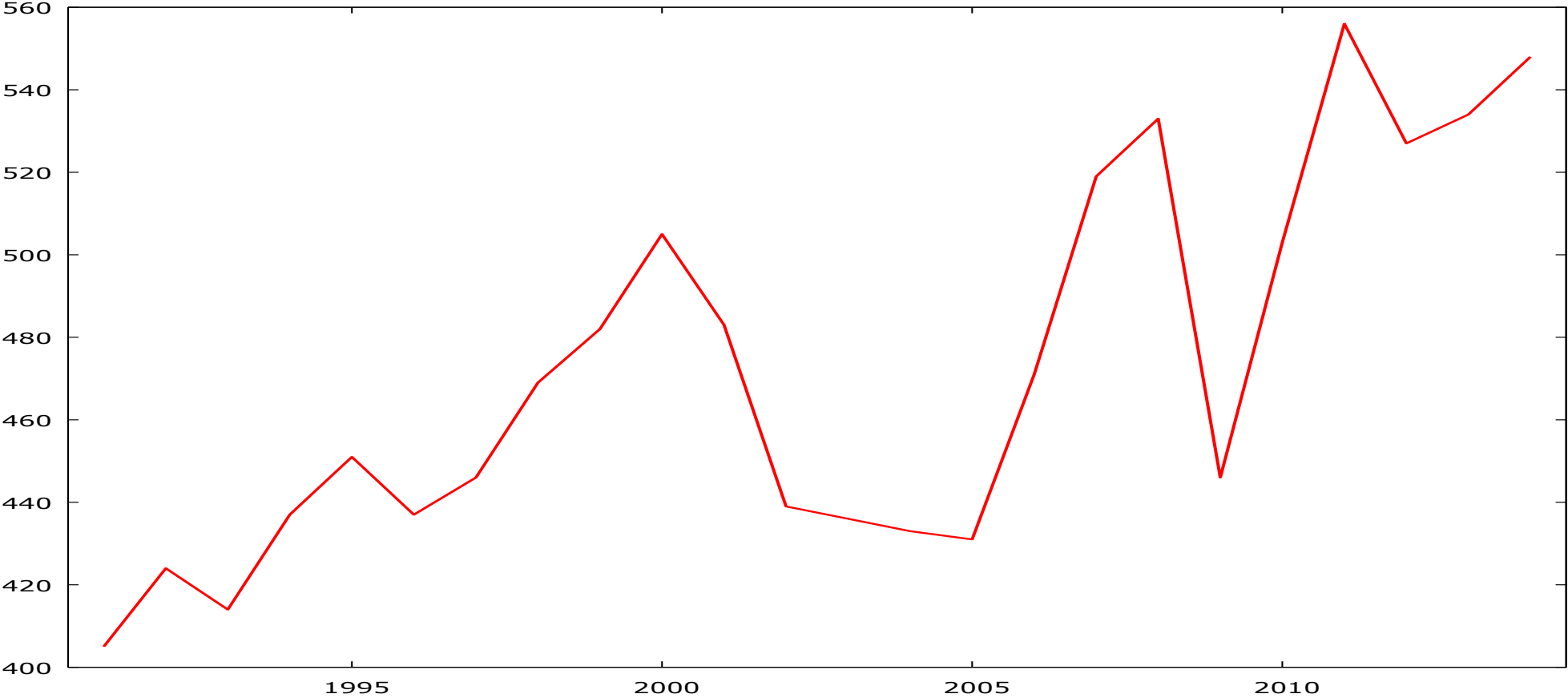|	*Koeffizient*	*Std. Fehler*	*t-Quotient*	*p-Wert*	
const	575,409	68,5377	8,3955	<0,0001	***
INCOMEGER_1	0,223883	0,0442791	5,0562	<0,0001	***
Dummy2	−52,2652	8,97933	−5,8206	<0,0001	***
time	16,4297	2,25986	7,2702	<0,0001	***

Mittel d. abh. Var.	1280,696	Stdabw. d. abh. Var.	187,2959
Summe d. quad. Res.	1326,081	Stdfehler d. Regress.	8,354265
R-Quadrat	0,998282	**Korrigiertes R-Quadrat**	0,998010
F(3, 19)	3679,550	P-Wert(F)	1,95e-26
Log-Likelihood	−79,26221	Akaike-Kriterium	166,5244
Schwarz-Kriterium	171,0664	Hannan-Quinn-Kriterium	167,6667
rho	0,044158	Durbin-Watson-Stat	1,864716

Goodness of fit: Consumption Function

Tatsächliche und angepasste CONSUMGER

INVESTMENT FUNCTION
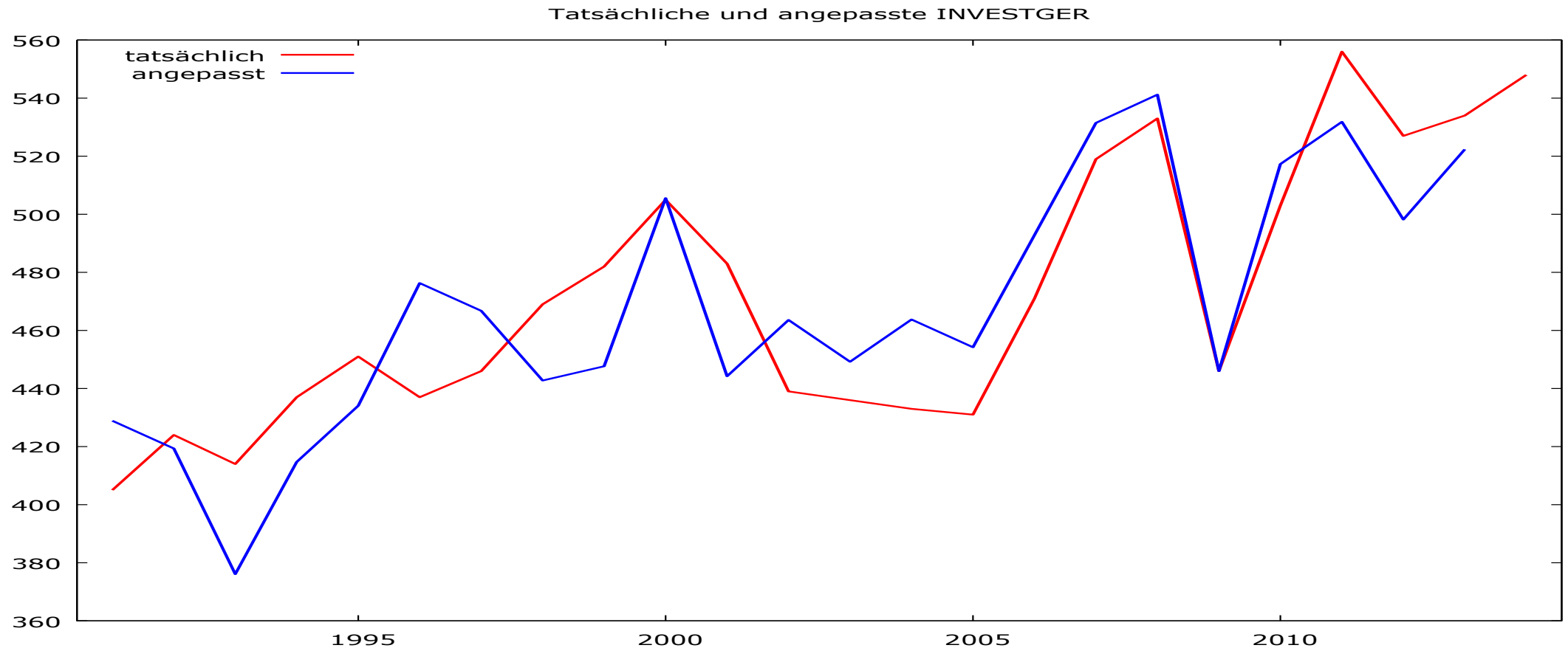
Investment, Germany, Time Series, in current Euro

Investment Function: Estimation

OLS, Sample 1991-2013 (T = 23)
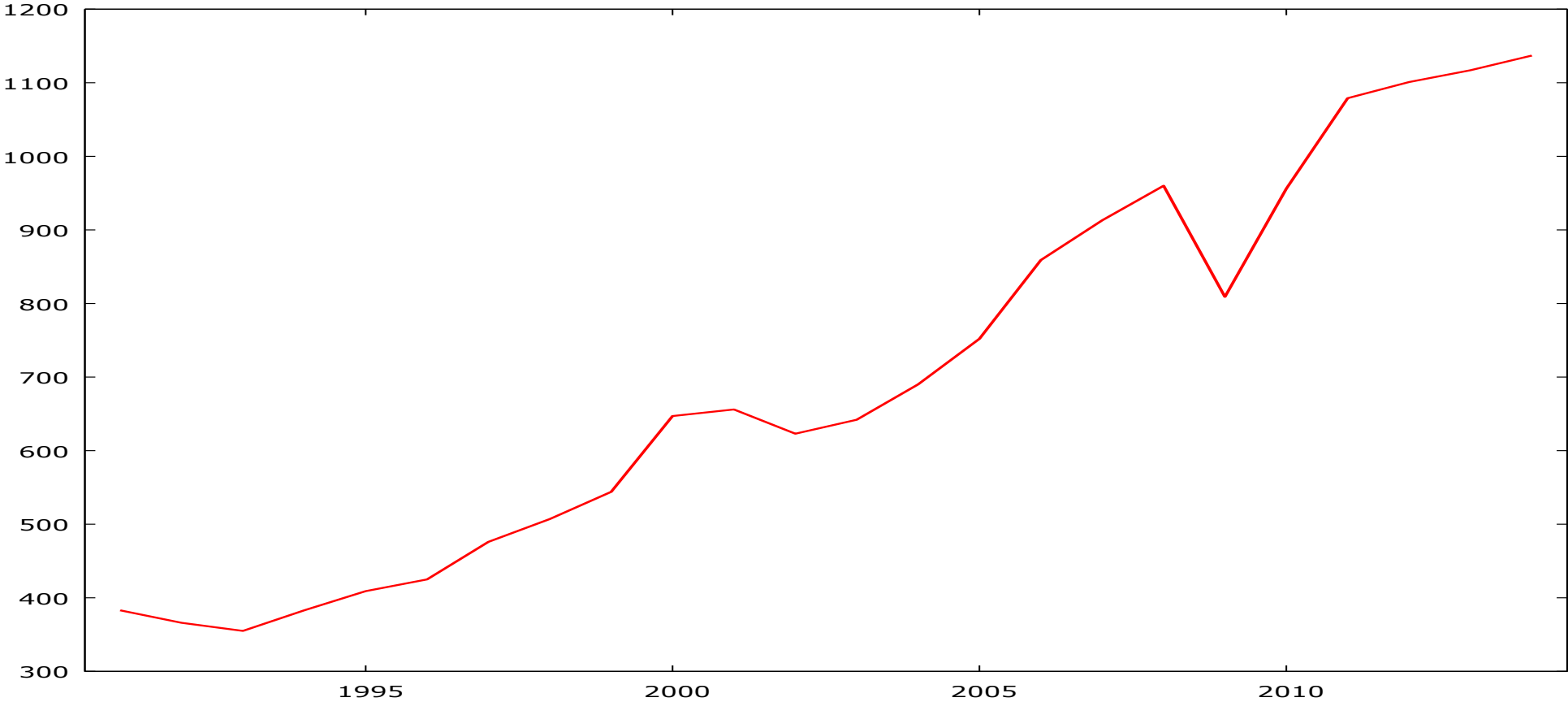Dependent Variable: INVESTGER

	Koeffizient	Std. Fehler	t-Quotient	p-Wert	
INTERESTLTGER	4818,11	156,085	30,8685	<0,0001	***
time	19,36	0,539764	35,8674	<0,0001	***
Dummydotcom	56,5971	13,4195	4,2175	0,0005	***
Dummy2	−76,0185	27,322	−2,7823	0,0119	**

Mittel d. abh. Var.	468,7391	Stdabw. d. abh. Var.	43,62987
Summe d. quad. Res.	12880,93	Stdfehler d. Regress.	26,03735
R-Quadrat	0,997472	**Korrigiertes R-Quadrat**	0,997073
F(4, 19)	1874,225	P-Wert(F)	2,22e-24
Log-Likelihood	−105,4077	Akaike-Kriterium	218,8154
Schwarz-Kriterium	223,3574	Hannan-Quinn-Kriterium	219,9577
rho	0,299354	Durbin-Watson-Stat	1,352735

Goodness of fit: Investment Function

Tatsächliche und angepasste INVESTGER

IMPORT FUNCTION
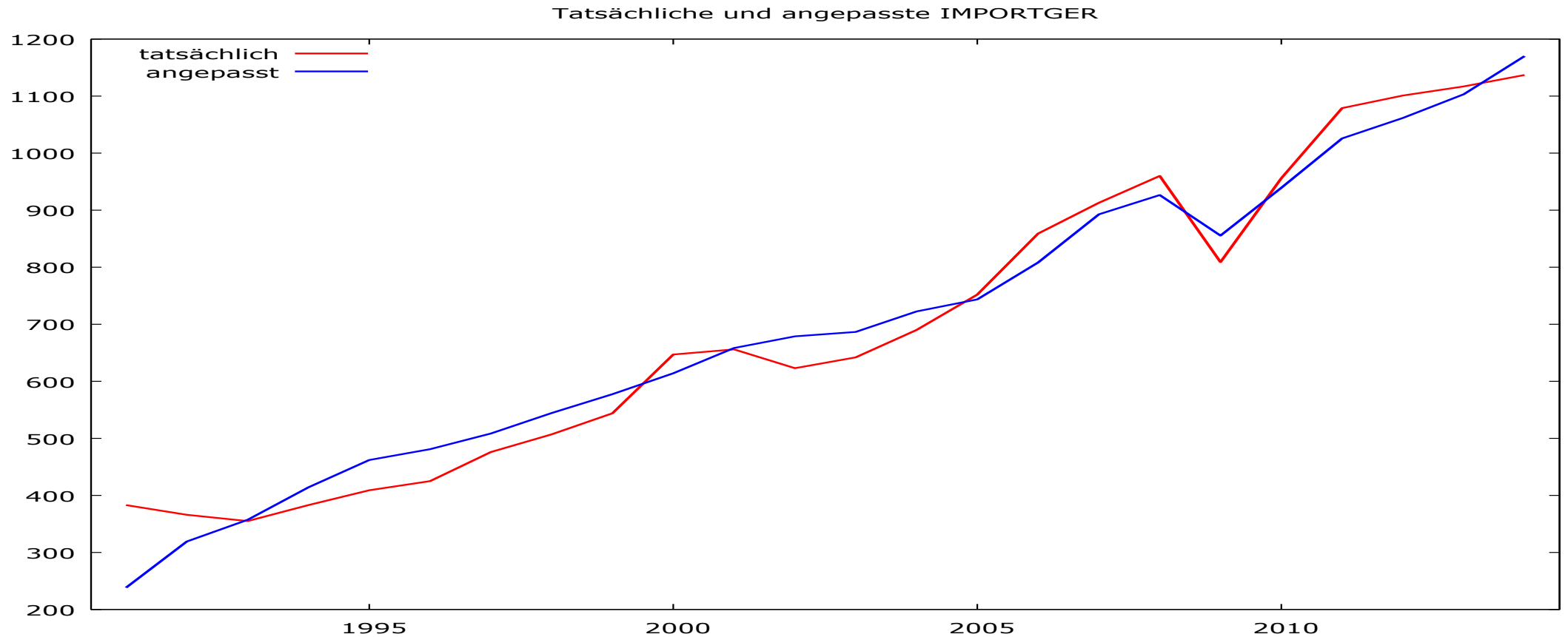
Import, Germany,
Time Series, in current Euro

Import Function: Estimation

OLS, Sample 1991-2014 (T = 24)
Dependent Variable: IMPORTGER

	Koeffizient	Std. Fehler	t-Quotient	p-Wert	
const	−873,812	62,8878	−13,8948	<0,0001	***
INCOMEGER	0,703817	0,0277715	25,3431	<0,0001	***

Mittel d. abh. Var.	699,5417	Stdabw. d. abh. Var.	264,1994
Summe d. quad. Res.	53169,92	Stdfehler d. Regress.	49,16111
R-Quadrat	0,966881	**Korrigiertes R-Quadrat**	0,965376
F(1, 22)	642,2751	P-Wert(F)	8,98e-18
Log-Likelihood	−126,4929	Akaike-Kriterium	256,9857
Schwarz-Kriterium	259,3418	Hannan-Quinn-Kriterium	257,6108
rho	0,405860	Durbin-Watson-Stat	0,790171

Goodness of fit: Import Function

Tatsächliche und angepasste IMPORTGER

MULTI-EQUATION ECONOMETRICS: METHODS AND PROBLEMS

MODEL ESTIMATION

- Application of *"gretl"* econometric software

- BEHAVIOURAL EQUATIONS
- **Consumption function**
- **Investment function**
- **Import function**

- EXOGENOUS VARIABLES
- **Government consumption**
- **Exports**
- **Long-term interest rates**
- **Dummy-variables**
- **Trend**

- DEFINITION
- Gross domestic product

Model Results I

Equation 1, SUR: Sample1991-2013 (T = 23)
Dependent Variable: **CONSUMGER**

	Koeffizient	Std.-fehler	t-Quotient	p-Wert
INCOMEGER	0,570425	0,00395091	144,4	1,15e-031 ***
Dummy2	23,6940	15,2590	1,553	0,1362
time	−0,877654	0,652575	−1,345	0,1937

Mittel d. abh. Var.	1249,565	Stdabw. d. abh. Var.	190,4203
Summe d. quad. Res.	5159,851	Stdfehler d. Regress.	14,97803

Model Results II

Equation 2: SUR, Sample 1991-2013 (T = 23)
Dependent Variable: **INVESTGER**

	Koeffizient	Std.-fehler	t-Quotient	p-Wert	
INTERESTLTGER	4801,39	141,314	33,98	1,77e-018	***
time	19,3950	0,490464	39,54	1,03e-019	***
Dummydotcom	57,6794	12,0123	4,802	0,0001	***
Dummy2	−76,1093	24,8308	−3,065	0,0064	***

Mittel d. abh. Var.	468,7391	Stdabw. d. abh. Var.	43,62987
Summe d. quad. Res.	12889,83	Stdfehler d. Regress.	23,67334

Model Results III
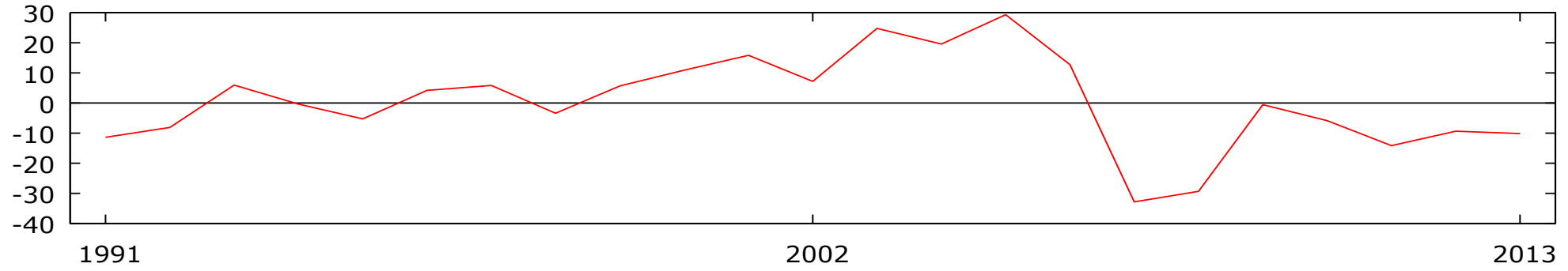
Equation 3: SUR, Sample 1991-2013 (T = 23)
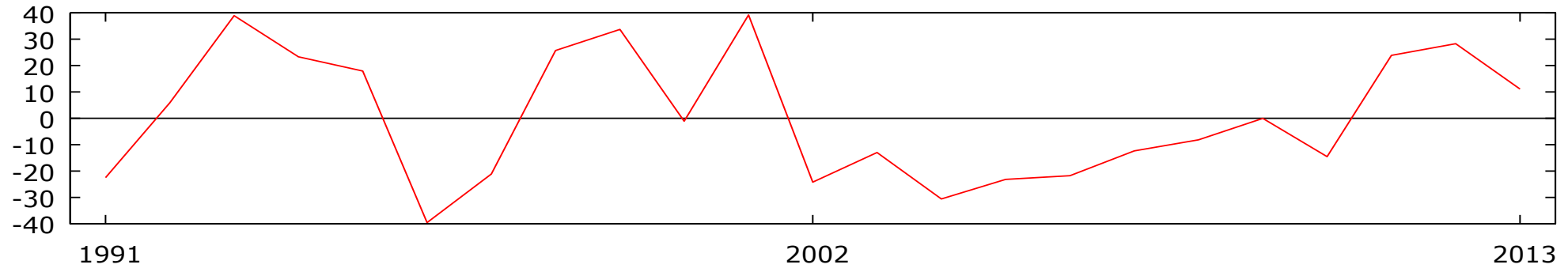Dependent Variable: **IMPORTGER**

	Koeffizient	Std.-fehler	t-Quotient	p-Wert
INCOMEGER	0,317848	0,0134520	23,63	3,98e-017 ***

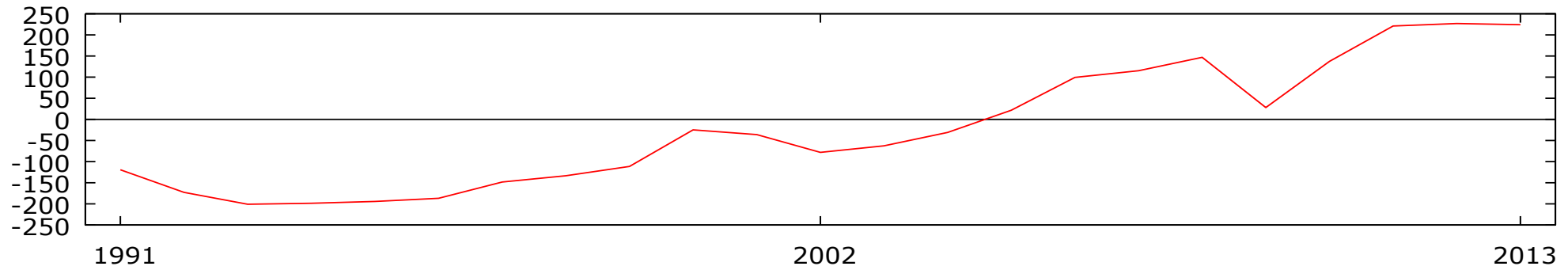|			
Mittel d. abh. Var.	680,5217	Stdabw. d. abh. Var.	252,7791
Summe d. quad. Res.	477108,4	Stdfehler d. Regress.	144,0272

CONSUMGER

INVESTGER

IMPORTGER

Model Results IV
Comparison of Parameter Estimates

Equation and Variable	Single Equation Estimate	System Estimate
CONSUMPTION FUNCTION		
iNCOMEGER	0.22	0.57
DUMMY2	- 52	23.69
TIME	16.4	- 0.878
INVESTMENT FUNCTION		
INTERESTLTR	4818.1	4801.4
TIME	19.36	19.39
DUMMYDOTCOM	56.6	57.67
DUMMY2	- 76	- 76.1
IMPORT DEMAND FUNCTION		
INCOMEGER	0.7	0.31

FORECASTING WITH MACRO-ECONOMETRIC MODELS

FORECASTING (1)

- **State of the work**
  - **Model is developed, estimated and assessed.**

- **Forecasting**
  - **Future development in a particular period of time**

- **Problems**
  - **Exogenous variables**
  - **Additional information: e.g. tax rules**

FORECASTING (2)

- **Extension of time series for exogenous variables**
  - **??**
  - **Time series models**

- **Additional information**
  - **Technical implementation: Add-factors: variation of intercept**
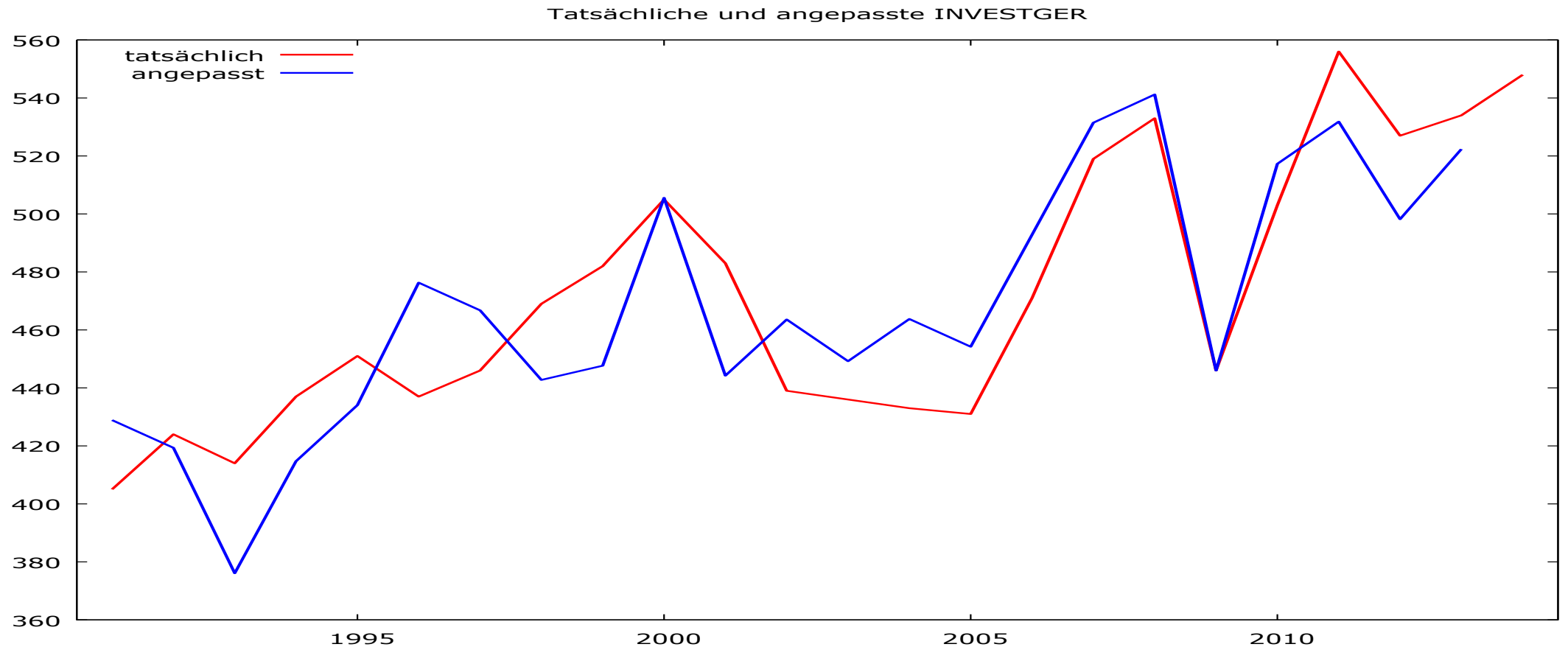 - **Exoginization of variables**
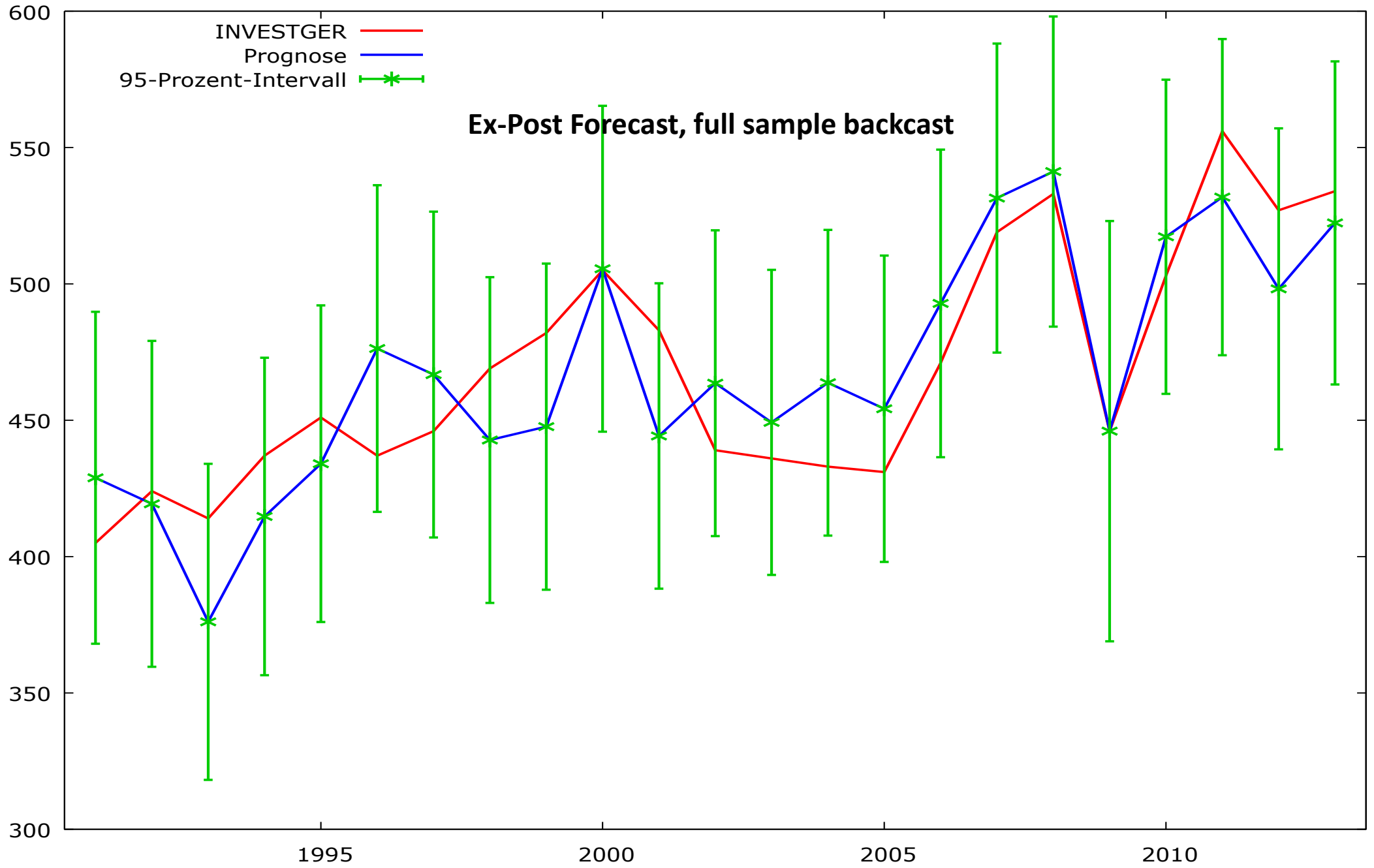
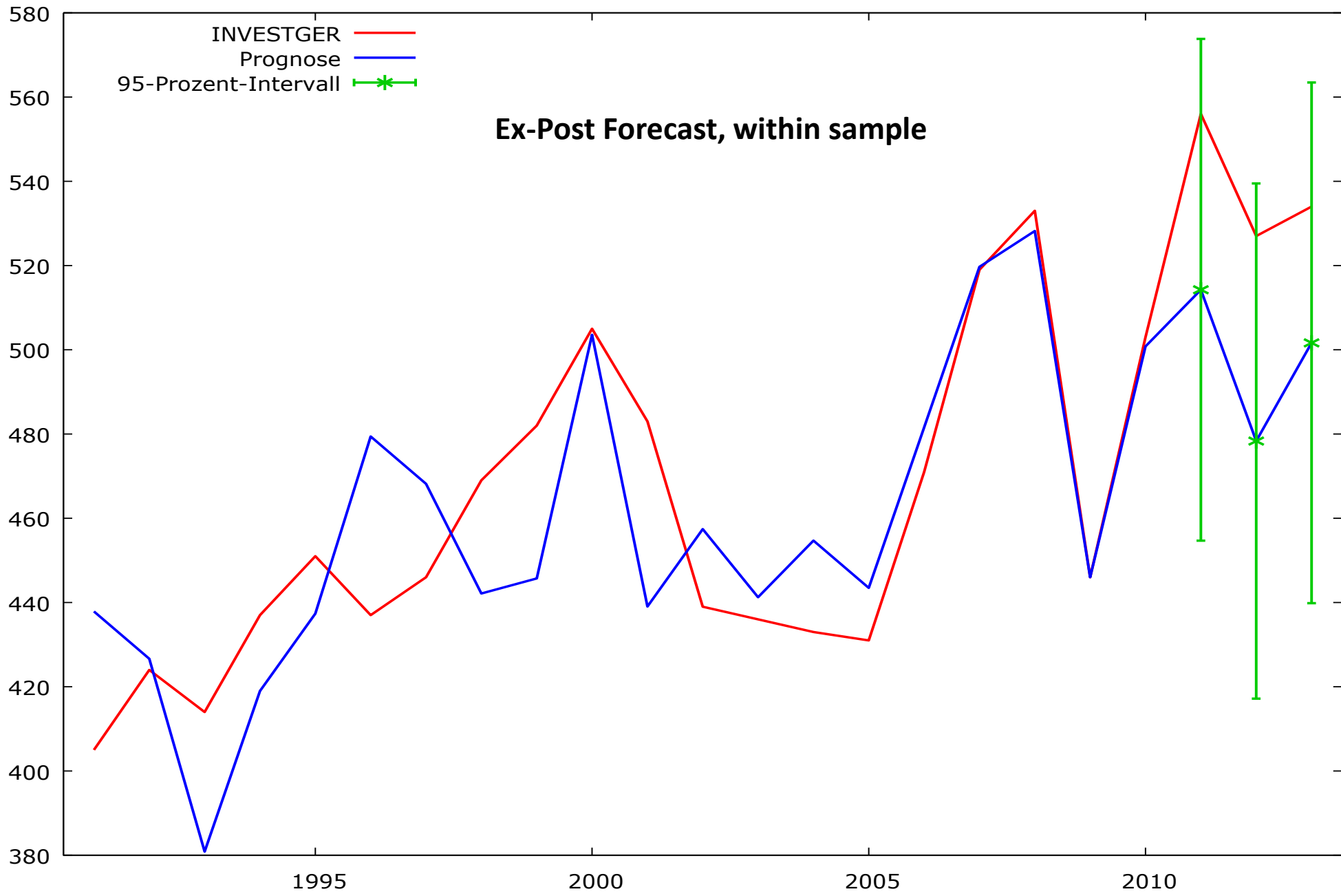# Forecasting Exercise: Investment function

OLS, **Sample 1991-2010 (T = 20)**

Dependent Variable: **INVESTGER**

	Koeffizient	Std. Fehler	t-Quotient	p-Wert	
INTERESTLTGER	4935,3	161,737	30,5144	<0,0001	***
time	18,3775	0,711892	25,8151	<0,0001	***
Dummydotcom	58,2218	12,9719	4,4883	0,0004	***
Dummy2	−61,1027	27,361	−2,2332	0,0402	**

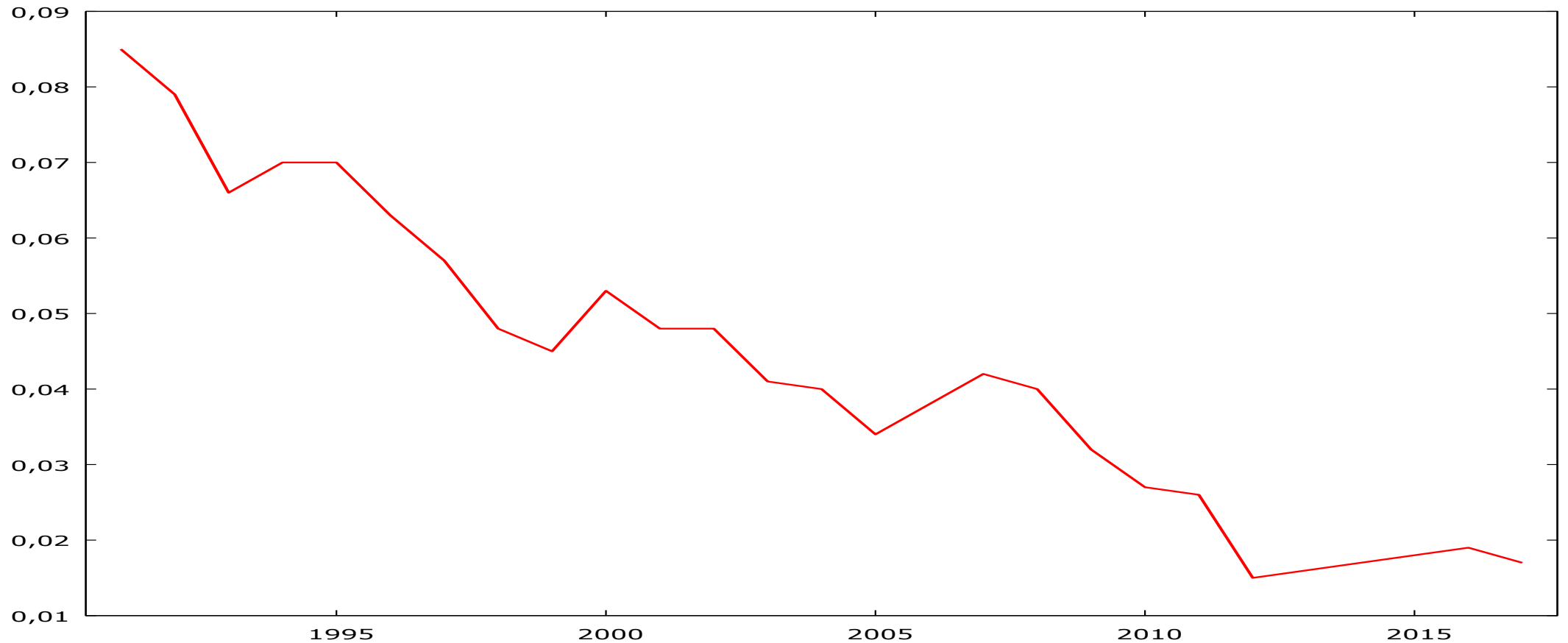|				
Mittel d. abh. Var.	458,2000		Stdabw. d. abh. Var.	35,82795
Summe d. quad. Res.	10093,41		Stdfehler d. Regress.	25,11650
R-Quadrat	0,997610		**Korrigiertes R-Quadrat**	0,997162
F(4, 16)	1669,699		P-Wert(F)	9,56e-21
Log-Likelihood	−90,61783		Akaike-Kriterium	189,2357
Schwarz-Kriterium	193,2186		Hannan-Quinn-Kriterium	190,0132
rho	0,149247		Durbin-Watson-Stat	1,594074

Goodness of fit: Investment Function

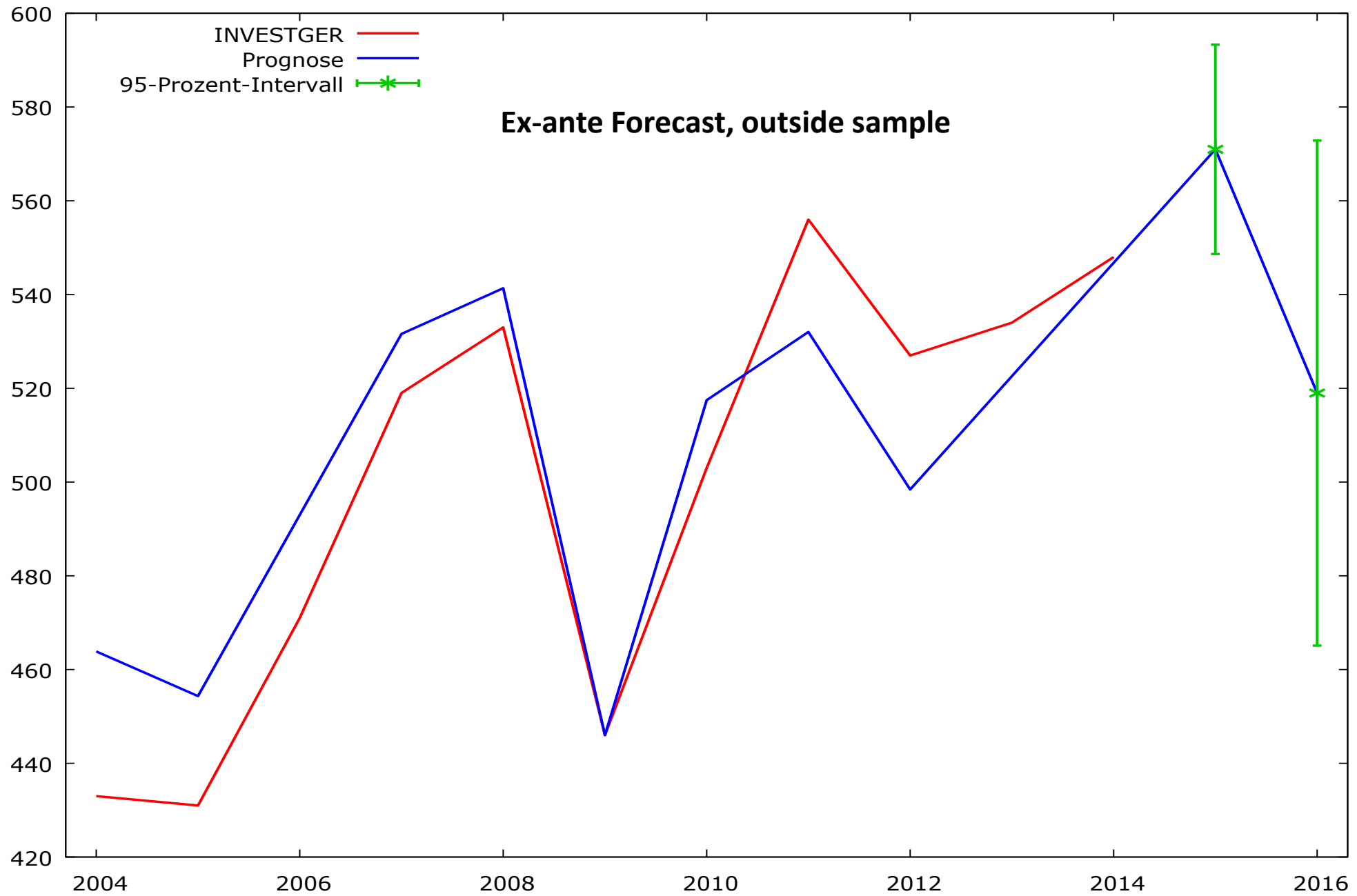Tatsächliche und angepasste INVESTGER

Long term Interest Rates, Germany, Arbitrarily Expanded Time Series

POLICY SIMULATION WITH MACRO-ECONOMETRIC MODELS

INTRODUCTION TO SIMULATION (1)

- **Purpose**
  - **Analysis of exogenous shocks**
  - **Analysis of policies**

- **Types of Simulation**
  - **Ex-post or ex-ante**
  - **Static or dynamic**
  - **Testing of alternative hypothesis**
  - **Forecasting simulation**

INTRODUCTION TO SIMULATION (2)

- **Ex-post or ex-ante**
  - **Ex-post: Assessment of model; quality of forecasts**
  - **Ex-ante: Forecasting simulation, comparison of alternative assumptions about the development of exogenous variables**

- **Static or dynamic**
  - **Static Testing of alternative hypothesis: The relevance of theoretical considerations (policy debates) for the economic development**

STRUCTURE OF MACRO-ECONOMETRIC MODELS

CORE ELEMENTS OF A MACRO ECONOMETRIC MODEL (1)

1. Demographic block
   - Population; size, age structure, gender composition
   - Usually exogenous

2. Central economic blocks

   Expenditure block: GDP, consumption, investment,

3. Production block
   - Production function
   - Factor demand
   - Inter-industry flows (input-output model)

CORE ELEMENTS OF A MACRO ECONOMETRIC MODEL (2)

4. Income block
   - Distribution of income
   - Wages and prices
   - Labour market

5. Government-fiscal policy block
   - Expenditure on consumption, investment and transfer payments
   - Taxation
   - Social security

CORE ELEMENTS OF A MACRO ECONOMETRIC MODEL (3)

6. Central bank monetary policy block
   - Money supply,
   - Interest rates
   - Transmission mechanism

7. Asset structure
   - Flow of funds and wealth accumulation

8. External block
   - Balance of payment
   - Exchange rate
   - Capital account
   - External exogenous link, World trade

PRACTICAL PROBLEMS: DATA COLLECTION, UP-DATING, STAFFING OF PROJECT TEAM

DATA COLLECTION

- **CATEGORIES**

- **National accounts**

- **Financial market data**

- **Labour market**

- **Demographic data**

- **Government expenditures**

- **…**

- **RECOMMENDATION**

- **Outsourcing of data collection and compilation of data base**

STAFFING

- **CATEGORIES**

- **Economists**
- **Mathematicians with statistical and econometric specialisation**
- **IT-specialist s**

RECOMMENDATION

- **Form a sufficiently large group with staff from different scientific profiles**

IT EQUIPMENT

- **SOFTWARE**
- **Econometric software**
- **E.g. EViews**

- **HARDWARE**
- **Laptop or desktop computer, but capacity of processor matters for simulation.**

Q & A

Thank you very much!
Vielen Dank!