Environment and technical change in endogenous growth theory.

Anton Bondarev

Department of Businness and Economics,
Basel University

28.02.2018

Preamble

- What is this all about? (Goal of the course)
- Position of the discipline
- Intentional structure
- Prerequisites
- Formalities

Main points

- Basic concepts of growth theory
- Technical change as the source of growth.
- Endogenous growth: sources of growth
- Environment in growth theory: sustainability, climate change, green growth
- Environment and technical change: their interaction
- Environment and technical change in endogenous growth models

Investments, savings and consumption

- Basic macroeconomic identity
- Representative household and its budget
- Savings and investments
- Productive capital and labour
- Ramsey problem

Ramsey growth model

- The first dynamic model of consumption (1928)
- Foundation of both Resource Economics and Growth Theory
- Maximization of **lifetime** utility
- No explicit production function
- Optimal choice of current consumption **rate**
- Capital accumulation provides higher consumption possibilities in the future

Main Idea: Choice between consuming now or saving for tomorrow (growth)

Typical growth framework

- Economic growth is the growth of output
- It leads to the increase in consumption possibilities
- Balanced growth path notion
- The source of growth are investments
- Savings rate defines the **growth rate** of the economy

Main Idea: Capital accumulation is used for improving consumption possibilities

Role of technical change

- Technology defines the productivity of production factors L, K
- Given constant technology per capita growth is **limited**
- The only source of ongoing growth is productivity increase
- The technical change itself is not sufficient to support growth
- Technical change has to be **managed** and stimulated

Ergo: To explain growth we need to explain technical change!

Evolution of technology in stylized facts

- Technical progress had **increasing speed** till recently
- Today R&D exhibits **declining productivity** leading to slowdown in growth
- Still, **larger fraction** of the world's population is participating in scientific research and development than ever;
- Technical change may be **non-monotonic**
- Knowledge spillovers may lead to **increasing returns to scale**
- Major part of R&D today is performed by **large multinational enterprises**

Some numbers from cliometric surveys: Industrial Era

	Labour productivity growth	Capital deepening	TFP
Austria			
1870-1890	0.9	0.64	0.26
1890-1910	1.69	0.66	1.03
Germany			
1871-1891	1.10	0.39	0.71
1891-1911	1.76	0.58	1.18
Great Britain			
1700-1760	0.40	0.14	0.26
1760-1801	0.20	0.07	0.13
1801-1831	0.50	0.10	0.40
1831-1871	1.25	0.35	0.90
1873-1913	0.90	0.38	0.52

Numbers from cliometric surveys:: XX century

	Labour productivity	Capital deepening	TFP
Italy, 1951-1973	4.51	1.61	2.90
Portugal, 1947-1973	4.47	2.46	2.01
Spain, 1951-1974	5.5	1.8	3.7
Sweden, 1950-1973	3.68	1.82	1.86
Korea,1960-1990	5.06	2.84	2.22
Singapore,1960-1990	4.97	3.34	1.63
Taiwan,1960-1990	6.07	3.17	2.90

Sources of technical change

- **Factor-enhancing** technical change:
  1. Capital deepening
  2. Human capital accumulation
  3. Embodied technical change (innovations)
- **New products creation**:
  1. General purpose technologies (GPT)
  2. Creative destruction
  3. Variety expansion
- Knowledge spillovers

Impact on the economy

- Factor-enhancing technical change increases **productivity**
- Products creation changes the **structure** of the economy:
  1. GPT creates new sectors and destroys some older ones, changing interrelationships (advance of IT)
  2. Creative destruction upgrades existing product, making obsolete the older version (new iPhone)
  3. Variety expansion creates new product but in line of existing structure (advance of smartphones)
- Change in knowledge spillovers affects growth rates non-monotonically

Stylized facts

- **Resources**:
  - Humanity uses more and more resources and wider diversity of them
  - Efficiency of usage and extraction is growing due to technical change
- **Environment**:
  - Environment is threatened as a by product of output (pollution)
  - Climate is changing as a result of economic activity (IPCC 2014)
  - Deteriorating environment negatively affects production /welfare
- Transition to a greener economy requires much effort and time

Resources and environment: Similarities and differences

- **Resources** may be:
  1. Limited (exhaustible) and unlimited (renewable)
  2. Essential and non-essential
- **Environment** may be treated as a renewable resource or as a public good
- Resource economics: optimal extraction rates and time to depletion
- Environmental economics: sustainable management and preservation of environment

Social welfare: efficiency vs optimality

- Leon Walras: every market distribution is efficient;
- Alfred Marshall: demand system and prices are keys to efficient distribution;
- Pareto: optimality and efficiency;
- Social welfare function concept;
- Ethical issues.

Special role of public goods

- "Standard" public good is available for all;
- Markets do not work in its efficient provision;
- Necessity of central government;
- Types of public goods;
- Are natural resources public goods?
- Common goods, open access goods and public goods: differences;
- Special role of environmental goods.

Environment as a public good

- There are resources, which are:
  1. Indivisible,
  2. Non-excludable,
  3. Are not human-made.
- These properties distinguish **environmental goods** from **resources** and **public goods**:
  1. Environmental goods cannot be produced;
  2. They cannot be "extracted" either;
  3. Can deteriorate, harming utility (social welfare).
- Examples:
  1. Air,
  2. Ocean,
  3. Wilderness areas,
  4. Biological diversity.

Birth of environmental economics

- Environmental goods increase social welfare and utility;
- Environment is deteriorated through economic activities;
- Intergenerational sustainability;
- Climate change as general environmental good;
- Discussion of optimal environmental policies:
  1. Double dividend hypothesis
  2. Environmental Kuznets curve
  3. Green growth hypothesis

Impact of technical change on resources

- Technology improves efficiency
- It opens up more extraction possibilities
- Some resources are substituted by others (coal by oil)
- Increasing output increases resource's demand
- Increasing efficiency saves the resource

Impact of technical change on environment

May be **ambiguous**:

- Negative:
  1. Technology improves output
  2. Increasing output damages the environment
- Positive:
  1. Newer technologies may be cleaner
  2. More resources available for **abatement**
- The **type** and **direction** of technical change are important

Competitive usage of savings

- Savings may be used for investments into
  1. Capital, directly increasing future output
  2. R&D, increasing factors' efficiency
  3. Abatement, minimizing environmental impact
- These usages are competitive
- Social planner is needed to manage this
- Optimal control approach vs. Market equilibrium

Main ideas and concepts

- Green growth concept
- Structural change concept
- Sustainable development
- Double dividend
- Environmental Kuznets curve
- Technology lock-in

Components

Each techno-environmental growth model consists of:

1. Growth model of the economy
2. Model of R&D in it
3. Place of environment and type of market failure studied (resource, climate, etc.)
4. Interaction between technology, growth and environment

Methods

- Dynamic systems analysis: steady states, stability
- General equilibrium tools: markets clearing, budget constraints, production
- Optimal control methods: social policy, optimal management

Control for the course

- Written exam **30.05.2018**
- Several open questions
- No math. problems, no calculations required
- Each question addresses **one** model from the lectures
- You have to demonstrate the overall understanding of the structure and differences from other approaches.

Intentional timeplan

Lecture Date	Topic
7.03	Introduction to growth theory
14.03	Resources and growth
21.03	Pollution and growth
28.03	**No lecture**
4.04	Endogenous growth and environment
11.04	Endogenous growth theory: Variety expansion
18.04	Variety expansion and environment
25.04	Endogenous growth theory: Quality ladders
2.05	Quality ladders and environment
9.05	Directed technical change
16.05	Directed technical change and environment
23.05	Doubly-differentiated R&D growth and environment
30.05	Exam