Why do we need theory (and metrics) of technology upgrading?

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Outline

- Motivation
- Past contributions and their limits
- Conceptual framework and its assumptions
- Towards metrics of technology upgrading

Motivation 1: Aggregate theories of growth are not useful

- Search for universal factors of growth is futile
- Technology is not reducible to single variable (TFP?'not even wrong')

Motivation 2: current metrices are atheoretical or not relevant for low/middle income economies

- Global innovation index and Innovation Union Scoreboard are pragmatic but atheoretical
- CDM model (RD>innovation>productivity) is is theoretically grounded but irrelevant for middle income economies (see EBRD 2014 Innovation in transition report)
- WEF GCI recognizes differences in drivers of growth (theoretically grounded) but is mixing technological and institutional variables

Motivation 3: wrong metrics leads to irrelevant policies

- The contradiction in the current EU approach between its dominant metrics (cf. IUS) which assumes identical technological paths and drivers of growth and the wish to push countries along divergent 'smart specialization' paths.

- The EU is pushing countries and regions to embark on process of formulating their SS strategies to avoid so called 'adding up' problem (Spence 2011: 94-96) or situation that too many regions are aiming for similar technologies and markets and thus competing each other out.

Vs.

- Its dominant metrics IUS which countries and regions are using as policy targets is actually reinforcing imitative policies towards R&D based growth.

- Outcome: metrics which determines policy instead of policy determining metrics

Our aim

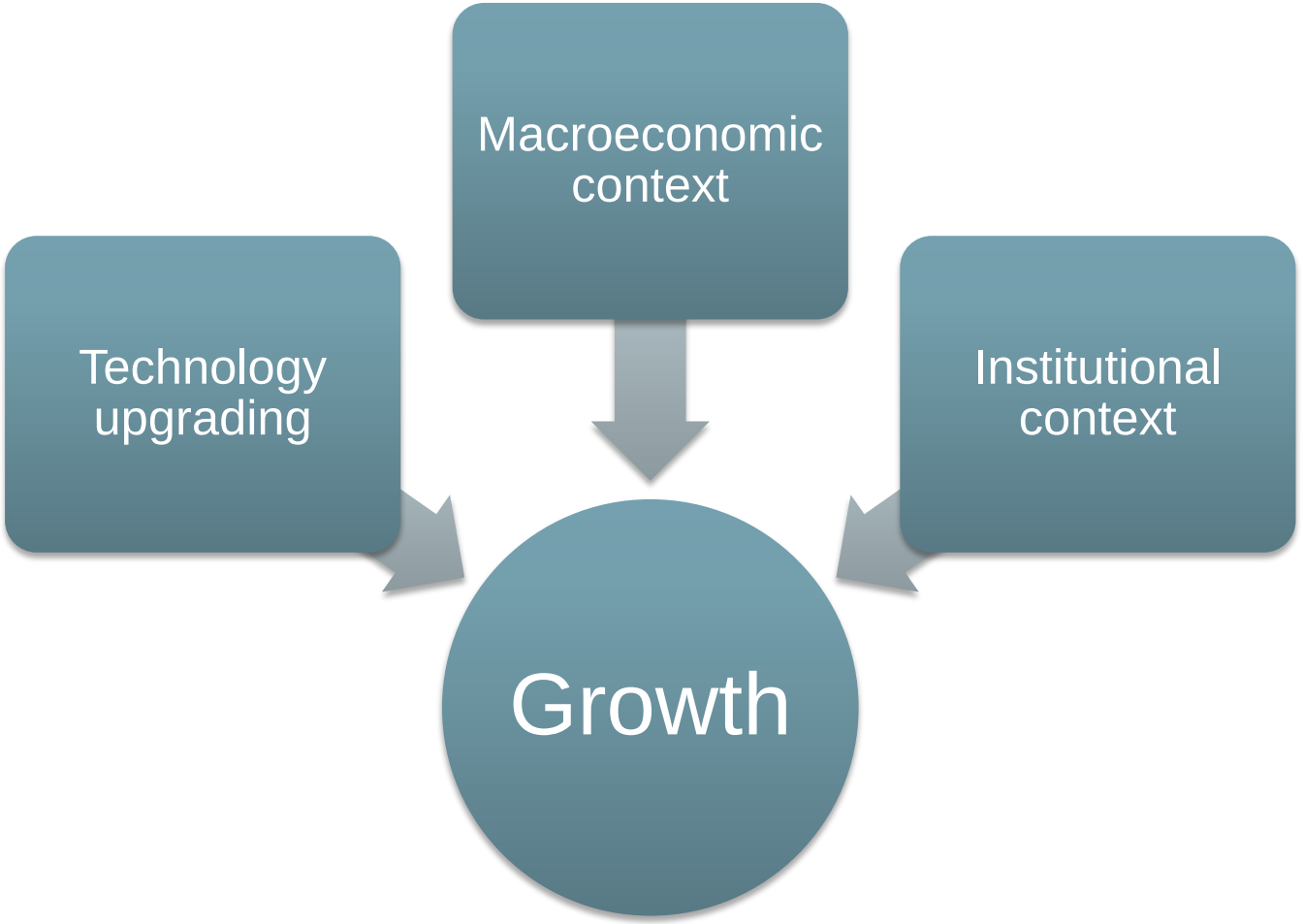
- to generate theoretically relevant but empirically grounded middle level conceptual and statistical framework which could illuminate a type of challenges which seem relevant for a large number of low income EU and neighbouring economies in their path out of potential middle-income trap.

An outcome

- to construct composite indicator of technology upgrading, which can complement, not replace, IUS and which reflect better different drivers and patterns of technology upgrading in the wider Europe

- cf. ‘measurement without theory’

Growth and technology upgrading



Past contributions

- Marshall (1890): differences among different economic sectors > aggregate effects on growth
- Schumpeter (1939): leading sectors > macroeconomic cycles
- Kuznets (1930): shifts in the relative importance of leading industries > life cycle patterns in terms of sales and innovation
- Rostow (1960): growth stages
- Chenery (1986): grouping of industries linked to patterns of development
- Akamatsu (1961): 'flying geese model'

Contemporary contributions

- Ozawa (2010): 'ladder of economic development'
- Upgrading via Global Value Chains (Gereffi, Schmitz, Kaplinsky, et al)
- 'New Structural Economics' Justin Yifu Lin (2005, 2010, 2012, etc.): technology upgrading by 'copying industries' based on latent comparative advantages in transition from low to middle income
- Keun Lee (2012): 'detour' or taking your own path in transition from middle to high income
- Foray (2014) - "Smart specialization' (history in making): the biggest experiment ever in innovation and growth policy (£120bn)

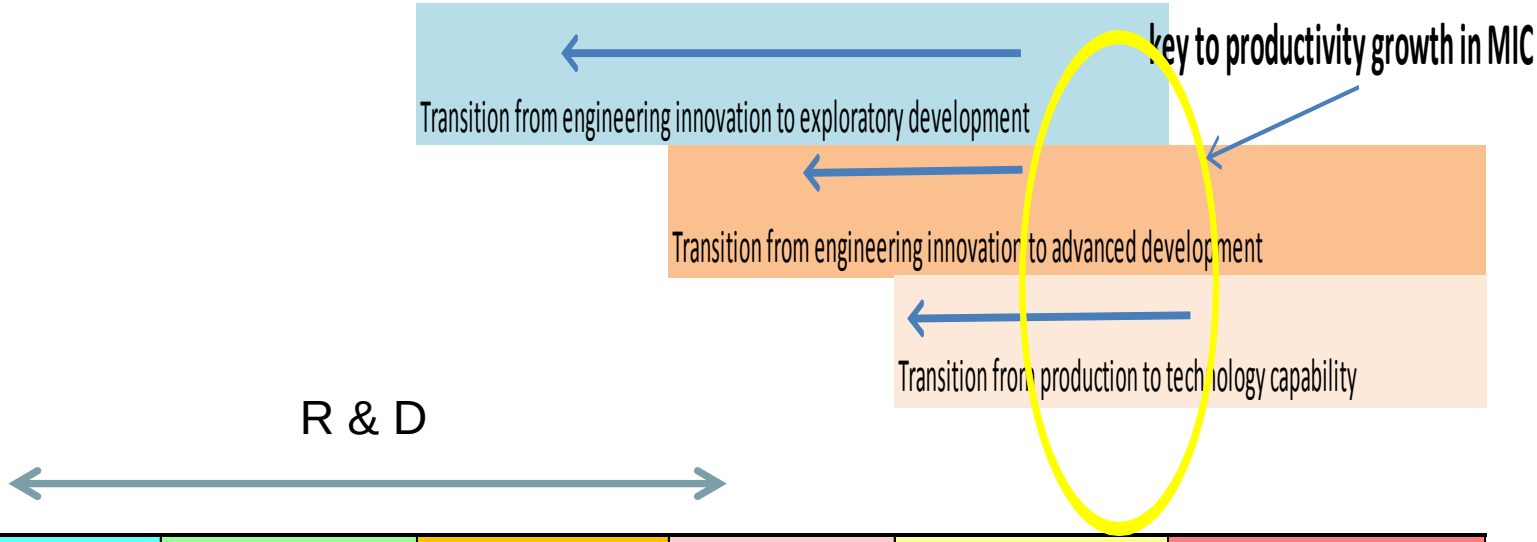
Relevant insights from these contributions

- Assumption that ‘all nations go through the same stages in the same order, though not necessarily at the same time’ (NVTunzelmann, 1995) > (i)relevant?
- Technology upgrading is an interactive process between ‘leaders’ and ‘followers’ (Akamatsu)
- International context of upgrading (GVC)
- Copying / not copying industries (Lin vs Lee)
  - copying of institutions ? Cf. Transition economies

Multi-level perspectives on technology upgrading

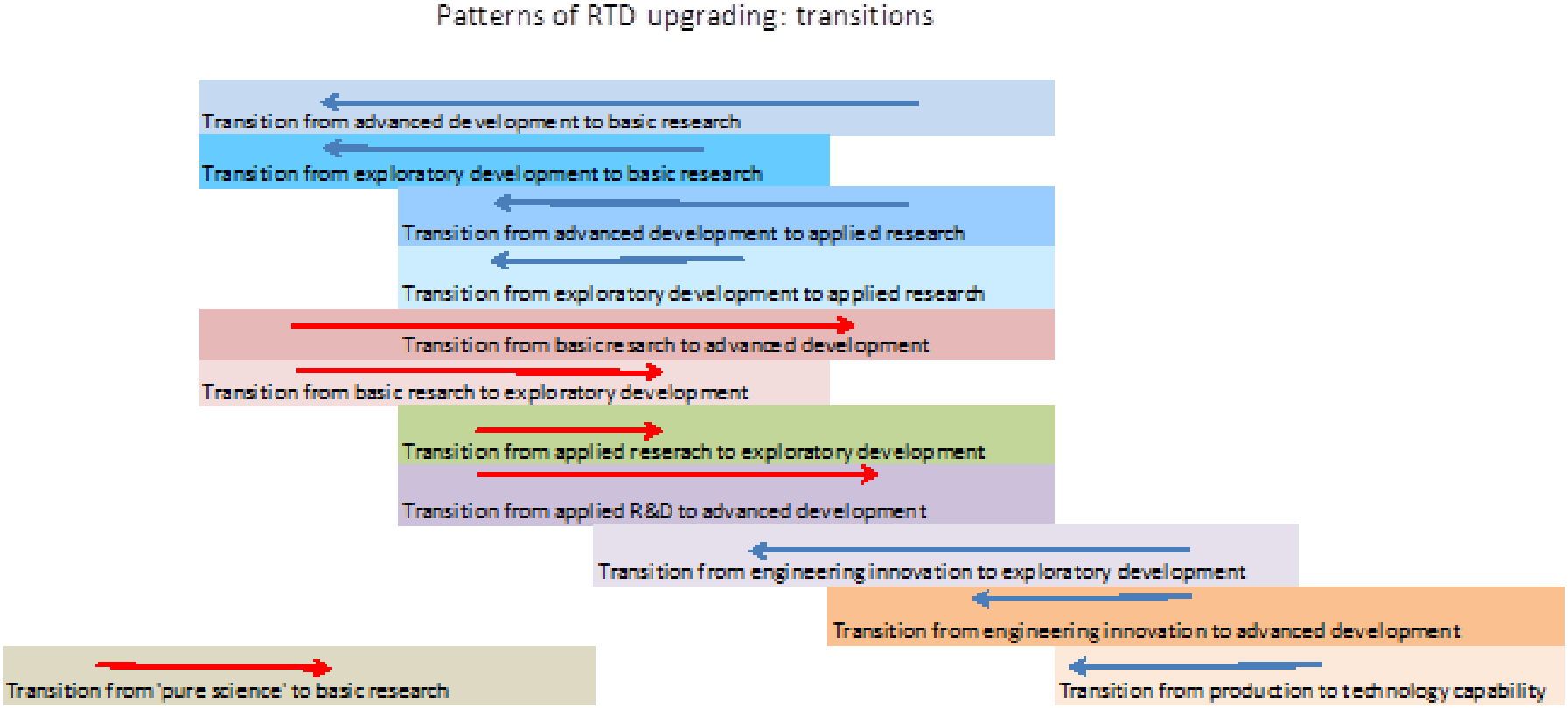
Types / Levels	Conceptual framework
Intra firm level	- Production vs. technology capability (Bell and Pavit, 1993)(Lall, Dahlman and Westphal, et al) -Reverse product life cycle: A combination of the product life cycle model in advanced firms by Utterback and Abernathy (1975) and Kim's (1980) three stage catch-up model of Acquisition – Assimilation - Implementation - Importance of minor improvements during reverse learning trajectory (Hobday 1995, 1998, 2004) - Different entry points for latecomer in post-catch up stage (Choung et al, 2014)
Intra-industry and inter-industry level	-Industry life cycle and dominant design (Klepper) -Upgrading towards high value-added industries (value chain upgrading)
Country level	Sequential upgrading of countries based on 'leading-sector' (Ozawa 2009) WEF rankings based on differing drivers of growth IUS innovation capacity of countries based on composite indicators of innovation activities

From production capability to technology capability



Basic research	Applied research	Exploratory development	Advanced development	Process and product engineering	Production capability
New knowedge for radically new marketable product	Differentiated product 'on paper'	Prototype in a system	Prototype in manufacture	Improvements of existing products and processes	Improved quality of products and processes
Own brand manufacturers		Own design manufacturers	Original equipment manufacturers		
PhD required with experience in R&D		PhD not required/ MSc and BSc required		Skilled engineers	Skilled technicians

Intensity of technology upgrading (scale)



Pure science	Basic research	Applied research	Exploratory development	Advanced development	Process and product engineering	Production capability
Intrinsic knowledge	New knowledge for radically new marketable product	Differentiated product 'on paper'	Prototype in a system	Prototype in manufacture	Improvements of existing products and processes	Improved quality of products and processes
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Taxonomies of firm level upgrading in international context

Authors	Taxonomy / Trajectory	Locus of upgrading
Hobday (1995)	Original Equipment Manufacturing (OEM) Original Design Manufacturing (ODM) Original Brand Manufacturing (OBM)	International production networks
Gereffi (1998)	*within* -factories, -inter-firm networks, -local or national economies, and -supranational macro-regions	Global value chains
Ernst (2001)	*hierarchy of* -industries, -factors of production, -consumption, -value chain stages -forward and backward linkages	Global production networks (2001, 2006), Global knowledge networks (2008), Global innovation networks (2009)
Humphrey and Schmitz (2004)	Process upgrading Product upgrading Functional upgrading Inter-sectoral upgrading	Global value chains

Different perspectives on technology upgrading and structural change

Structural changes which promote technology upgrading	ICT as generic technology: proxy of structural change Knowledge intensive business services (KIBs) Knowledge Intensive Activities (KIA) Lee (2012) indicators of technology diversification
Infrastructural upgrading	An important element or externality of technology upgrading. Inefficiencies in infrastructure can hinder otherwise competitive firms to upgrade Ozawa (2009) infrastructure upgrading

Country level upgrading taxonomies

- IUS upgrading: moderate innovators….followers
- WEF upgrading: factor > efficiency > innovation based
- Ozawa: labor-driven> scale-driven> assembly driven> R&D driven > IT driven
- Hausman et al; Upgrading based on the complexity of export products
- Etc……

Different patterns of technology upgrading at different income levels

TOWARDS THEORY OF TECHNOLOGY UPGRADING

- A key to economic growth is in improved technology capability, which cannot be reduced to a single variable (Lee, 2012) > a number of drivers.
- A multidimensional process = technology, structural change, interaction with global economy
- Based on broader understanding of innovation, which goes well beyond R&D.
- A multi-level process = micro, mezzo and macro grounded
- At its core is structural change in various dimensions: technological, industrial, organisational.
- It is also an outcome of interaction between global forces (embodied in international trade and investment flows) and local strategies (pursued by host country firms and governments)

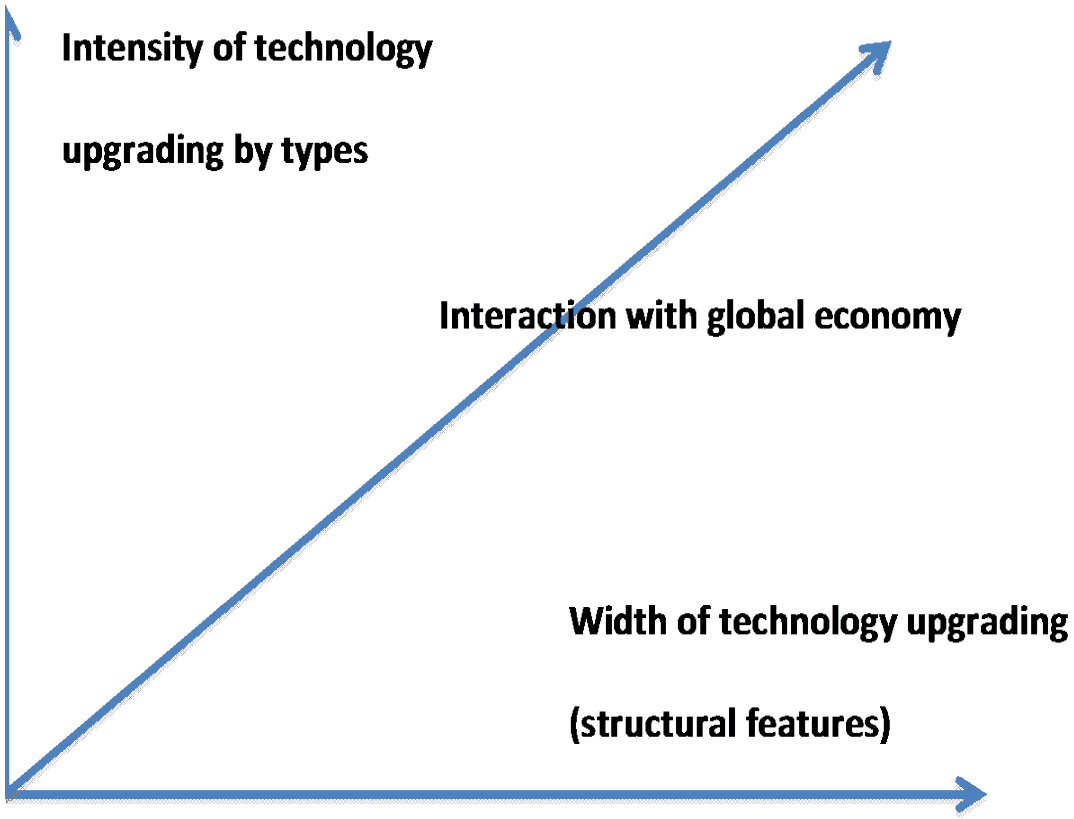
Limitations (assumptions) of our conceptual (statistical) framework

- Functional approach to technology upgrading ie. not institutional setups
- We abstract of demand upgrading (hierarchy of consumption)
- We are skeptical about the notion of industry upgrading and idea of hierarchy of industries (from low VA to high VA industries)
- Technology and production are strictly interconnected (embodied knowledge)

Technology upgrading is three-dimensional process proxied by a variety of indicators, which address three aspects:

- Intensity and different types of technology upgrading through various types of innovation and technology activities
- Widening or broadening of technology upgrading through different forms of technology and knowledge diversification
- Interaction with the global economy

Dimensions of technology upgrading



Dimensions of technology upgrading

Intensity of technology upgrading by types	• Production capability • Technology capability • R&D and knowledge intensity
Interaction with global economy	• Technology imports • Knowledge imports • Knowledge cooperation
Breadth of technology upgrading	• Infrastructure (human, physical, organizational) • Structural change • Firms' structure

DIMENSIONS OF TECHNOLOGY UPGRADING

INTENSITY (SCALE)

1. Production capability
2. Technology capability
3. R&D and knowledge intensity

BREADTH (SCOPE)

- Infrastructure: human capital and physical and organisational
- Structural change indicators
- Firms' structure

INTERACTION WITH GLOBAL ECONOMY

1. Technology and knowledge imports

Countries by the level of income

Lower Middle Income (GNI pc atlas method $1046-4125)	Upper Middle Income (GNI pc atlas method $4126-12745)	Lower High Income (GNI pc atlas method $12176-30000)	Upper High Income (GNI pc atlas method $30001-)
Ghana	Albania	Chile	Austria
India	Argentina	Czech Republic	Belgium
Indonesia	Belarus	Estonia	Germany
Moldova	Brazil	Greece	Ireland
Morocco	Bulgaria	Korea	Italy
Philippines	China	Poland	Japan
Ukraine	Hungary	Portugal	Norway
Vietnam	Jordan	Russia	Sweden
	Kazakhstan	Slovenia	UK
	Malaysia	Spain	USA
	Mexico		
	Peru		
	Romania		
	South Africa		
	Thailand		
	Turkey		

THANK YOU