The Depression in Finland in the 1990s

Juan Carlos Conesa
Timothy J. Kehoe
Kim J. Ruhl

ITAM
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Real GDP per Working Age Person in Finland

[Graph showing the trend of real GDP per working age person in Finland from 1980 to 2005, with an index scale from 70 to 140.]
Understanding the Finnish Depression

Base case: neoclassical growth theory

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


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
   --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 \( \{C_t, K_t, L_t\} \)

\[
\max \sum_{t=0}^{\infty} \beta \left( \gamma \log(C_t) + (1-\gamma) \log(hN_t - L_t) \right)
\]

s.t. \( C_t + K_{t+1} = w_tL_t + (1-\delta+r_t)K_t \)

Technology

\[
Y_t = A_tK_t^\alpha L_t^{1-\alpha}
\]

Feasibility

\[
C_t + K_{t+1} - (1-\delta)K_t = A_tK_t^\alpha L_t^{1-\alpha}
\]
The Balanced Growth Path

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

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 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

[Graph showing the index of real GDP per working age person from 1980 to 2005, with data and base case model lines.]
Capital/Output Ratio in Finland

Data vs. Base Case Model

Graph showing the capital/output ratio in Finland from 1980 to 2005, comparing data with the base case model.
Hours Worked per Working Age Person in Finland

- Base case model
- Data

The graph shows the trend of hours worked per working age person in Finland from 1980 to 2005.
### Growth Accounting Summary

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<thead>
<tr>
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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

- Labor tax
- Consumption tax
- Capital income tax
Detrended Real GDP per Working Age Person in Finland

index (1989=100)

open model with constant terms of trade

open model

data
A Model with Taxes and Government Spending

Households choose \( \{C_t, K_t, L_t\} \)

\[
\max \sum_{t=T_0}^{\infty} \beta \left( \gamma \log(C_t) + (1 - \gamma) \log(hN_t - L_t) \right)
\]

s.t. \((1 + \tau_t^c)C_t + K_{t+1} = (1 - \tau_t^{\ell})w_tL_t + \left(1 + (1 - \tau_t^k)(r_t - \delta)\right)K_t + T_t\)

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


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”

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

TFP is measured with real GDP, $\hat{Y}_t = (1 + \tau^c_{\tau})C_t + I_t + G_t$

Recalibrate $\beta, \gamma$
Exogenous Productivity, Detrended

base case = TFP
model with taxes and government
Real GDP per Working Age Person in Finland

Index (1980=100)
Capital/Output Ratio in Finland

model with taxes

model with taxes and government

data
Hours Worked per Working Age Person in Finland

- Model with taxes and government
- Model with taxes

Source: Data
## Growth Accounting Summary

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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)


Post-crisis labor allocation is correct

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

index (1980=100)
Net Exports

[Graph showing the share of GDP (%) from 1980 to 2005 with peaks and troughs]

-8.0 -6.0 -4.0 -2.0 0.0 2.0 4.0 6.0 8.0 10.0 12.0


share of GDP (%)

Net Exports
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

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

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

\[
C_t + K_{t+1} - (1 - \delta)K_t = D_t \left( \omega Z_{d,t}^\rho + (1 - \omega) M_t^\rho \right)^{\frac{1}{\rho}}
\]
The firm’s problem

\[
\min_{Z_t, M_t} \ Z_t + p_{m,t} M_t
\]

s.t. \( \bar{Y}_t \leq D_t \left( \omega Z_t^\rho + (1 - \omega) M_t^\rho \right)^{1/\rho} \)

Investment-consumption good price

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

\[ \frac{p_{\text{imports}}}{p_{\text{exports}}} \]

\[ p_{\text{cons+inv}} \]

\[ p_{\text{exports}} \]
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

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

TFP is calculated with real GDP:

$$\hat{Y}_t = q_T (C_t + I_t) + X_t - p_{m,T} M_t$$
Detrended Real GDP per Working Age Person in Finland

- exogenous trade balance model
- balanced trade model
- data

Index (1989=100)

Year:
- 1980
- 1985
- 1990
- 1995
- 2000
- 2005
Capital/Output Ratio in Finland

[Graph showing the capital/output ratio from 1980 to 2005, with three lines indicating data, exogenous trade balance model, and balanced trade model.]
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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 $p_m \equiv 1$
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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

\[ y_t = f(\ell, m_t) \]

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

\[ \max f(\ell, m_t) - a_t m_t \]

The first-order condition is

\[ f_m(\ell, m_t) = a_t \]

By the implicit function theorem

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

Real GDP

\[ Y(a_t) = f(\ell, m(a_t)) - a_t m(a_t) \]
How does real GDP change when $a$ changes?

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

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

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:

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

Compared to real GDP in the closed economy:

$$Y_t = c_t = f(\overline{\ell}, m_t) - x_t$$
A competitive economy solves

$$\max f(\ell, m_t) - p_t m_t$$

The first-order condition is

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

- Open model
- Open model with constant terms of trade
- Data
Detrended Real GDP per Working Age Person in Finland

index (1989=100)


open model with constant terms of trade

open model

data
Measured TFP

Data open model

open model with constant terms of trade
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

- Base case = TFP
- Model with taxes and government
- Open economy (at consumption prices)