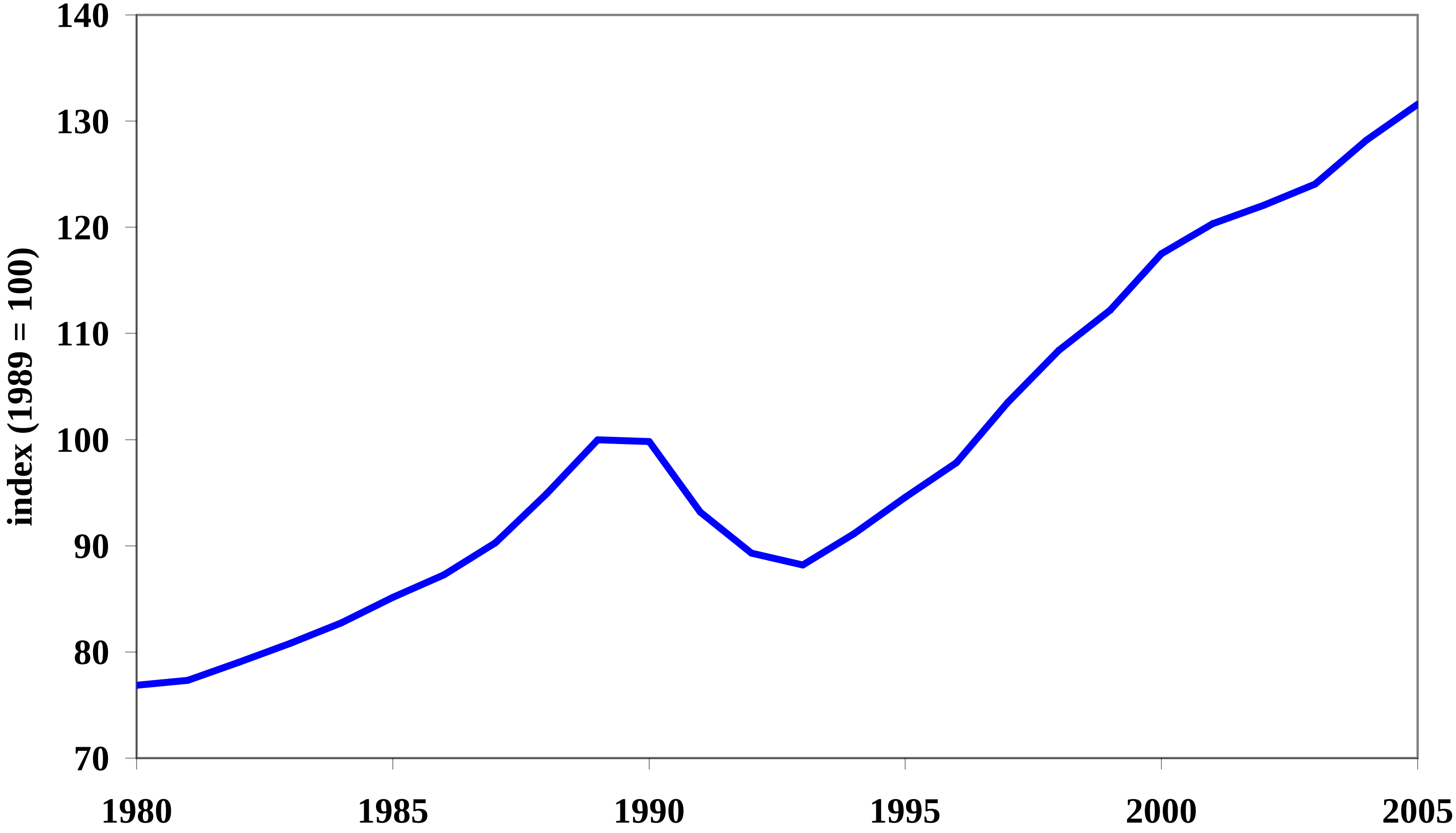
# The Depression in Finland in the 1990s

**Juan Carlos Conesa**
**Timothy J. Kehoe**
**Kim J. Ruhl**

**ITAM**
**February 2009**

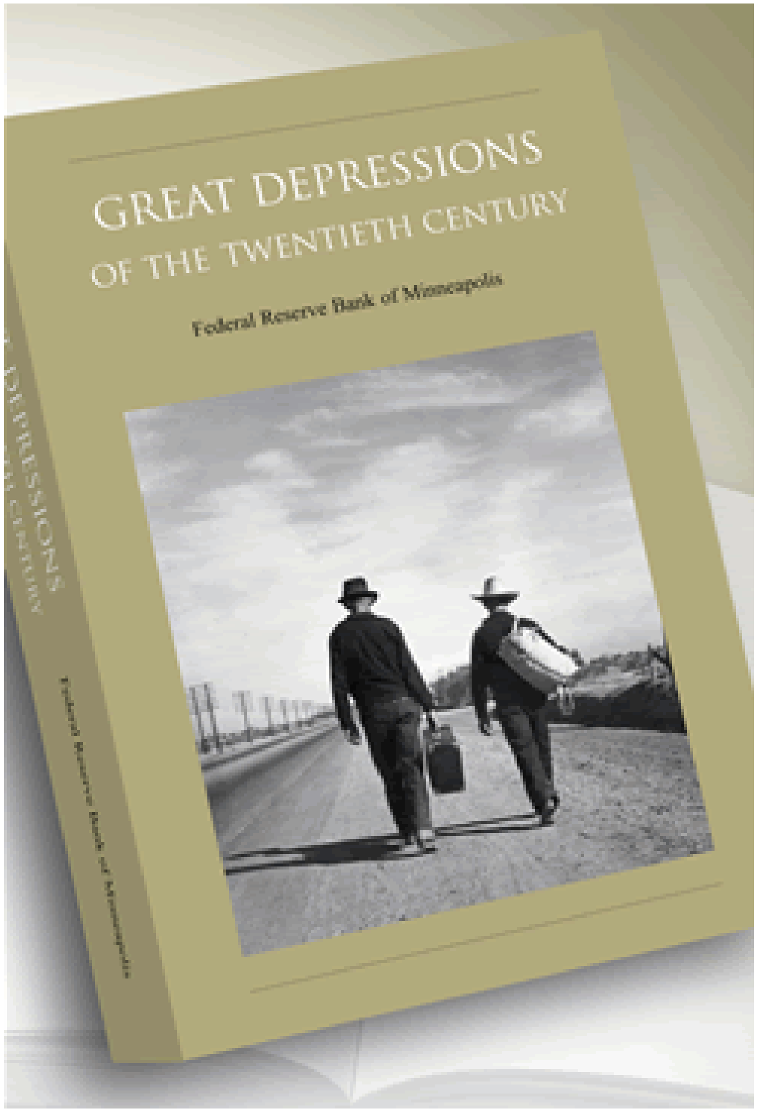
# Real GDP per Working Age Person in Finland



# Understanding the Finnish Depression

Base case: neoclassical growth theory

Cole and Ohanian (1999, 2002), Kehoe and Prescott (2007)




Expanded and revised version of the RED 2002 volume.

Data and programs available at

www.greatdepressionsbook.com

# Understanding the Finnish Depression

Base case: neoclassical growth theory

Cole and Ohanian (1999, 2002), Kehoe and Prescott (2007)

Extensions: following Kiander and Vartia (1996)

1. Bad policy: labor market policies, especially labor taxes

   --add taxes and government spending

2. Bad luck: collapse of Soviet Union

   --add terms of trade shocks, trade balance shocks

3. Bad banking: banking crisis in 1991-94

   --add investment sector, shocks to investment production

# Overview of the Results

Base case model

- Accounts for 51% of fall in output
- Cannot account for decrease in labor during crisis
- Labor input is too high after the crisis

Model with taxes and government spending

- Accounts for 136% of fall in output
- Labor falls too much during crisis
- Labor input recovers to the level in the data

Model with terms of trade shocks

- Accounts for 72% of fall in output
- Cannot account for decrease in labor during crisis labor
- Labor input is too high after the crisis

# The Growth Model

Households choose $\{C_t, K_t, L_t\}$

$$\max \sum_{t=T_0}^{\infty} \beta \left( \gamma \log\left(C_t\right) + \left(1-\gamma\right) \log\left(\bar{h} N_t - L_t\right) \right)$$

$$\text{s.t. } C_t + K_{t+1} = w_t L_t + \left(1 - \delta + r_t\right) K_t$$

Technology

$$Y_t = A_t K_t^{\alpha} L_t^{1-\alpha}$$

Feasibility

$$C_t + K_{t+1} - \left(1-\delta\right) K_t = A_t K_t^{\alpha} L_t^{1-\alpha}$$

# The Balanced Growth Path

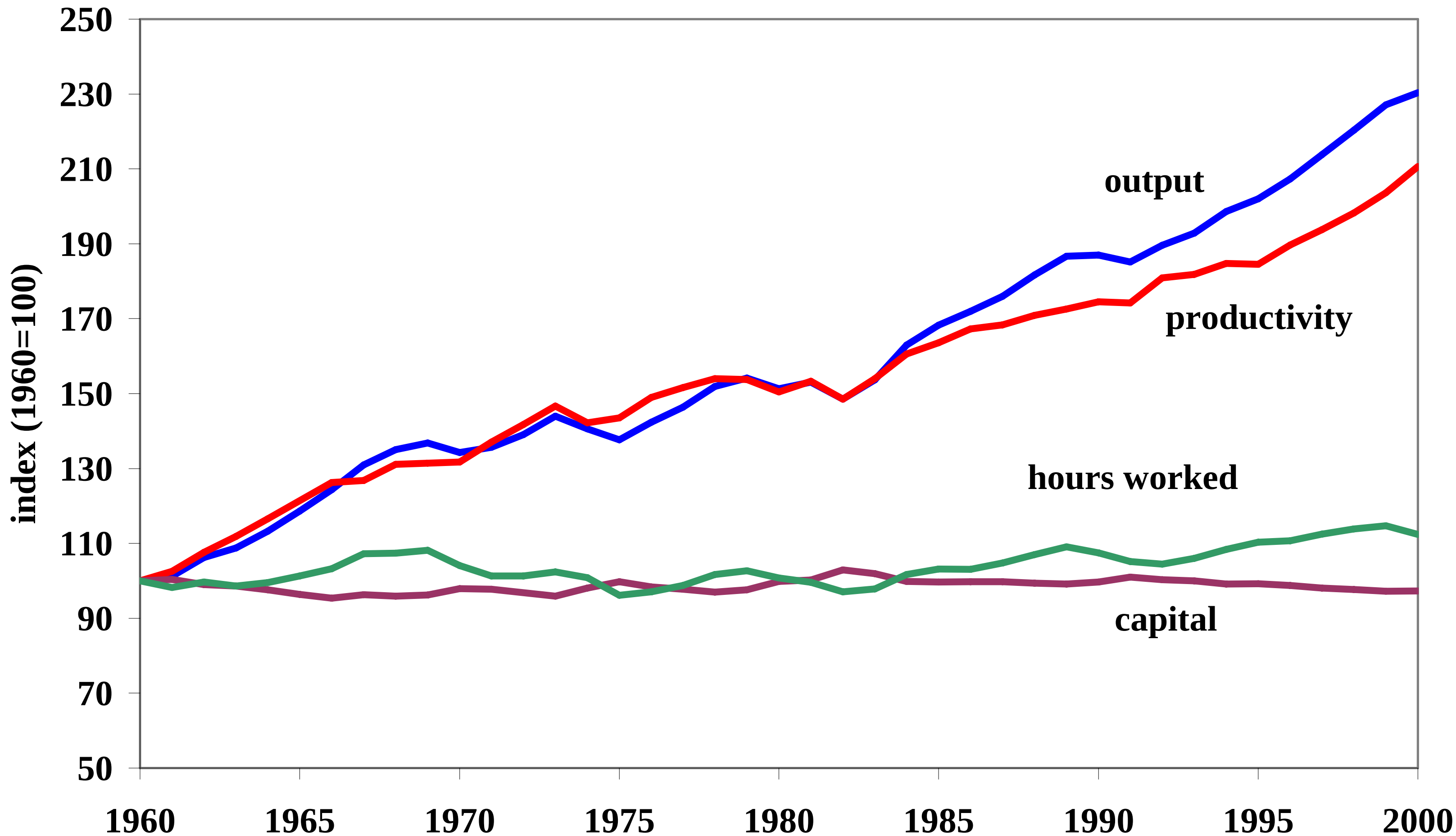
$$\frac{Y_t}{N_t} = A_t^{\frac{1}{1-\alpha}} \left( \frac{K_t}{Y_t} \right)^{\frac{\alpha}{1-\alpha}} \left( \frac{L_t}{N_t} \right)$$

When $A_{t+1} = g^{1-\alpha} A_t$

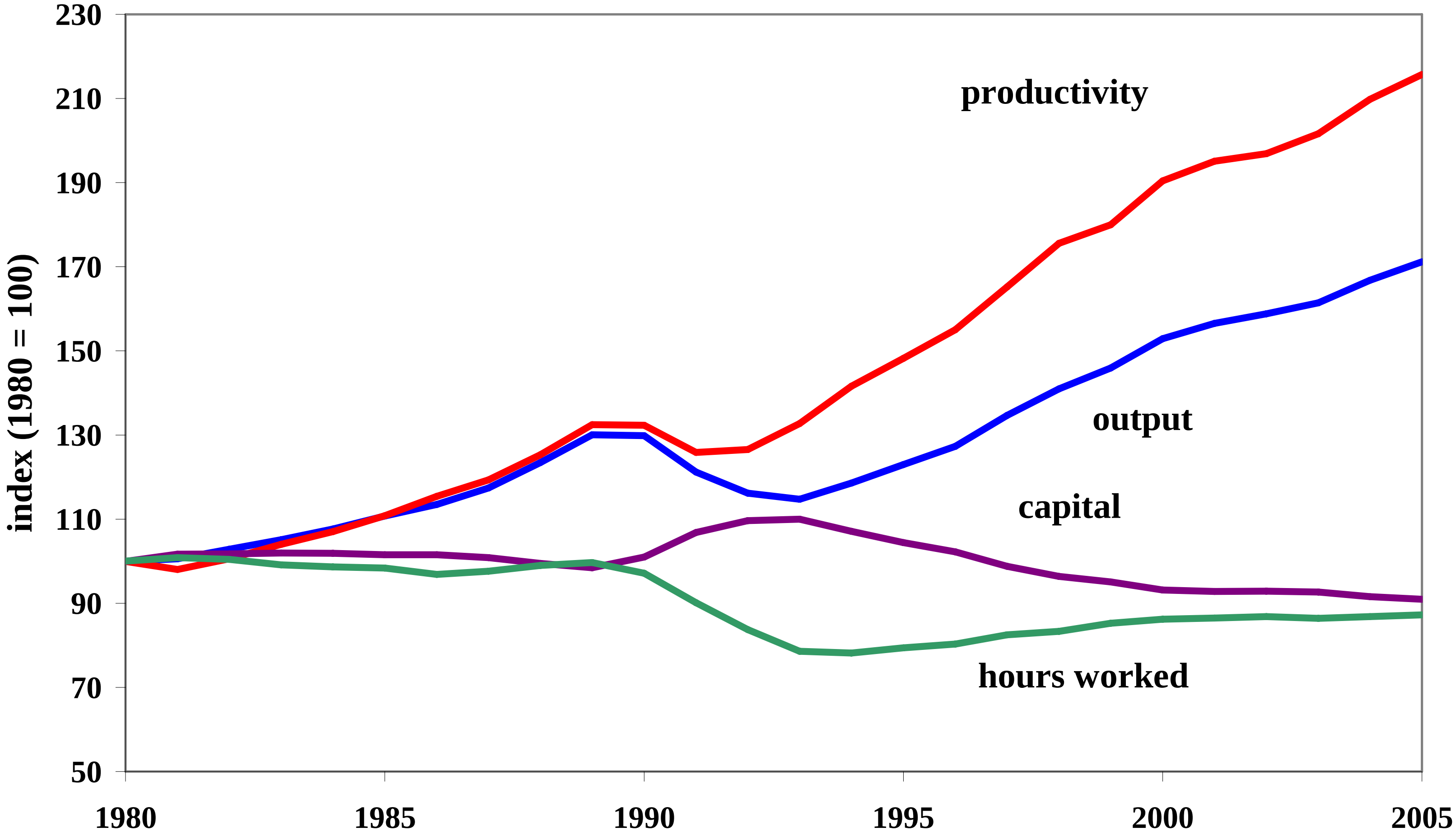
- $\frac{K_t}{Y_t}$ and $\frac{L_t}{N_t}$ are constant

- $\frac{Y_t}{N_t}$ grows at rate $g-1$, assume $g-1=0.02$ as in U.S.

## Growth Accounting for the United States



# Growth Accounting for Finland



# Growth Accounting Summary

| | Data |
|---|---|
| **Crisis 1980-89** | |
| change in Y/N | 2.92 |
| due to TFP | 3.13 |
| due to K/Y | -0.17 |
| due to L/N | -0.03 |
| **Crisis 1989-93** | |
| change in Y/N | -3.14 |
| due to TFP | 0.05 |
| due to K/Y | 2.77 |
| due to L/N | -5.96 |
| **Recovery 1993-2005** | |
| change in Y/N | 3.33 |
| due to TFP | 4.04 |
| due to K/Y | -1.58 |
| due to L/N | 0.87 |

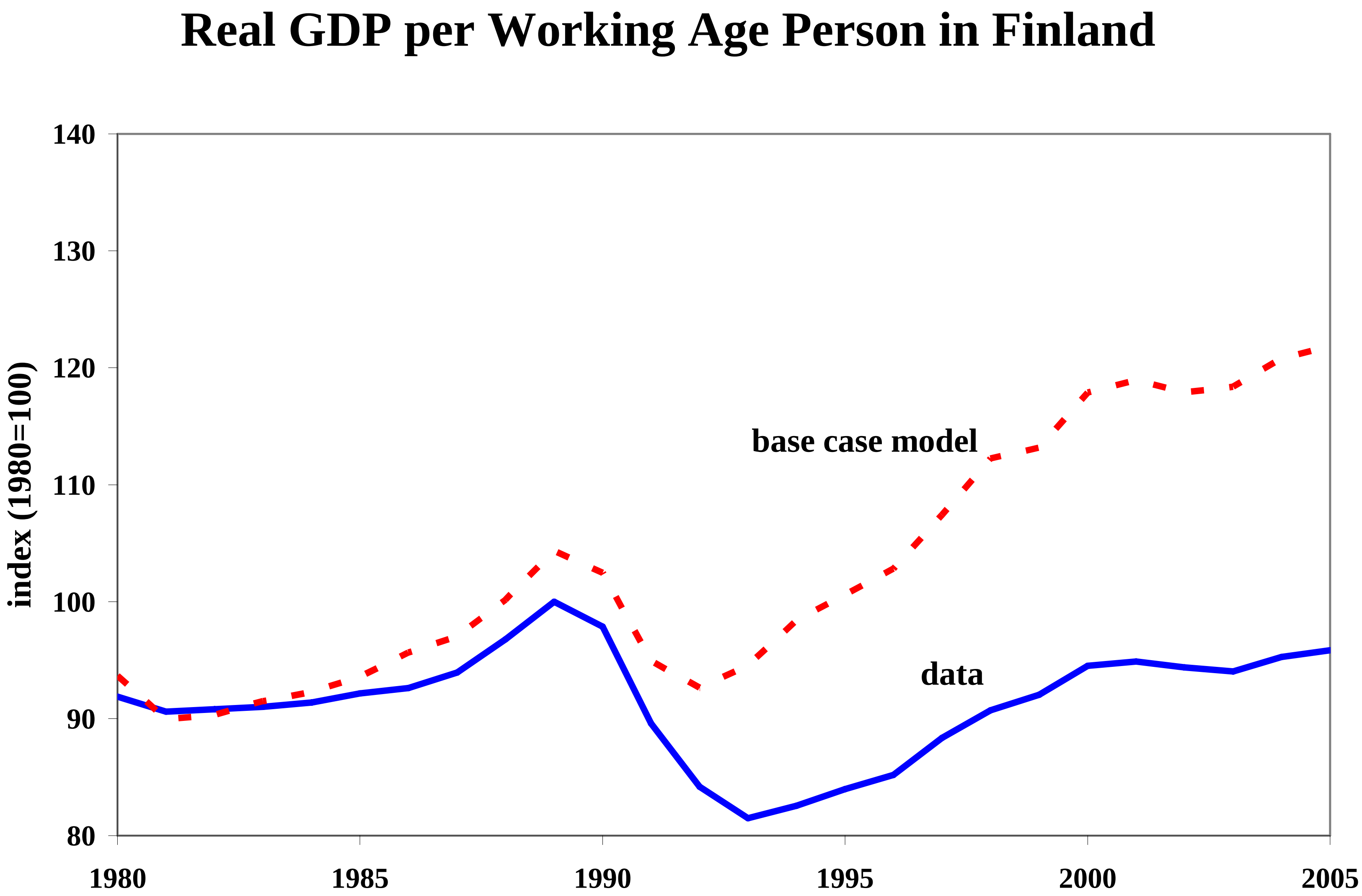
# Base Case Model

Standard Growth Model

- TFP is exogenous, foreseen
  - computed from data
- Population growth rates exogenous, foreseen
  - from the data

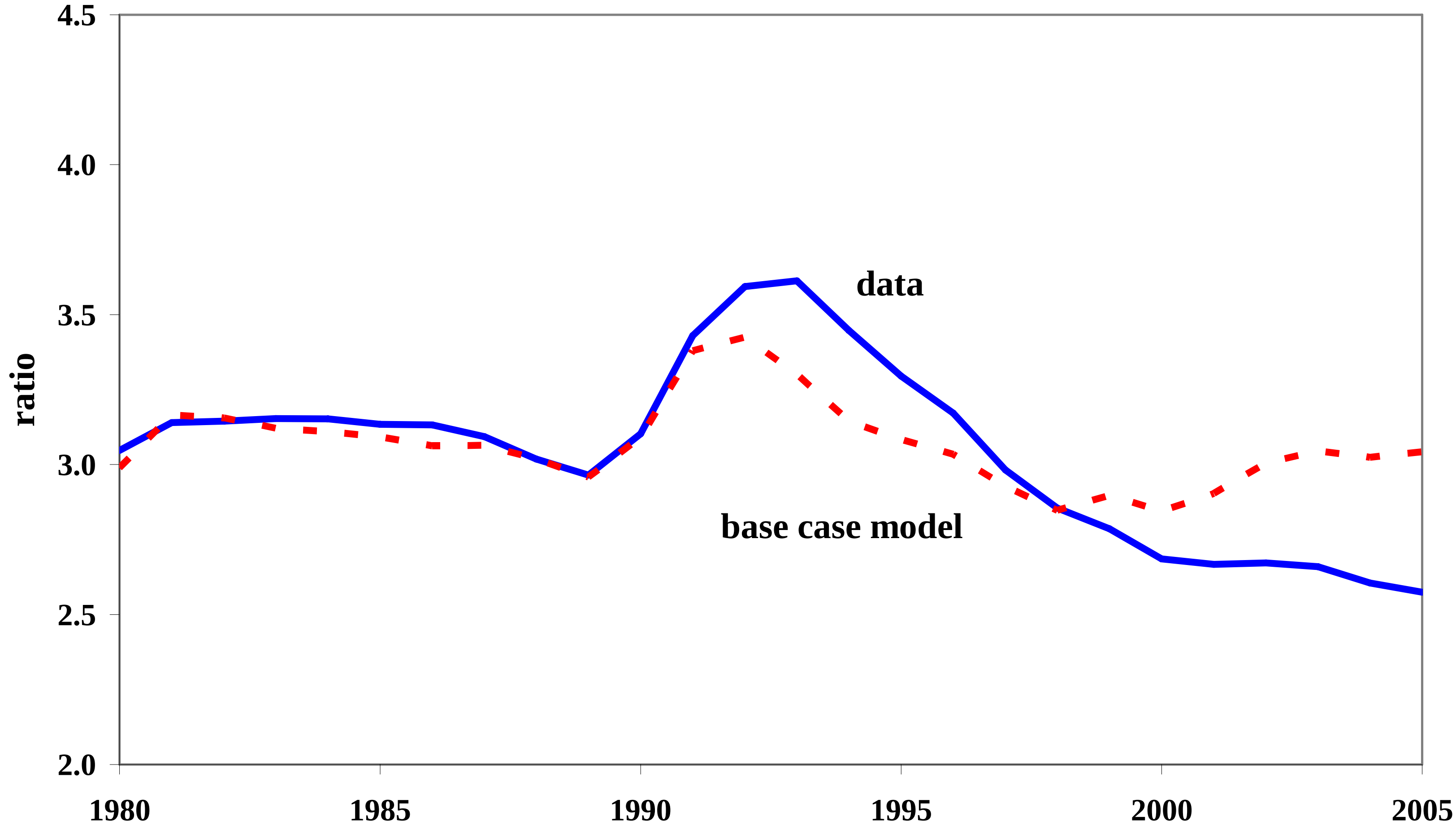
Calibrate using 1970-80 data

- $\alpha = 0.359,\ \beta = 0.975,\ \gamma = 0.285$

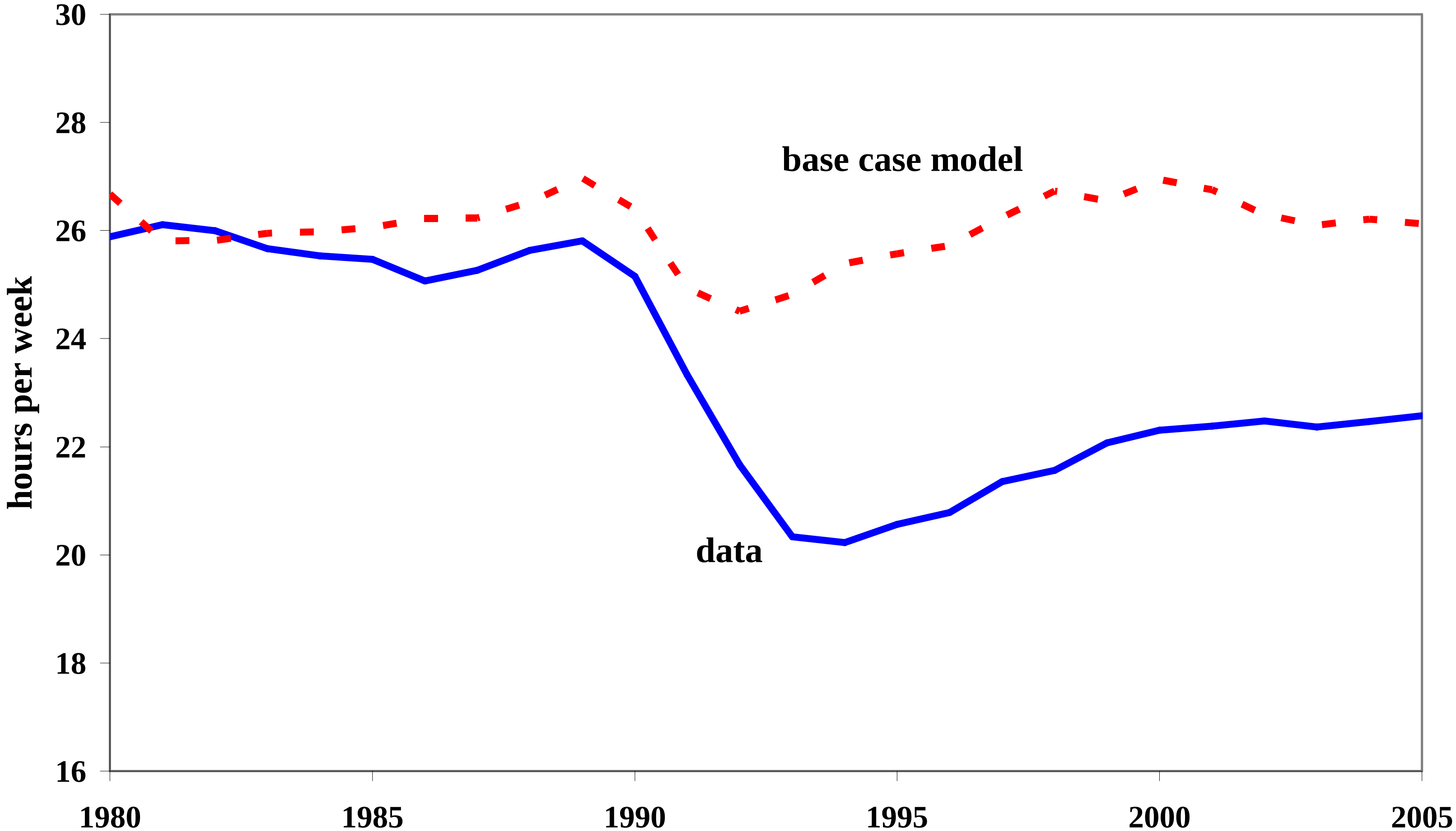


Real GDP per Working Age Person in Finland
index (1980=100)
140
130
120
110
100
90
80
1980
1985
1990
1995
2000
2005
base case model
data

# Capital/Output Ratio in Finland



# Hours Worked per Working Age Person in Finland



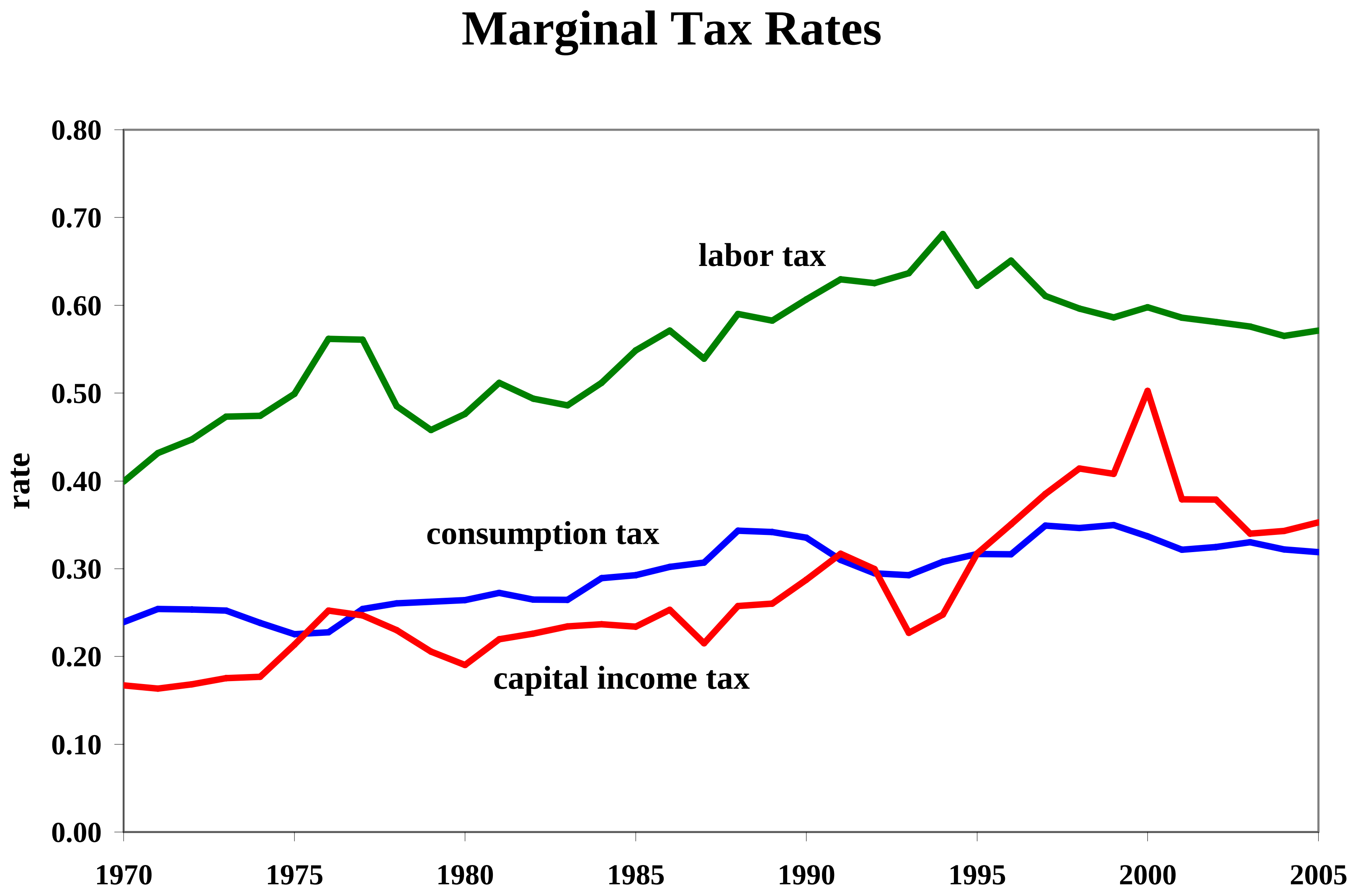
# Growth Accounting Summary

| | Data | Model Base Case |
|---|---|---|
| **Crisis 1980-89** | | |
| change in Y/N | 2.92 | 3.18 |
| due to TFP | 3.13 | 3.13 |
| due to K/Y | -0.17 | -0.07 |
| due to L/N | -0.03 | 0.12 |
| **Crisis 1989-93** | | |
| change in Y/N | -3.14 | -0.50 |
| due to TFP | 0.05 | 0.05 |
| due to K/Y | 2.77 | 1.54 |
| due to L/N | -5.96 | -2.09 |
| **Recovery 1993-2005** | | |
| change in Y/N | 3.33 | 4.01 |
| due to TFP | 4.04 | 4.04 |
| due to K/Y | -1.58 | -0.39 |
| due to L/N | 0.87 | 0.35 |

# Model with Taxes and Government Spending

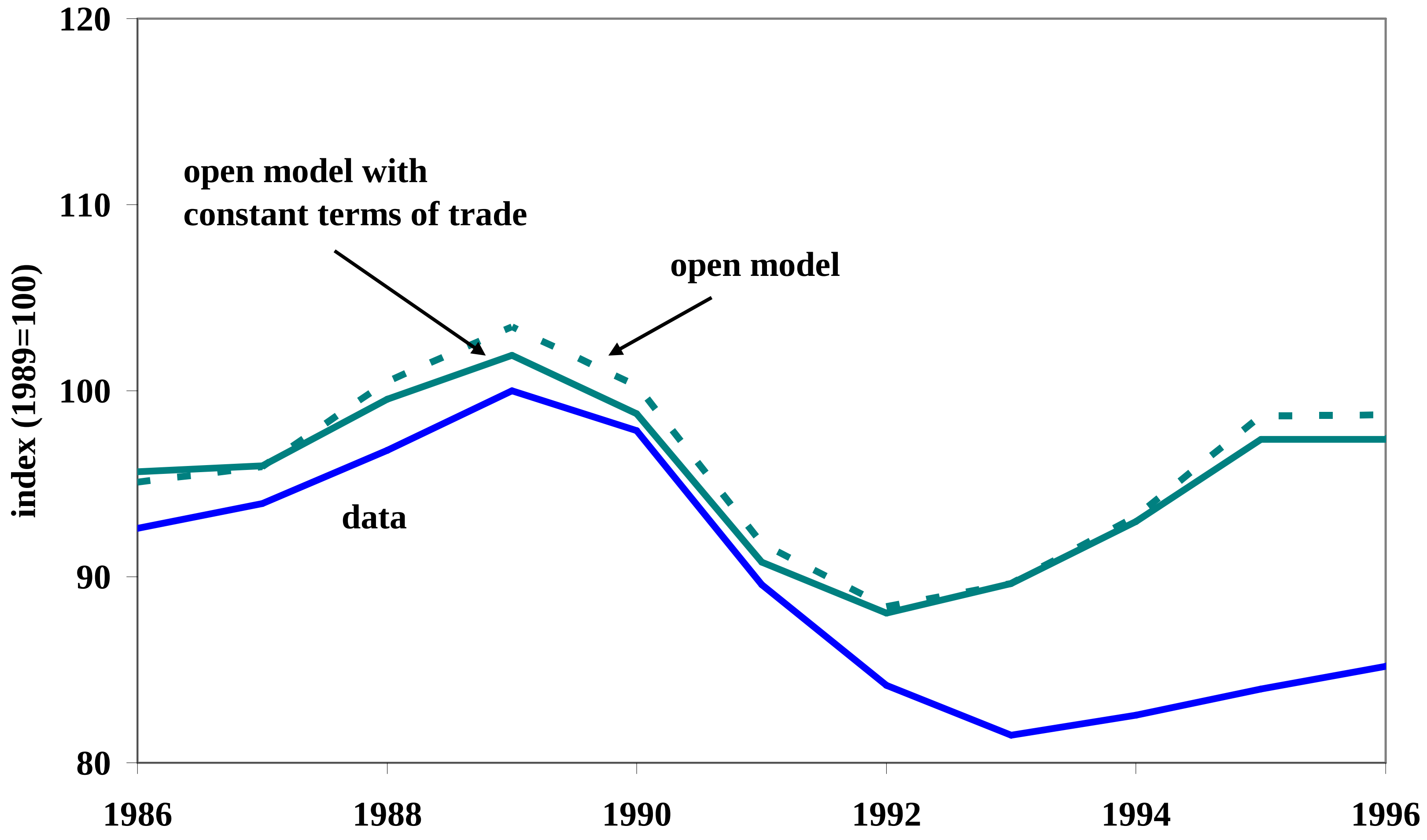
Add 4 exogenous and foreseen variables

- Government expenditures, $G$
- Consumption tax, $\tau^c$
- Labor income tax, $\tau^\ell$
- Capital income tax, $\tau^k$



Marginal Tax Rates
rate
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
1970
1975
1980
1985
1990
1995
2000
2005
labor tax
consumption tax
capital income tax

# Detrended Real GDP per Working Age Person in Finland



# A Model with Taxes and Government Spending

Households choose $\{C_t, K_t, L_t\}$

$$\max \sum_{t=T_0}^{\infty} \beta \Big( \gamma \log\big(C_t\big) + \big(1-\gamma\big)\log\big(\bar{h}N_t - L_t\big)\Big)$$

s.t. $(1+\tau_t^c)C_t + K_{t+1} = (1-\tau_t^\ell)w_t L_t + \Big(1+(1-\tau_t^k)(r_t-\delta)\Big)K_t + T_t$

Government budget constraint

$$\tau_t^c C_t + \tau_t^\ell w_t L_t + \tau_t^k (r_t - \delta)K_t = G_t + T_t$$

Feasibility

$$C_t + K_{t+1} - (1-\delta)K_t + G_t = A_t K_t^\alpha L_t^{1-\alpha}$$

# Tax Model Calibration

Taxes computed as in Mendoza, Razin, and Tesar (1994)

Prescott (2002): marginal rate = average rate * 1.6

What to do with government spending?

1. Set $G_t = 0$, taxes are lump sum rebated to households

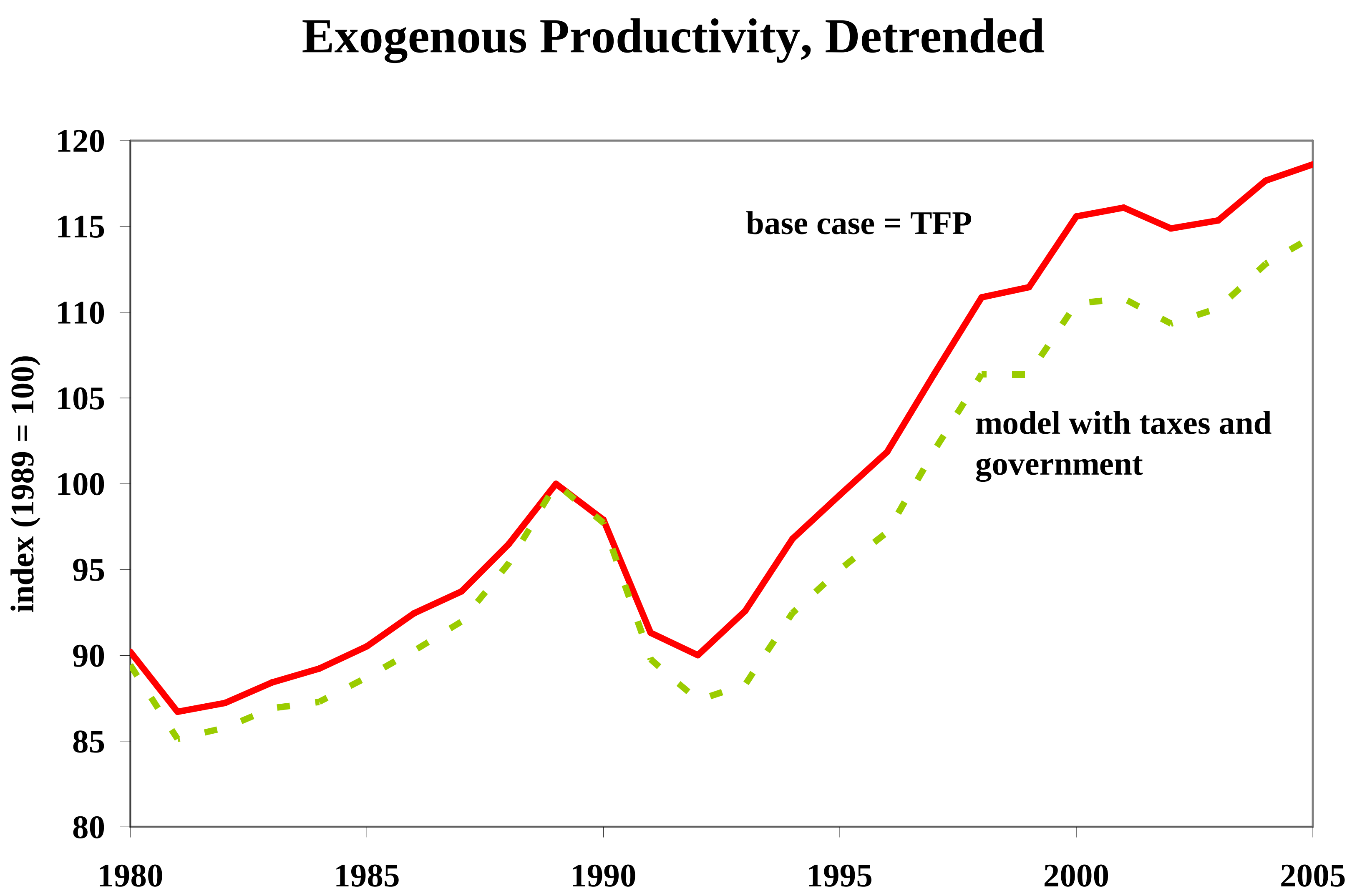
2. Set $G_t$ from national accounts data

Exogenous productivity is no longer "TFP"

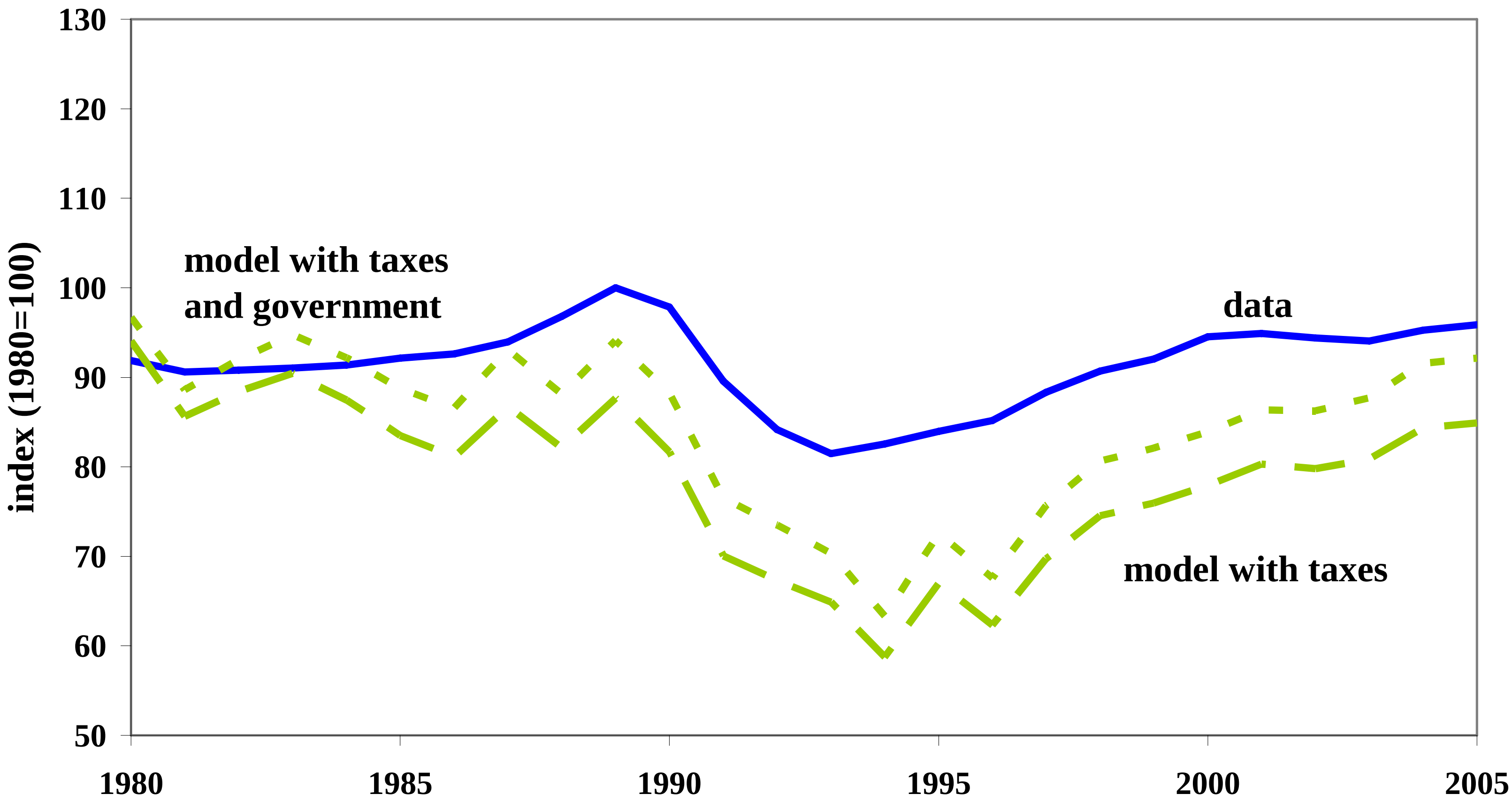
$$A_t = \frac{C_t + I_t + G_t}{K_t^{1-\alpha} L_t^{\alpha}}$$, "GDP at factor prices"

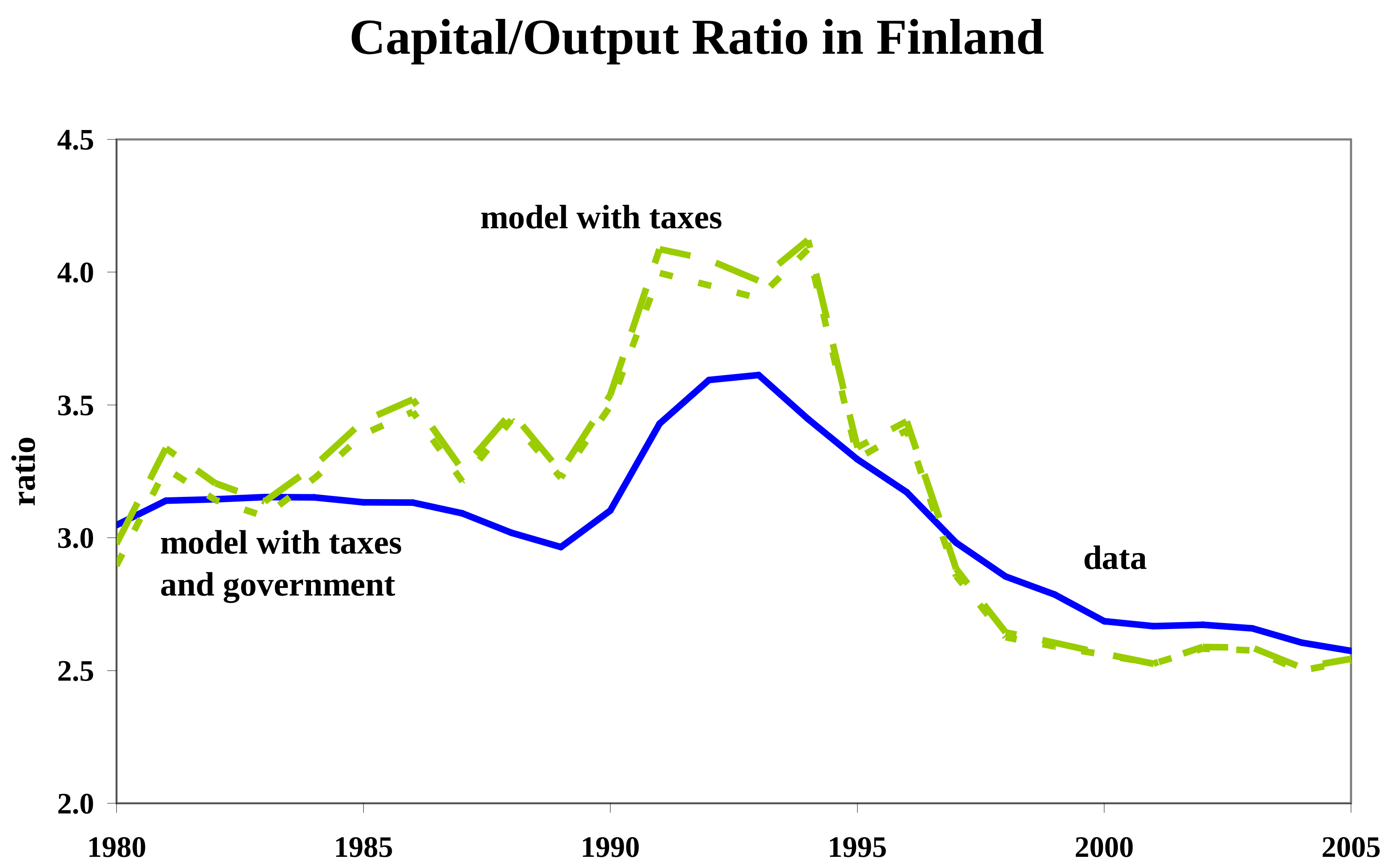
TFP is measured with real GDP, $\hat{Y}_t = (1 + \tau_{\bar{T}}^{c}) C_t + I_t + G_t$

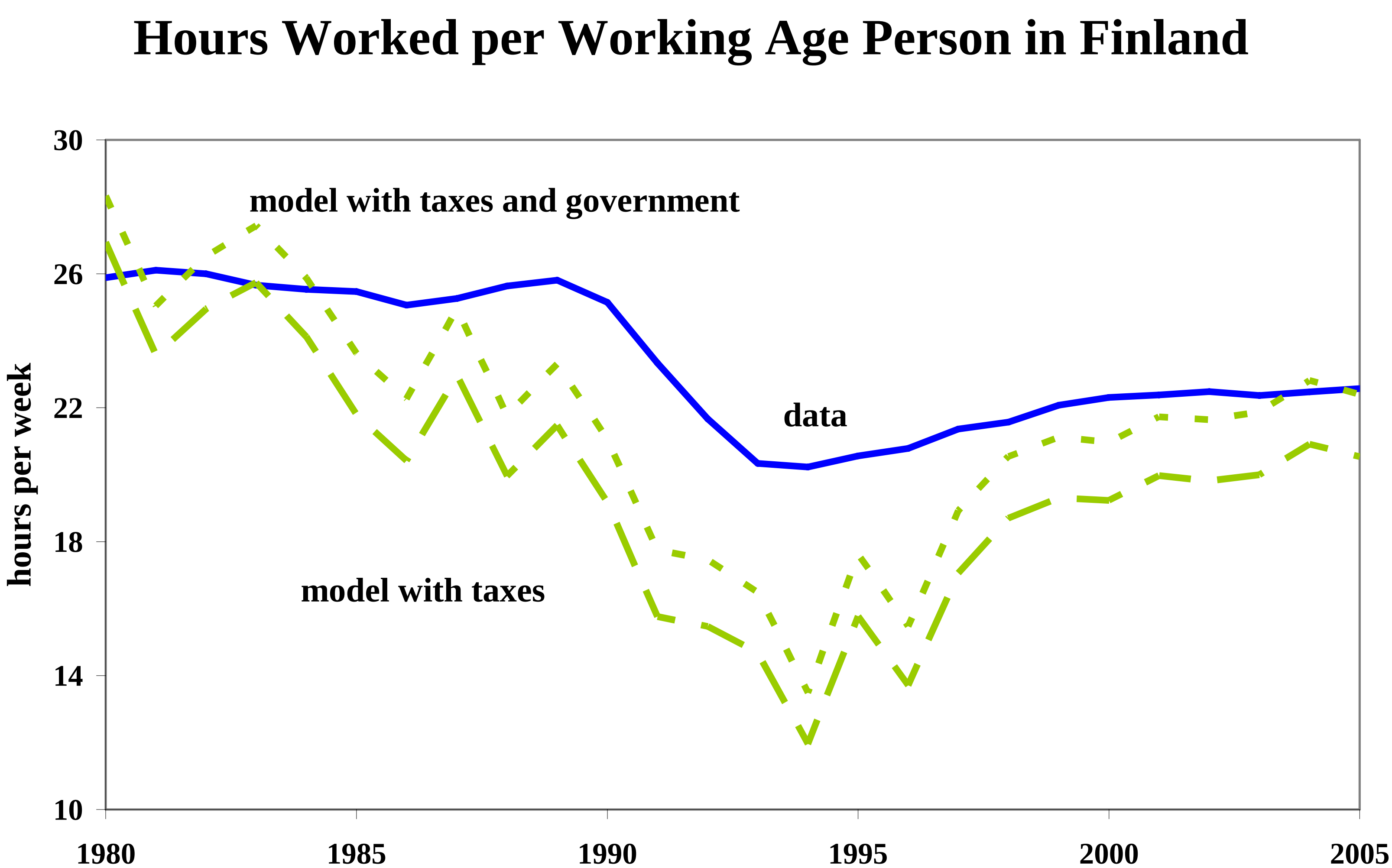
Recalibrate $\beta$, $\gamma$


Exogenous Productivity, Detrended
index (1989 = 100)
120
115
110
105
100
95
90
85
80
1980
1985
1990
1995
2000
2005
base case = TFP
model with taxes and government

# Real GDP per Working Age Person in Finland




Capital/Output Ratio in Finland
ratio
4.5
4.0
3.5
3.0
2.5
2.0
1980
1985
1990
1995
2000
2005
model with taxes
model with taxes
and government
data



Hours Worked per Working Age Person in Finland
hours per week
30
26
22
18
14
10
1980
1985
1990
1995
2000
2005
model with taxes and government
data
model with taxes

# Growth Accounting Summary

| | Data | Model Base Case | Model Taxes | Model Taxes & Gov't |
|---|---|---|---|---|
| **Crisis 1980-89** | | | | |
| change in Y/N | 2.92 | 3.18 | 1.09 | 1.62 |
| due to TFP | 3.13 | 3.13 | 3.43 | 3.30 |
| due to K/Y | -0.17 | -0.07 | 0.77 | 0.76 |
| due to L/N | -0.03 | 0.12 | -3.11 | -2.44 |
| **Crisis 1989-93** | | | | |
| change in Y/N | -3.14 | -0.50 | -5.45 | -4.79 |
| due to TFP | 0.05 | 0.05 | 0.66 | 0.50 |
| due to K/Y | 2.77 | 1.54 | 2.46 | 2.26 |
| due to L/N | -5.96 | -2.09 | -8.56 | -7.55 |
| **Recovery 1993-2005** | | | | |
| change in Y/N | 3.33 | 4.01 | 4.11 | 4.07 |
| due to TFP | 4.04 | 4.04 | 3.60 | 3.82 |
| due to K/Y | -1.58 | -0.39 | -2.07 | -2.06 |
| due to L/N | 0.87 | 0.35 | 2.58 | 2.31 |

Economy overreacts to taxes

- Output falls by too much: 4.79% vs. 3.14% in data
- Hours worked falls by too much: -7.55% vs. 5.96%

Explanations

- In Scandinavia, revenues used to fund subsidies and transfers to workers, lowering the effective tax rate. Ragan (2005) and Rogerson (2007)
- Utility functions with lower labor supply elasticity. Conesa and Kehoe (2007)

Post-crisis labor allocation is correct

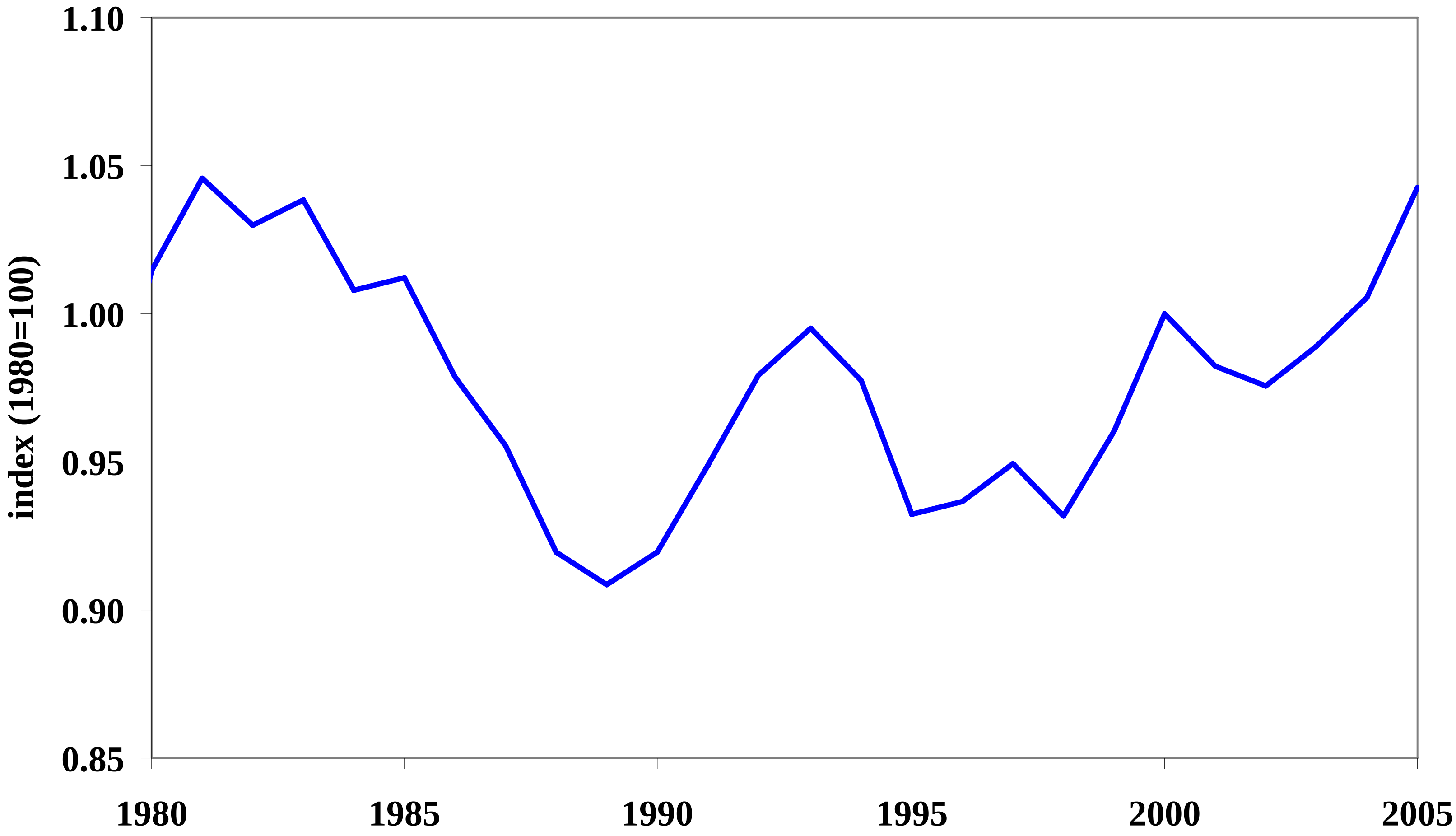
- Long run response to tax rates Prescott (2002), Ohanian, Raffo, and Rogerson (2006)

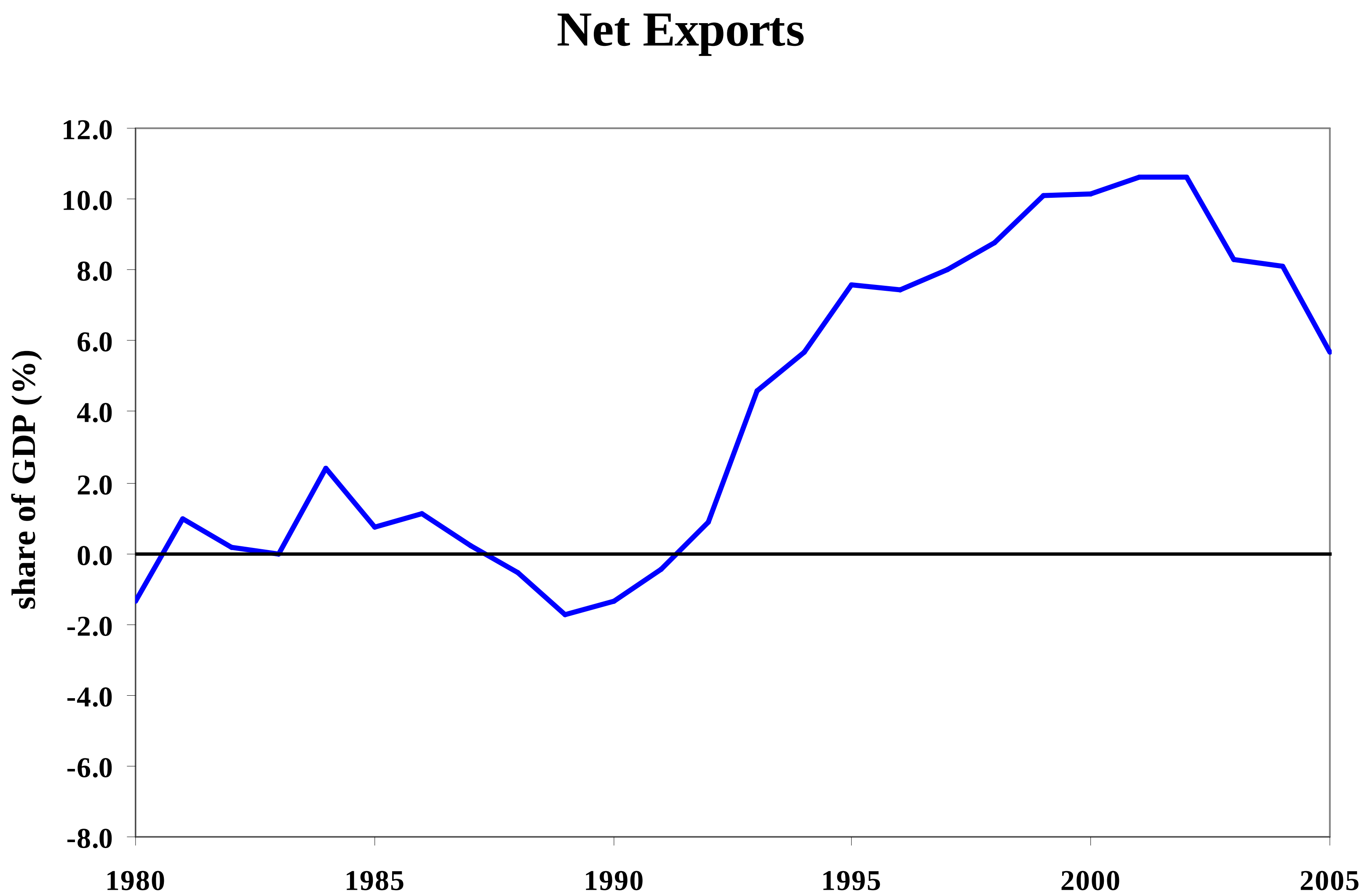
# Open Economy Model

Crisis was accompanied by

- Depreciation of terms of trade
- Reversal of the trade balance

# Price of Imports/Price of Exports in Finland




Net Exports
share of GDP (%)
12.0
10.0
8.0
6.0
4.0
2.0
0.0
-2.0
-4.0
-6.0
-8.0
1980
1985
1990
1995
2000
2005

# Open Economy Model

Two kinds of goods:

- Imports ($m -$ goods)
- Domestically produced goods ($d -$ goods)

Domestic good is the numeraire

- The terms of trade, $p_m$, is exogenous

# Open Economy Model

Households

$$\max \sum_{t=T_0}^{\infty} \beta^t \left(\gamma \log\left(C_t\right) + \left(1-\gamma\right) \log(\bar{h} N_t - L_t)\right)$$

$$\text{s.t. } q_t C_t + q_t (K_{t+1} - (1-\delta) K_t) = w_t L_t + r_t K_t$$

Domestic Good Technology

$$Z_t + X_t + B_t = A_t K_t^{\alpha} L_t^{1-\alpha}$$

Feasibility

$$C_t + K_{t+1} - (1-\delta) K_t = D_t \left(\omega Z_{d,t}^{\rho} + \left(1-\omega\right) M_t^{\rho}\right)^{\frac{1}{\rho}}$$

The firm's problem

$$\min_{Z_t, M_t} \quad \mathrm{Z}_t + p_{m,t} M_t$$

$$\text{s.t.} \quad \bar{\mathrm{Y}}_t \leq D_t \left( \omega Z_t^{\rho} + (1-\omega) M_t^{\rho} \right)^{\frac{1}{\rho}}$$

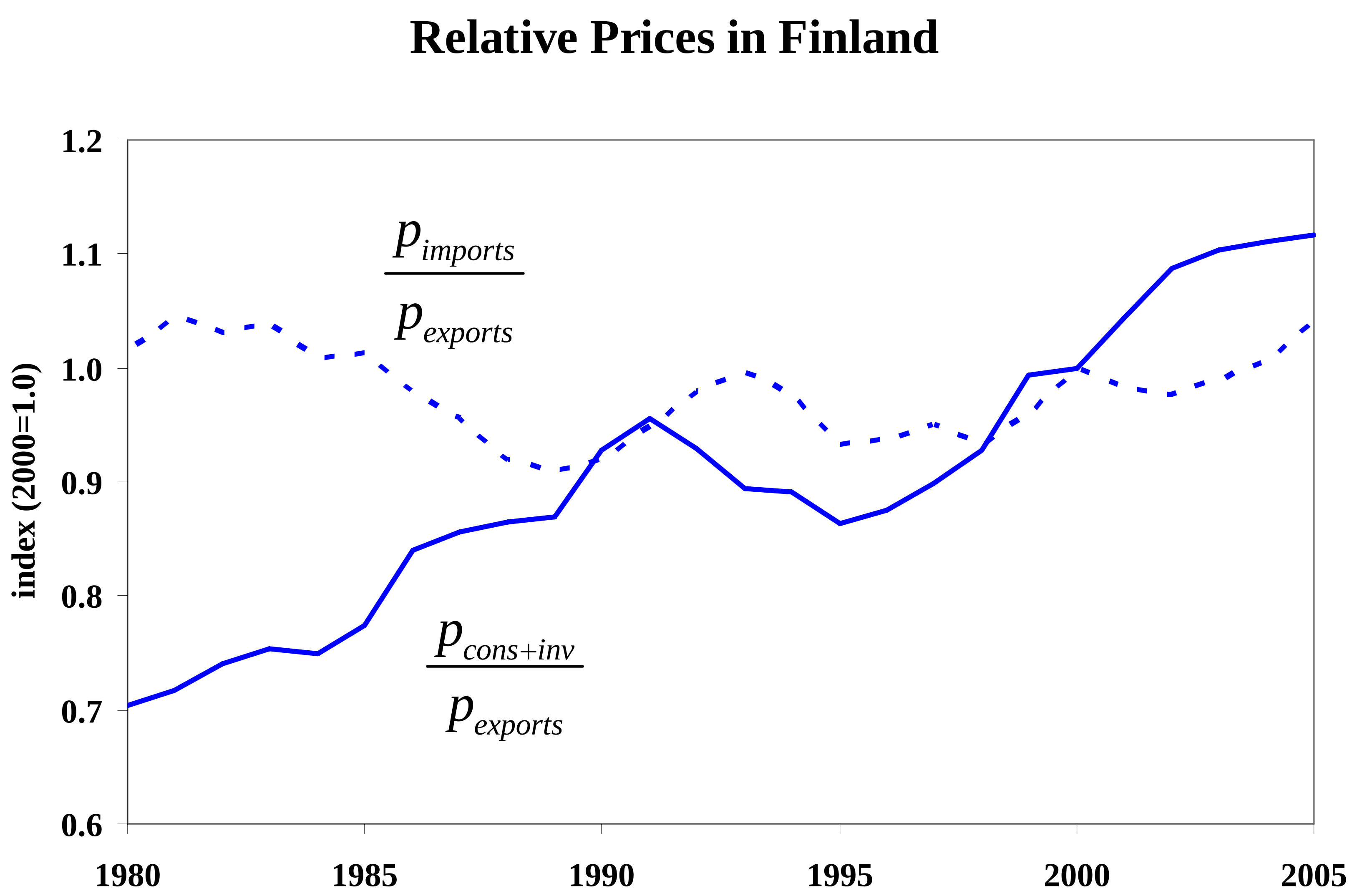
Investment-consumption good price

$$q_t = D_t^{-1} \left( \omega^{\frac{1}{1-\rho}} + (1-\omega)^{\frac{1}{1-\rho}} \, p_{m,t}^{\frac{-\rho}{1-\rho}} \right)^{\frac{1-\rho}{-\rho}}$$

# Open Economy Model Calibration

Exogenous processes

- Terms of trade, $p_{m,t}$, from data
- Productivity in investment-consumption sector, $D_t$, from data


Relative Prices in Finland
index (2000=1.0)
1.2
1.1
1.0
0.9
0.8
0.7
0.6
1980
1985
1990
1995
2000
2005
$\frac{p_{imports}}{p_{exports}}$
$\frac{p_{cons+inv}}{p_{exports}}$

# Open Economy Model Calibration

Exogenous processes

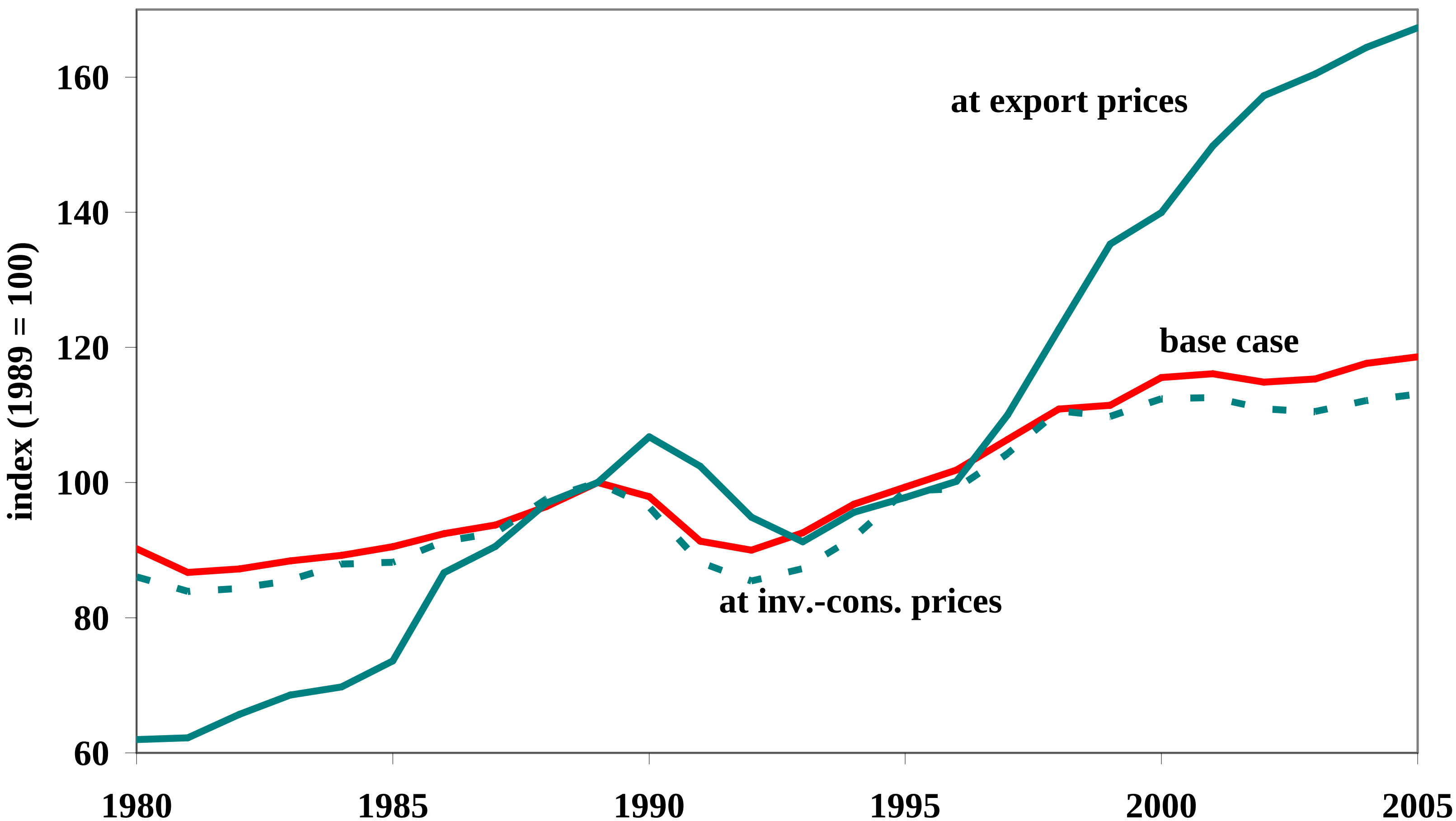
- Terms of trade, $p_{m,t}$, from data
- Productivity in investment-consumption sector, $D_t$, from data
- Productivity in the domestic sector, $A_t$

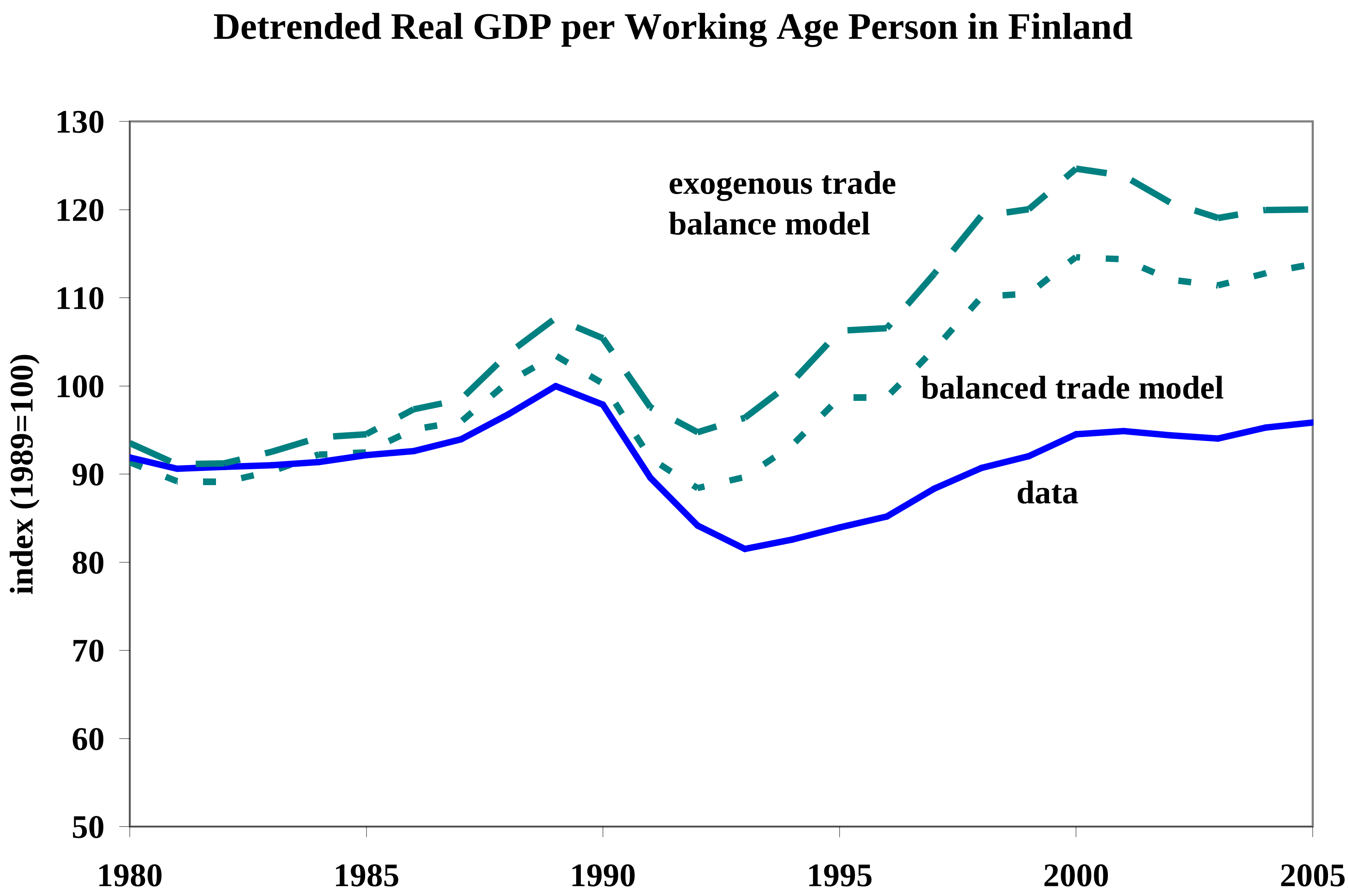
Exogenous productivity is

$$A_t = \frac{\omega^{-\frac{1}{\rho}}\left(\left(C_t + I_t\right)^{\rho} D_t^{-\rho} - \left(1-\omega\right) M_t{}^{\rho}\right)^{\frac{1}{\rho}} + X_t}{K_t{}^{\alpha} L_t{}^{1-\alpha}}$$

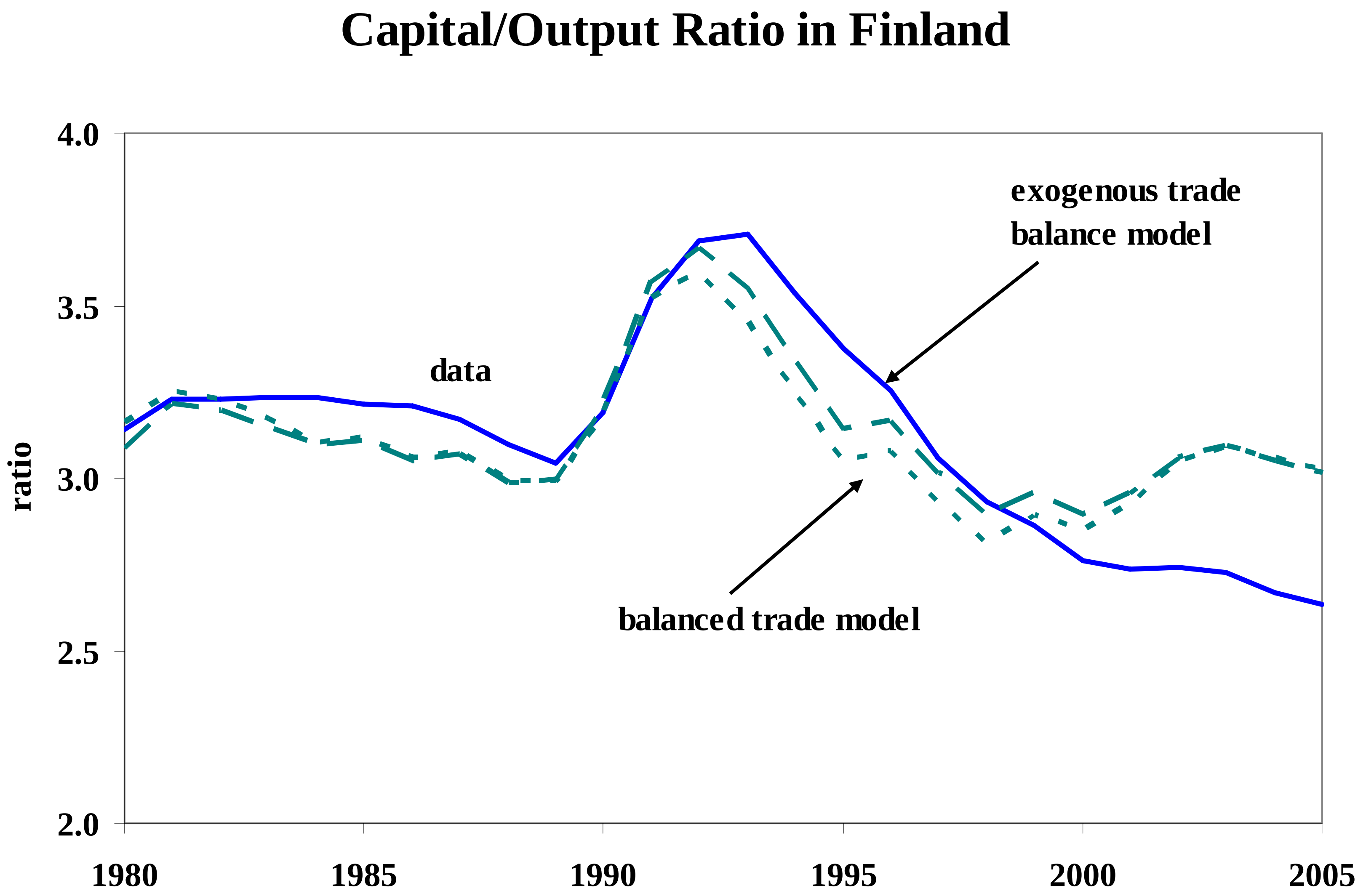
TFP is calculated with real GDP: $\hat{Y}_t = q_{\bar{T}}\left(C_t + I_t\right) + X_t - p_{m,\bar{T}} M_t$

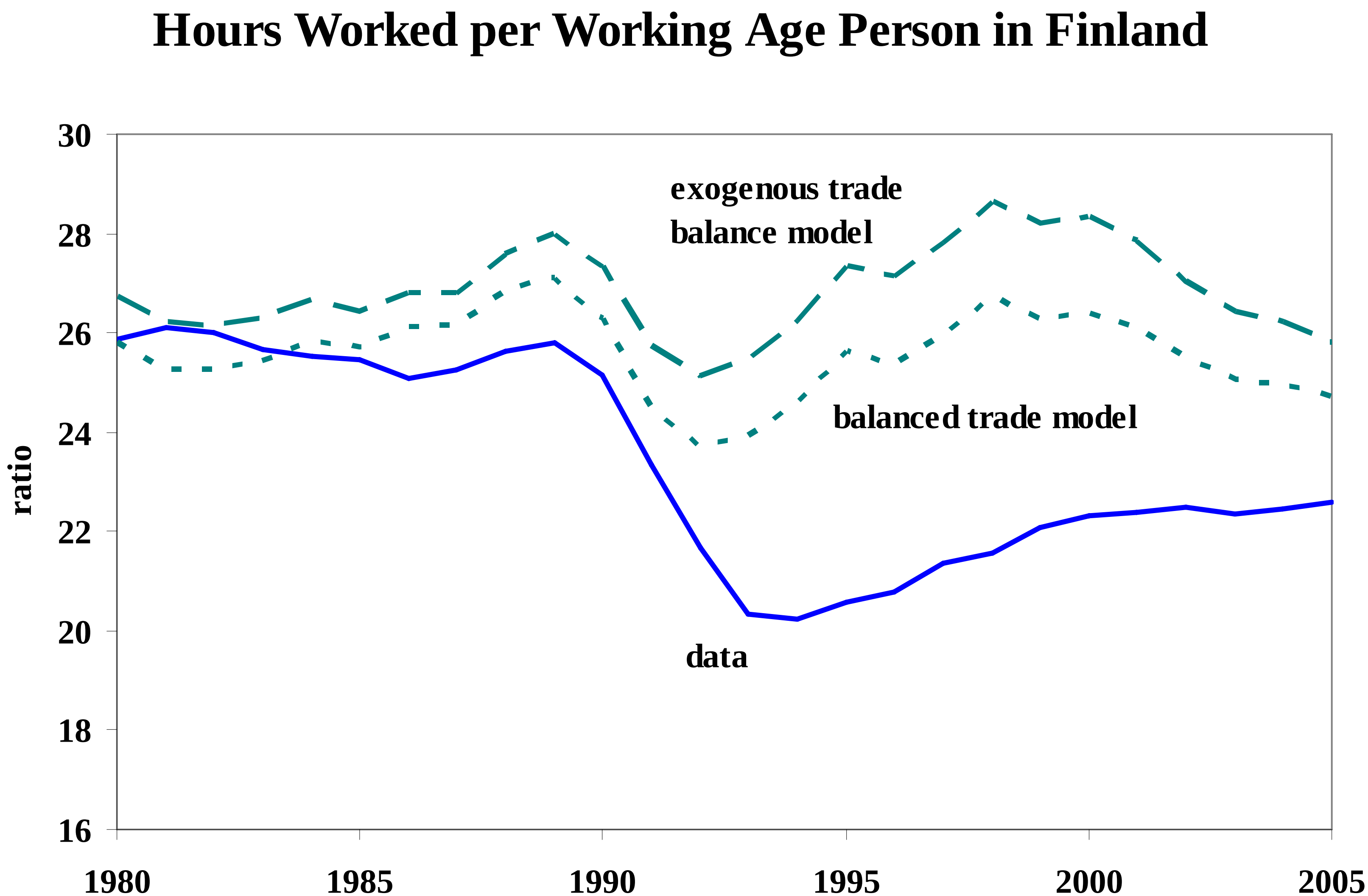
# Detrended Exogenous Productivity Factor





Detrended Real GDP per Working Age Person in Finland
index (1989=100)
130
120
110
100
90
80
70
60
50
1980
1985
1990
1995
2000
2005
exogenous trade
balance model
balanced trade model
data


Capital/Output Ratio in Finland
4.0
3.5
3.0
2.5
2.0
ratio
exogenous trade balance model
data
balanced trade model
1980
1985
1990
1995
2000
2005


Hours Worked per Working Age Person in Finland
30
28
26
24
22
20
18
16
ratio
1980
1985
1990
1995
2000
2005
exogenous trade
balance model
balanced trade model
data

| | Data | Model Open Economy | Model Exogenous Trade Balance |
|---|---|---|---|
| **Growth 1980-89** | | | |
| change in Y/N | 2.92 | 3.36 | 3.55 |
| due to TFP | 3.15 | 3.16 | 3.23 |
| due to K/Y | -0.19 | -0.34 | -0.19 |
| due to L/N | -0.03 | 0.54 | 0.51 |
| **Crisis 1989-93** | | | |
| change in Y/N | -3.14 | -1.60 | -0.79 |
| due to TFP | 0.07 | -0.47 | -0.82 |
| due to K/Y | 2.75 | 2.00 | 2.38 |
| due to L/N | -5.96 | -3.13 | -2.35 |
| **Recovery 1993-2005** | | | |
| change in Y/N | 3.33 | 3.97 | 3.81 |
| due to TFP | 4.06 | 4.31 | 4.47 |
| due to K/Y | -1.59 | -0.62 | -0.76 |
| due to L/N | 0.87 | 0.27 | 0.10 |

# What Happened to TFP?

Two extra exogenous processes

1. Terms of trade
2. Productivity in the investment-consumption sector

What is the terms of trade effect?

Leave calibration unchanged, set $p_m \equiv 1$

| | Data | Model Open Economy | Model Open Economy No TOT |
|---|---|---|---|
| **Growth 1980-89** | | | |
| change in Y/N | 2.92 | 3.36 | 3.17 |
| due to TFP | 3.15 | 3.16 | 3.12 |
| due to K/Y | -0.19 | -0.34 | -0.21 |
| due to L/N | -0.03 | 0.54 | 0.27 |
| **Crisis 1989-93** | | | |
| change in Y/N | -3.14 | **-1.60** | **-1.28** |
| due to TFP | 0.07 | -0.47 | -0.38 |
| due to K/Y | 2.75 | 2.00 | 1.52 |
| due to L/N | -5.96 | **-3.13** | **-2.36** |
| **Recovery 1993-2005** | | | |
| change in Y/N | 3.33 | 3.97 | 3.94 |
| due to TFP | 4.06 | 4.31 | 4.27 |
| due to K/Y | -1.59 | -0.62 | -0.62 |
| due to L/N | 0.87 | 0.27 | 0.29 |

# Are Shocks to the Terms of Trade Shocks to Productivity?

# Are Shocks to the Terms of Trade Shocks to Productivity?

**No.**

A terms of trade deterioration can affect supplies of inputs.

A terms of trade deterioration does not affect productivity.

This result follows from the way real GDP is constructed.

# A Simple Closed Economy

Consumption good production

$$y_t = f(\overline{\ell}, m_t)$$

Intermediate good production

$$m_t = \frac{x_t}{a_t}$$

$$p_t = a_t$$

Feasibility

$$c_t + x_t = y_t$$

Real GDP at base year prices

$$Y_t = c_t = y_t - x_t$$

A competitive economy solves

$$\max f(\overline{\ell}, m_t) - a_t m_t$$

The first-order condition is

$$f_m(\overline{\ell}, m_t) = a_t$$

By the implicit function theorem

$$m'(a_t) = \frac{1}{f_{mm}(\overline{\ell}, m(a_t))} < 0$$

Real GDP

$$Y(a_t) = f\left(\overline{\ell}, m(a_t)\right) - a_t m(a_t)$$

How does real GDP change when $a$ changes?

$$Y(a_{t+1}) - Y(a_t) \approx \frac{dY(a_t)}{da_{t+1}}(a_{t+1} - a_t)$$

$$\frac{dY(a_t)}{da_{t+1}} = f_m(\bar{\ell}, m(a_t))m'(a_t) - a_t m'(a_t) - m(a_t) = -m(a_t) < 0$$

Real GDP and TFP fall with a decline in productivity.

# A Simple Open Economy

Reinterpret the closed economy as an open economy.

The intermediate is imported at price $p$, the terms of trade

$$p_t m_t = x_t$$

Real GDP in the open economy:

$$Y_t = c_t + x_t - p_0 m_t = y_t - p_0 m_t = f(\bar{\ell}, m_t) - p_0 m_t$$

Compared to real GDP in the closed economy:

$$Y_t = c_t = f(\bar{\ell}, m_t) - x_t$$

A competitive economy solves

$$\max f(\overline{\ell}, m_t) - p_t m_t$$

The first-order condition is

$$m'(p_t) = \frac{1}{f_{mm}(\overline{\ell}, m(p_t))} < 0$$

How does real GDP change when $p$ changes?

$$Y(p_{t+1}) = f(\bar{\ell}, m(p_{t+1})) - p_0 m(p_{t+1})$$

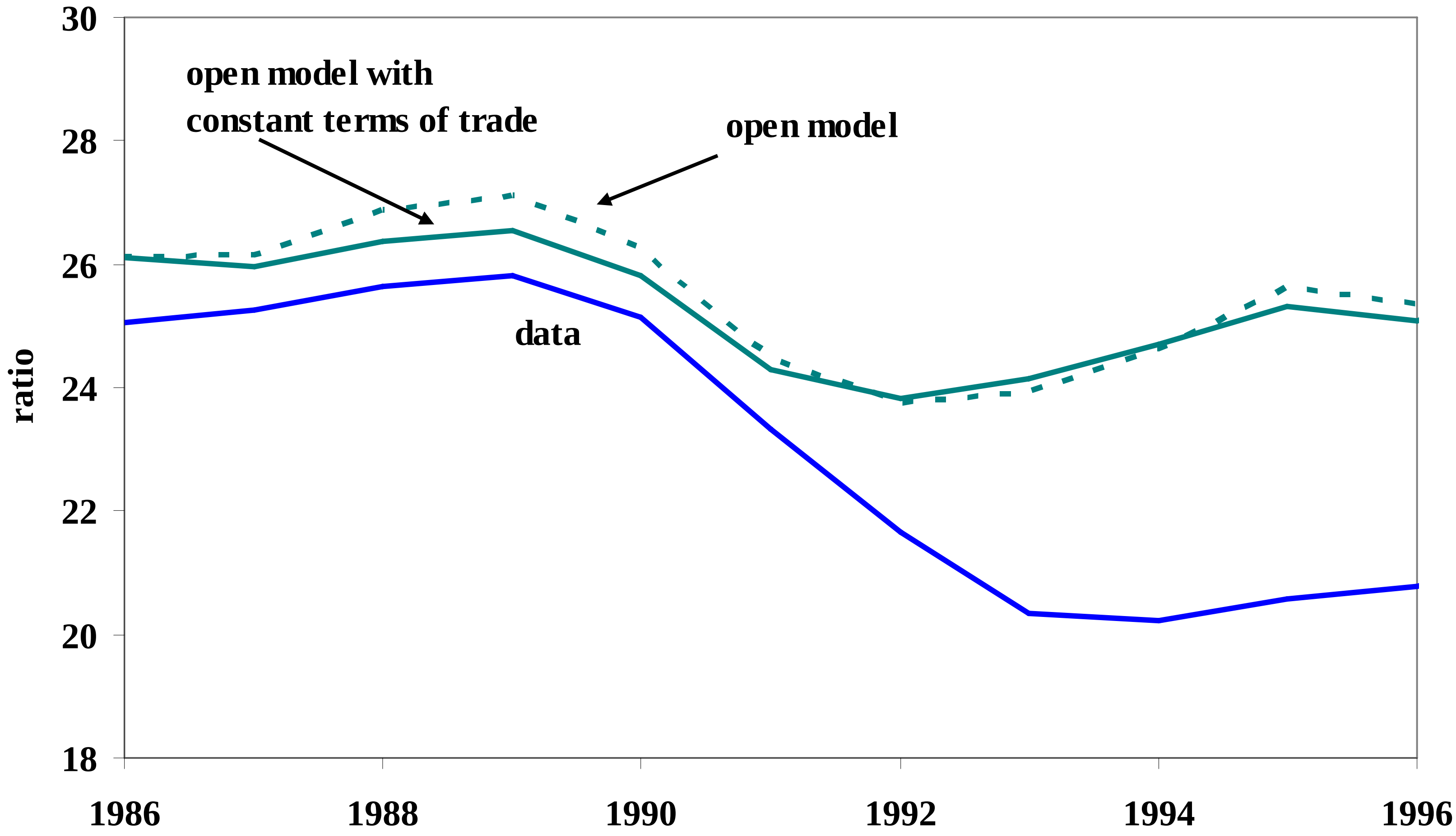
$$\frac{dY(p_t)}{dp_{t+1}} = f_m(\bar{\ell}, m(p_t))m'(p_t) - p_0 m'(p_t) = (p_t - p_0)m'(p_t)$$

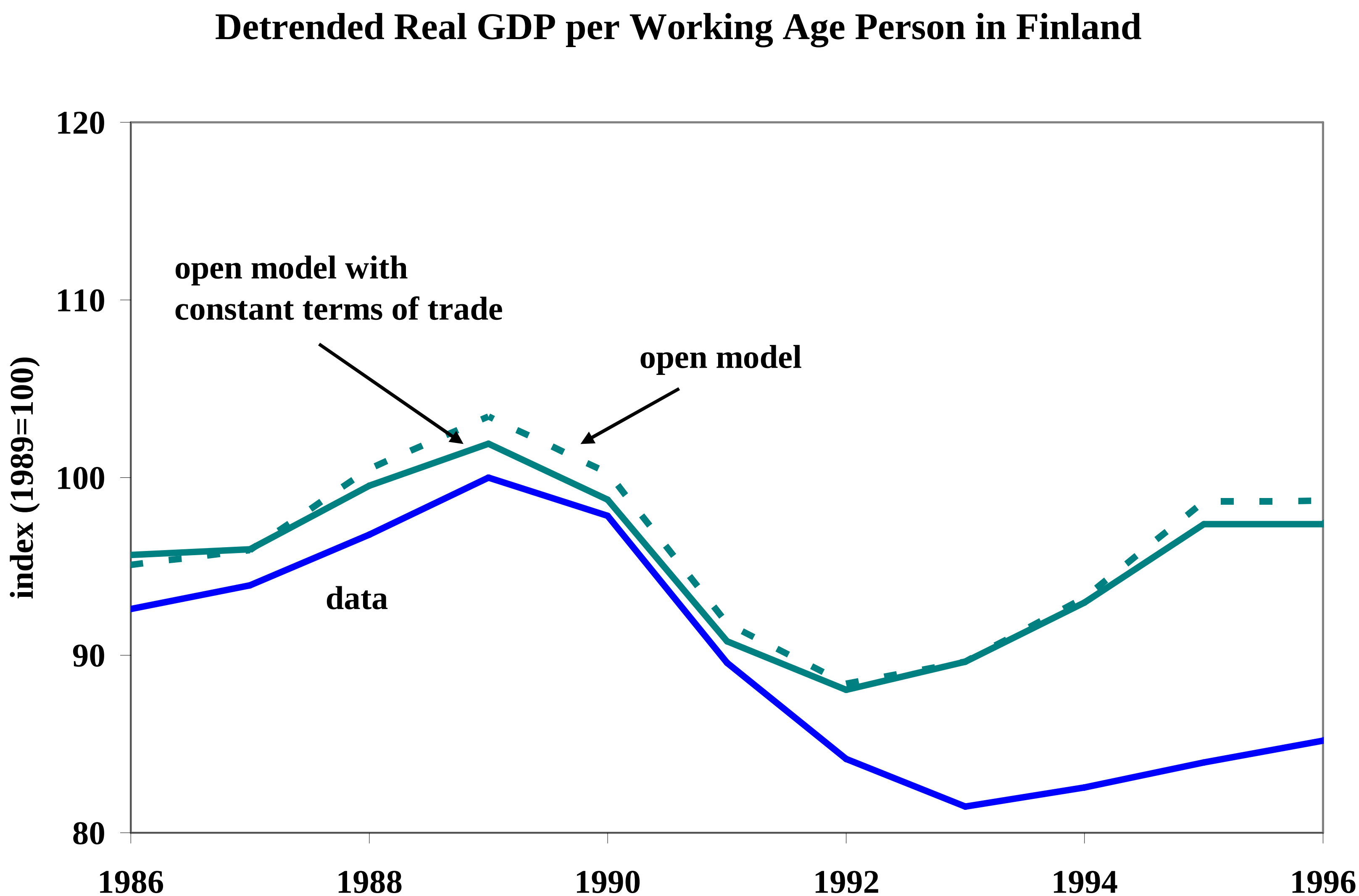
Real GDP and TFP can increase or decrease, depending on $p_t - p_0$.

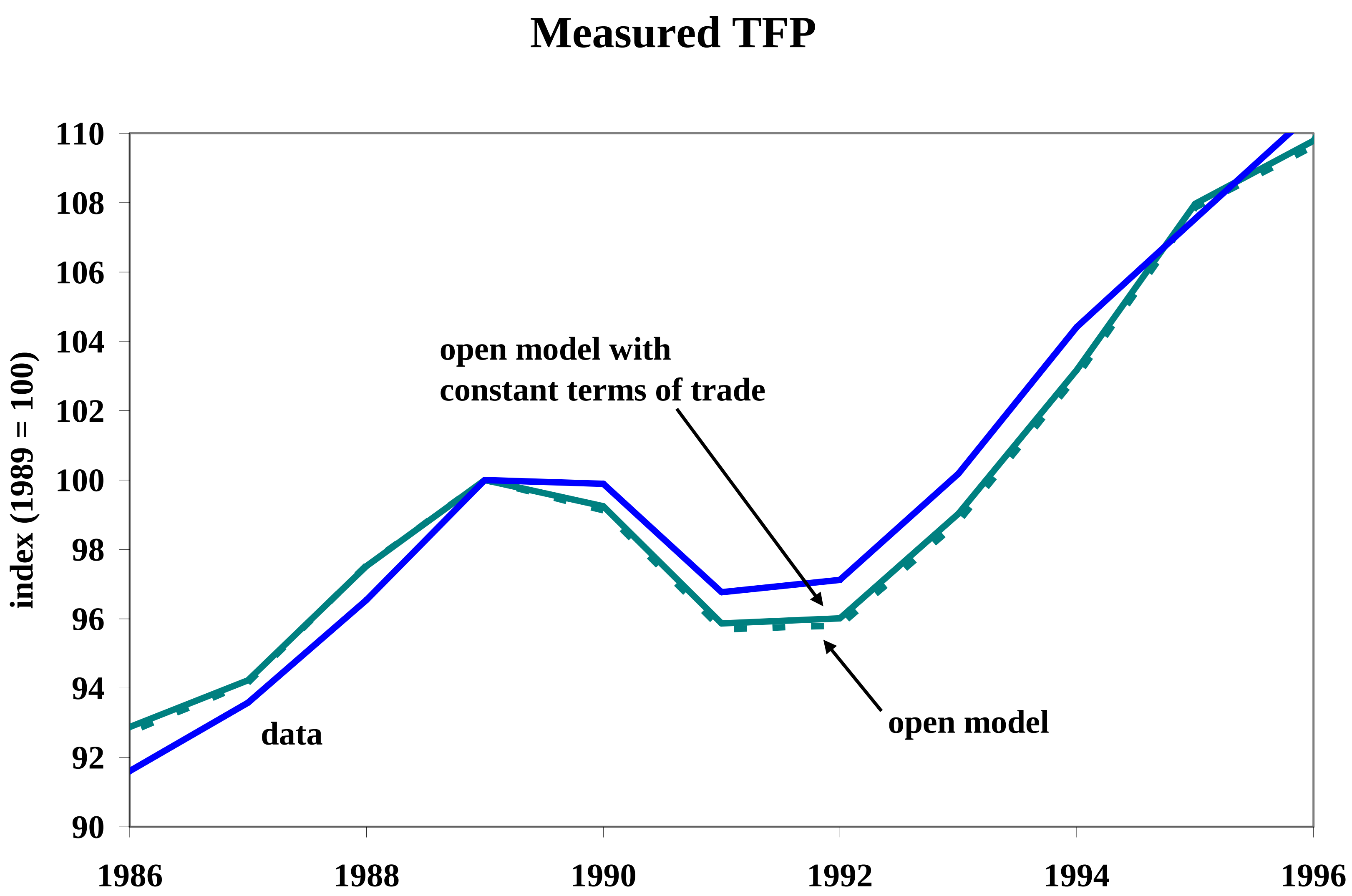
With chain weighting the first-order effect is *always* zero.

With variable labor supply, real GDP will change, but productivity will not.

# Hours Worked per Working Age Person in Finland




Detrended Real GDP per Working Age Person in Finland
index (1989=100)
120
110
100
90
80
1986
1988
1990
1992
1994
1996
open model with
constant terms of trade
open model
data



Measured TFP
index (1989 = 100)
110
108
106
104
102
100
98
96
94
92
90
1986
1988
1990
1992
1994
1996
open model with
constant terms of trade
data
open model

# What Have We Learned?

1. The crisis in Finland is accounted for by
   - Decrease in TFP
   - Decrease in hours worked
2. Standard model accounts for 51% of output decline
3. Adding policy: taxes, government spending
   - Model accounts for 136% of output decline
   - Improves behavior of labor
4. Open economy model
   - Model accounts for 72% of output decline
5. Endogenous TFP:

# Exogenous Productivity, Detrended