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Evidence-based policy making

Upgrading technology in Central and Eastern European economies

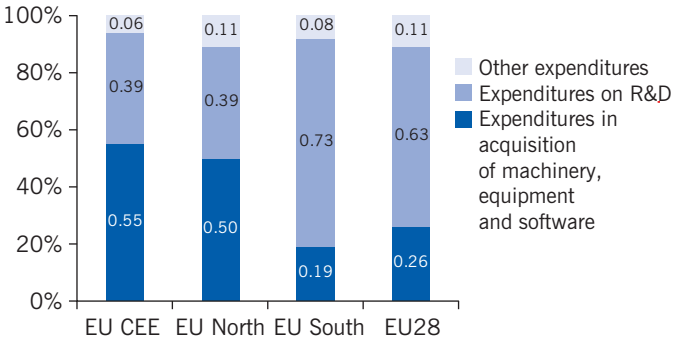
Existing policies in Eastern Europe will not sufficiently promote technological innovation

Keywords: technology upgrading, productivity, R&D and innovation, Central and Eastern Europe, EU

ELEVATOR PITCH

The future growth of Central and Eastern Europe (CEE) depends on upgrading technology, exporting and coupling domestic technology efforts while improving their position in global value chains. Current policies in the region are not geared to these tasks, despite the availability of huge financial opportunities in the form of EU structural funds. Existing policies are overly focused on research and development (R&D) and neglect sources of productivity growth, such as management practices, skills, quality, and engineering. The challenge is how to design industrial and innovation policies so that they promote modernization and drive structural change.

Structure of innovation expenditures: 2010–2012 in EU28 regions



Source: Based on Eurostat, Innovation Survey 2010–2012.Online at: http://ec.europa.eu/eurostat/web/microdata/community-innovation-survey

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KEY FINDINGS

Pros

- Coupling domestic technology efforts with the import of new equipment and management practices could help promote technology upgrading in CEE.
- Production capability and engineering, in addition to research, are important antecedents to development and innovation in CEE.
- Production capability is the most significant driver of productivity growth in CEE.
- CEE economies are specialized in the low value-added segments of the global production chain and benefit from vertical specialization with EU North firms.

Cons

- In CEE, technology transfer activities are important but neglected drivers of innovation along with non-R&D-based innovation activities.
- Innovation policy in CEE is based solely on R&D, imitating best practices in northern Europe, instead of addressing regionally specific challenges.
- CEE economies over-prioritize attracting foreign direct investment and do not place enough emphasis on the quality of subsidiary developments.

AUTHOR'S MAIN MESSAGE

CEE economies do not grow based on research-driven innovation whereby domestic research produces innovation that leads to growth; instead, they rely on the interaction of domestic R&D with more advanced technology from imported equipment and inputs. However, this situation is not reflected in policy, which is geared solely toward the traditional idea of research-driven growth. CEE countries would hence be better served by enacting policy that encourages improvements in production capability. This, in turn, would generate demand for local R&D and innovation, which is currently lacking.

MOTIVATION

The economies of Central and Eastern Europe (CEE) grew rapidly from the beginning of the 21st century until the onset of the global financial crisis in 2008. The crisis hit this region extremely hard, with a few exceptions (e.g. Poland). Since 2008, growth has resumed, though at much lower levels. Furthermore, the process of convergence with the developed EU economies, which had previously been very strong, has slowed down substantially. This raises questions about the sustainability of the pre-2008 growth, as well as about the current, undoubtedly quite weak, recovery. There is an increasing realization that the region's growth model needs to change. Current policies are narrowly focused on research and development (R&D)-based growth and do not address the key drivers of technology accumulation and productivity growth. A more appropriate model would be based on productivity, export, and technology upgrading. However, this requires a deep understanding of the nature of technological change and innovation in CEE.

The essential drivers of innovation vary across economies based on their levels of development; as such, policy approaches in CEE should reflect regionally specific drivers of productivity and technology upgrading. Innovation activities in CEE are similar to other EU economies in terms of frequency and intensity, but differ in terms of the actual activities taking place. They are much less R&D-driven and much more focused on production capability or activities related to management practices, quality, and engineering improvements, which is why the region's policy focus on research-driven innovation does not match well with the reality of its innovation activities. In terms of technology upgrading, CEE can be categorized within the BRIC (Brazil, Russia, India, and China) range, which does not seem sufficient to catch up to advanced economies' levels. The region's policies should therefore shift toward drivers of technology upgrading, which are found in downstream activities (e.g. quality, management practices, engineering) and couple them with the upgrading of local and foreign suppliers.

DISCUSSION OF PROS AND CONS

Growth in CEE before 2008 was driven by domestic consumption, growth in non-tradable sectors and, to a large extent, by total factor productivity or what is conventionally defined as "technological progress." However, evidence suggests that productivity was not driven by technological capabilities, but rather by production capability. R&D is important to the region, but that is largely due to its absorption function (i.e. as a means to facilitate the mastery of imported technologies and knowledge), rather than as a driver of innovation [1].

The post-2008 challenge for CEE countries is how to shift their economies toward a method of growth that is driven by investments and improvements in productivity. This coincides with the EU-level policy shift toward industrial upgrading and innovation-driven growth, encompassed by large-scale smart specialization investments in R&D and innovation activities [1]. Smart specialization strategies are large-scale investment activities in R&D, innovation, and information and communications technology areas funded by EU structural funds.

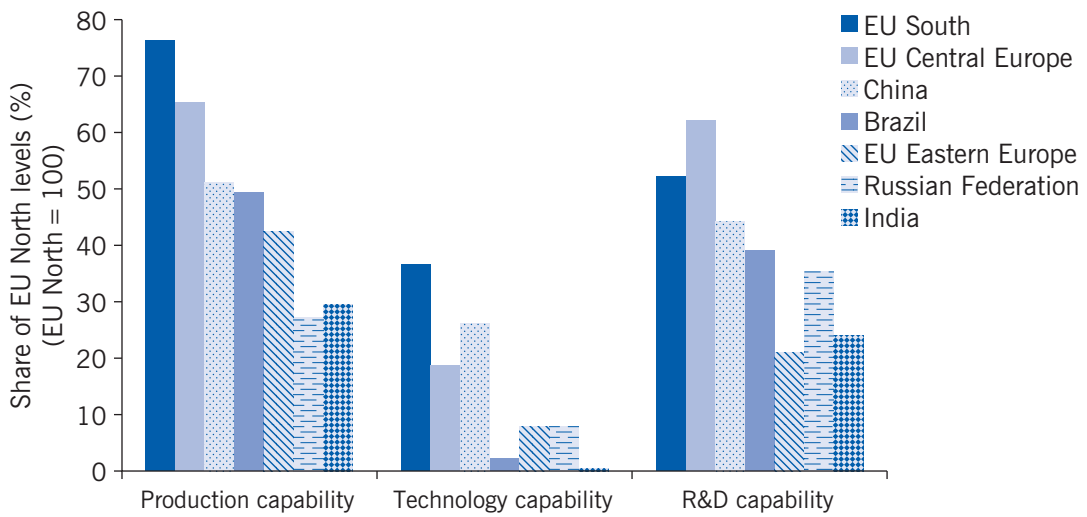
Central and Eastern Europe in a comparative perspective

As a means of comparing technology upgrading on an international level, it is interesting to measure CEE countries against BRIC countries in terms of production, R&D, and

technology capability. Figure 1 distinguishes between Central Europe (Estonia, Poland, Czech Republic, Hungary, and Slovenia), Eastern Europe (Romania and Bulgaria), and the BRIC countries, as well as the other EU region—EU South (Greece, Cyprus, Malta, Portugal, Spain, and Italy). The figure compares these regions to the EU North (the remaining EU12 developed economies) and finds substantial differences. These gaps are largest in terms of technology capability, where CEE ranks between 10% and 20% of the capacity of EU North, between 20% and 60% in terms of R&D capability and between 40% and 60% in terms of production capability.

When compared to the BRIC region, Central Europe ranks higher when it comes to the level of development of their production and R&D capability, and is ahead of three out of four BRIC countries (except China) in terms of technology capability. On the other hand, Eastern Europe trails behind the BRIC range in all three types of technology upgrading. Central Europe's high position in production capability is due to its strong integration into European industrial networks, particularly the German-Austrian industrial system [3].

Figure 1. Production, technology, and R&D capability



Note: *Production capability* captures the rate of activities and output in relation to production activity. *Technology capability* is built on measuring technology generation capabilities though patents and industrial design. *R&D capability* captures the knowledge developed by investments in R&D as well as the influence of capabilities embodied in people, that is, R&D personnel, scientists, and their publication outputs. Country groups are: EU South (Greece, Cyprus, Malta, Portugal, Spain, Italy), EU Central Europe (Czech Republic, Hungary, Poland, Slovenia, Estonia), EU Eastern Europe (Romania, Bulgaria), and EU North (the remaining EU12 developed economies). The data suggest that the current levels of technology upgrading in both Central and Eastern Europe are too low to catch up with advanced economies.

Source: Recalculated based on Radosevic, S., and E. Yoruk. "A new metrics of technology upgrading: The Central and East European Countries." In: *A Comparative Perspective*. UCL Centre for Comparative Studies of Emerging Economies Working Paper Series No. 2, 2016. Online at: https://www.ucl.ac.uk/ssees/comparative-studies-emerging-economies/working-papers [2].

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Technology upgrading: Perspective on growth

Identifying the drivers of productivity or total factor productivity is often an uncertain or controversial endeavor. In this article, the issue is approached through the prism of

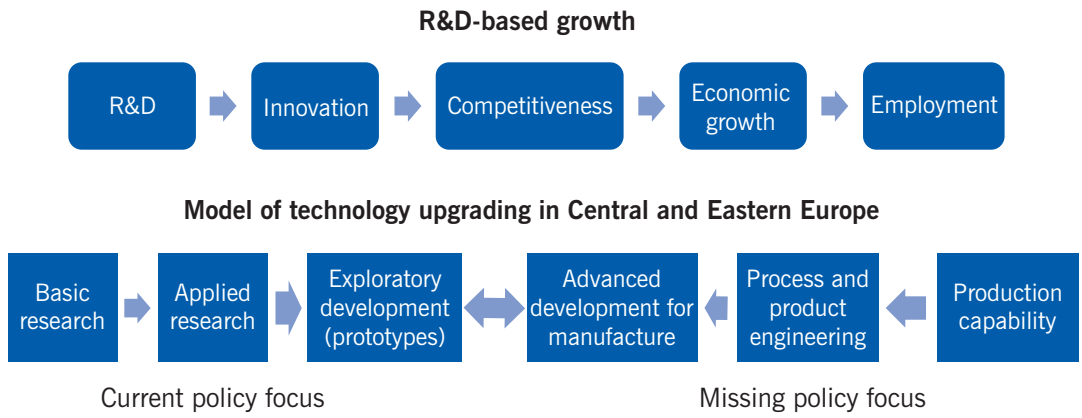
technology upgrading. Technology upgrading denotes substantial changes in a country's specialization and knowledge base, which increase its capacity to use and generate technology as a cumulative capability [4]. Technology upgrading is depicted through the improved ability of a firm or an economy "to move to more profitable and/or technologically sophisticated capital and skill-intensive economic niches" [4], pp. 51–52. In a nutshell, technology upgrading is "a shift to higher value-added products and production stages through increasing specialization" [5]. (See also [2].)

It is usually assumed that R&D drives growth, which drives innovation, which, in turn, further drives growth. However, this model of technology upgrading is not typical for middle-income economies. In these economies, the mode of innovation is most often located in "downstream" activities related to production capability. This refers to the capability to produce at global standards of quality at a given standard technology. Improving production capabilities is about improvements in process engineering, quality improvements, and management practices. Instead of innovating based on R&D, these economies are much more likely to innovate based on incremental innovation, cost-oriented process innovations, and technology adoption. These are demand-driven innovations, rather than supply or R&D-driven ones. Technology upgrading in these economies, which includes the majority of CEE countries, is about improving management practices before moving to process engineering improvements [6].

Similarly, it is conventionally assumed that innovation takes places in a linear sequence, in which R&D leads to innovation that leads to productivity (referred to as the R>D>I sequence). However, the evidence on technology upgrading in economies that operate behind the technology frontier suggests that technology upgrading does not occur this way; rather, it very often follows an inverse sequence, which starts from production capability and moves toward innovation and R&D, similar to an inverse product life cycle (Figure 2).

The linear R&D-driven model of technology upgrading captures only a part of the spectrum of technology upgrading activities in CEE. An alternative is a two-way model, where growth is based not only on the traditional R>D>I sequence, but also on a sequence in which production capability induces engineering that leads to development and finally

Figure 2. Alternative models of technology upgrading



Source: Based on Radosevic, S., and K. Ciampi Stancova. "Internationalising smart specialisation: Assessment and issues in the case of EU new member states." *Journal of the Knowledge Economy* (2015) [7].

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results in innovation (PC>E>D>I sequence). In fact, due to the strong focus on production processes rather than research innovation in CEE economies, this latter process is a much more important driver of productivity growth, as compared to the R&D push focused R>D>I model.

R&D, innovation, and technology upgrading in Central and Eastern Europe: Evidence

Production capability vs R&D capability

R&D and innovation in CEE are largely determined by the skill of the labor force and quality improvements in processes and products [6]. Production capability, proxied by the ISO 9001 certification, is the most significant driver of productivity growth in transition economies [1]. ISO certificates represent a generic management standard, which indicates that there are business processes in place that should guarantee operational efficiency (i.e. production capability). Diffusion of ISO standards thus denotes diffusion of the best production practices, which are then expected to drive productivity improvements. The importance of production capability has been confirmed by econometric research on the determinants of growth in the EU regions during the 1990s, which shows that innovation, as defined by patents, is not the key driver of economic growth in peripheral regions [1].

Similar intensity but different nature of innovation activities

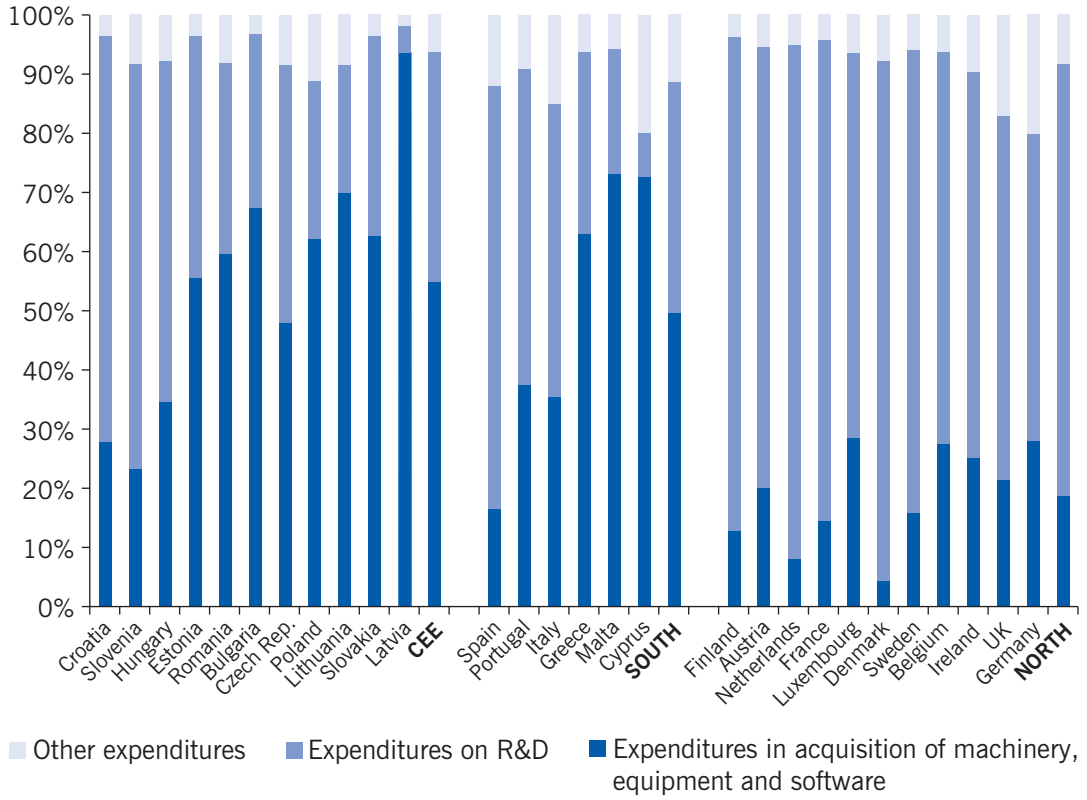
The frequency of innovating firms is similar among the more developed EU countries and CEE countries, but non-R&D innovators dominate in CEE [8]. Hence, the nature of the innovation process is different in CEE compared to more developed EU countries, though the frequency of innovation activities is quite similar. This is reflected in the structure of innovation expenditures, which are quite different between developed and less developed EU countries. As seen in Figure 3, innovation in the EU CEE and EU South groups includes a greater proportion of acquisition of new machinery, equipment, and software, and relatively less of R&D activities.

The differences shown in Figure 3 are to be expected, given the lower share of continuously active R&D firms in EU CEE and EU South. In 2012, the share of firms with continuous R&D activity was twice as high in the EU North as compared to the EU CEE and EU South [8]. The share of enterprises that engaged in external R&D was also significantly higher in EU North as compared to EU South and EU CEE. Differences in other types of innovation activity were less pronounced. Firms that are engaged in acquisition of machinery, equipment, and software represent the largest share of firms in both EU South and EU CEE. Overall, the data exemplify the high prevalence of R&D active firms in the more developed EU countries, and, by contrast, firms' focus on acquisition of new technologies in the less developed EU South and EU CEE regions.

The effective use of imported technology: Key to current technology upgrading

CEE economies are small open economies whose technology accumulation is largely driven by the import of new equipment and foreign knowledge in the form of licenses, know-how, and production capabilities. Technology transfer activities are major drivers of innovation in the region, along with non-R&D-based innovation activities (e.g. quality

Figure 3. Structure of innovation expenditures, 2010–2012



Note: The bars CEE, SOUTH, and NORTH represent the averages for the countries in each respective group.

Source: Author's own calculations based on Eurostat, Innovation Survey 2010–2012. Online at: http://ec.europa.eu/eurostat/web/microdata/community-innovation-survey

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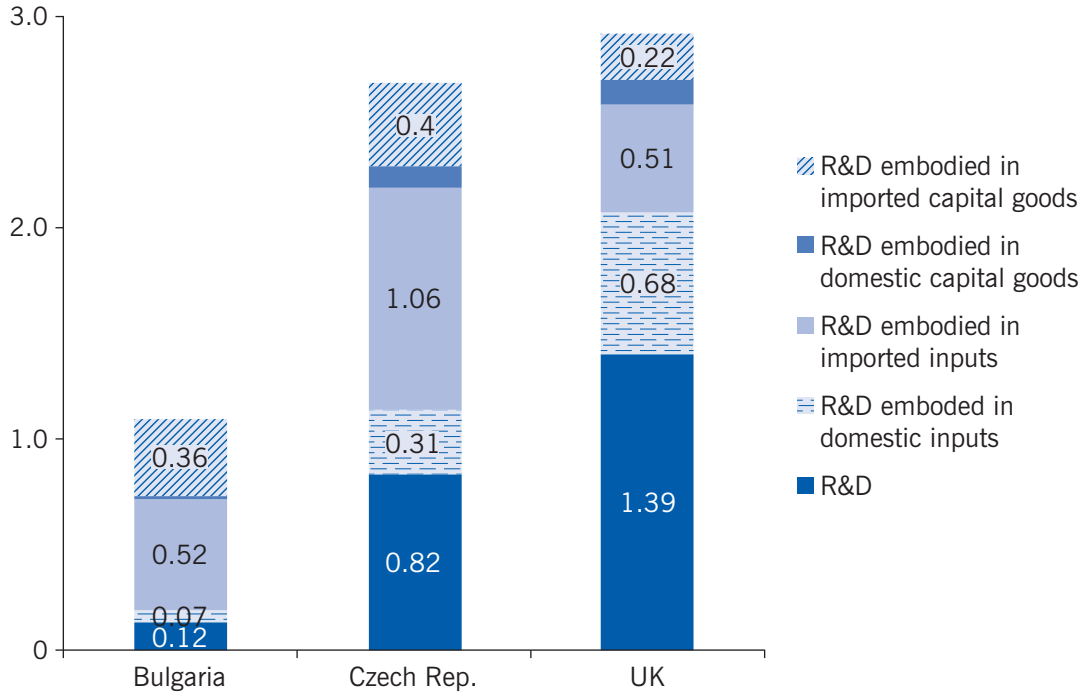
and engineering improvements). Innovation activities are about adoption and adaptation of imported technology and inputs [9]. In other words, R&D in CEE includes not only direct or own R&D, but also technology and R&D that is embodied in imported inputs and capital goods. For example, Figure 4 shows that the main difference between the UK and Bulgaria and the Czech Republic is due to each country's own R&D, and not R&D embodied in imported inputs and capital goods. In fact, R&D intensity embodied in imported capital goods and inputs in Bulgaria and the Czech Republic is similar to the UK; i.e. Bulgaria imports equally sophisticated equipment and inputs as does the UK. So, the key for Bulgarian firms is how to generate value-added using similarly sophisticated equipment and inputs as in the UK, but without the same levels of domestically generated R&D. In other words, how can they achieve global standards of productivity by assimilating and adopting foreign technology in the absence of their own R&D [9]? This challenge calls for improving absorptive capacity through better management practices and vocational training, as well as gradual orientation of local private and public R&D toward effective adaptation of foreign technology and R&D.

Technology integration and technology upgrading in CEE

CEE countries are specialized in the low value-added yielding assembly stage of the global production chain. By contrast, EU North firms are typically located higher up the value

Figure 4. R&D intensities in value-added in 2000 (shares in %)



Source: Radosevic, S. (ed.). *Synthesis Report: WP3. Innovation, Entrepreneurship and Industrial Dynamics. Technology Upgrading and Innovation Policy in Central and Eastern Europe*. GRINCOH Working Paper Series No. 3, 2015. Online at: http://www.grincoh.eu/media/syhtnesis_reports/grincoh_wp3_synthesis_report_radosevic.pdf [9]; Author's own calculations based on Knell, M. *Embodied Technology Diffusion and Intersectoral Linkages in Europe*. Europe Innova Sectoral Innovation Watch Deliverable WP4, 2008. Online at: https://www.researchgate.net/profile/Mark_Knell/publication/265369750_Product-embodied_technological_diffusion_and_intersectoral_linkages_in_Europe/links/5409c8550cf2d8daaabf3431.pdf?origin=publication_detail

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chain and tend to benefit more in terms of output, employment, and labor productivity growth from intense vertical specialization. Evidence shows that the effect of vertical integration in CEE is mixed, so long as countries remain in the lower end of the value-added assembly stages of the global value chain [10]. This situation hinders the effectiveness of focusing on upstream R&D activities and programs. These upstream targets are designed to generate new products and employment through a kind of "trickle down" process, but if there is no solid foundation of applied production knowledge from and to which to trickle down, then investment in cutting edge R&D excellence is much less relevant [7]. On the other hand, technology upgrading and innovation closely related to production capability in manufacturing and services are key areas of modernization for CEE, due to the region's heavy focus on these segments of the value chain.

The literature shows that economies that have successfully caught up to the most developed ones such as Korea and Taiwan have cultivated an interaction between their own technology efforts and the R&D that is embodied within foreign technology imports. As CEE economies are currently situated behind the technology frontier, their firms are reliant on foreign knowledge. Hence, their technology efforts are, by necessity, focused on how to assimilate and adopt foreign technology. Thus, the underlying path of their technology upgrading is not the R>D>I sequence, but rather relies on the interaction of their own R&D with knowledge embodied in imported equipment and inputs [9].

The stylized path of how countries undergo technology upgrading includes four distinct stages, each of which is characterized by transitions in how technology is created, imported, and adapted [9]. This upgrading path is relevant for CEE countries, as most of them are currently struggling to pass through the final two stages. In the initial stage of the technology upgrading process overall R&D intensity is low. For countries at this stage, their own R&D and the sophistication of imported technologies are at comparatively low levels. In stage 2 there is an increase in the sophistication levels of imported equipment and inputs, know-how, and licenses. In stage 3 the economy further increases levels of own R&D and the sophistication of imported knowledge. Further upgrading requires the coupling of imported knowledge with domestic knowledge generation through increased R&D intensity within both business and public sectors. Finally, in stage 4 domestic knowledge generation becomes the dominant component. As R&D intensity increases, the relative importance of knowledge embodied in imported inputs and equipment decreases as the country approaches the world technology frontier. The key challenge in this context for CEE countries is how they will couple their own knowledge generation activities with absorption and adaptation of foreign knowledge (i.e. transition from stage 3 into stage 4). This process is not automatic and linear; one can distinguish thresholds in terms of production, R&D and technology capabilities, which require transformative innovation policy appropriate to each specific stage.

Copying policies despite different conditions

Innovation policy in CEE implicitly and mistakenly assumes that R&D is the major driver of technology upgrading in the region. This approach reflects "the best practices" of the EU North countries, rather than the technological positions and constraints of the CEE region. Research on the innovation policy mixes in the EU28 region has shown that despite relatively large differences between countries in terms of technological and economic development, their policy mixes are pretty homogenous [11].

According to the technology upgrading perspective, countries at different innovation levels require different policy mixes that reflect their specific technology challenges. However, technological differences between countries are just one of many factors that influence the composition of policy mixes, many of which have to do with path dependencies, policy trends, and perceptions of best practices [11]. The commercialization of academic research or science–industry collaborations make up the most frequent innovation-focused policy measures; by contrast, much less attention is given to supporting firms' adoption of imported technology and knowledge. This feature is equally strong in other transition economies outside the EU [6].

Before opting for one or another policy instrument, policymakers should be certain that they understand their country's specific circumstances and challenges. For CEE, policy should shift toward drivers of technology upgrading, which are located in downstream activities, and couple them with global sourcing and value chain-oriented policies; for example, supplier development, establishing technology centers by foreign firms linked to domestic suppliers, or technical cooperation agreements between local and foreign firms. CEE countries are unlikely to attract significant supply-driven R&D in the business sector because there are few locations in CEE with the relevant science and technology infrastructure [12]. As such, it would be more effective to foster demand-driven R&D, i.e. R&D that is associated with the implementation of improved products and processes, which are produced or assembled in CEE. However, this type of policy requires critical

mass of specialized skills, technology-based small- and medium-size enterprises and international funding, which, in turn, require inflows of foreign direct investment (FDI) complemented by local investments in technology and firm-specific infrastructures. The challenge for CEE countries is thus: how can they attract technology-oriented FDI and exploit it to leverage local investment in R&D, especially in downstream areas [7]?

Meeting this challenge requires a transition from prioritizing and attracting FDI toward a focus on the functional, product, and process upgrading of FDI-based subsidiaries. A good example of this policy was provided by CzechInvest, the Czech Republic's investment promotion agency, who recognized the need to shift from FDI investments focused on manufacturing and blue-collar jobs toward new sectors. CzechInvest identified this transition as a "shift from quantity to quality" [7]. This type of policy initiative requires closer links between FDI and industry and innovation policies. The tendency in CEE has been to focus on FDI inflows at the expense of the R>D>I content of FDI; in other words, the primary policy aim has been to generate employment rather than to induce technological upgrading of the economy. However, this approach only offers a temporary easing of the problem, since it merely addresses cost competitiveness, without resolving the issue of technology competiveness [7]. The smart specialization strategies driven by EU structural fund programs represent unique opportunities for integrating FDI or supplier development and innovation policy.

LIMITATIONS AND GAPS

Analysis of this topic in general is limited by poor monitoring of non-R&D activities and by the absence of research on paths of technology modernization that take place outside of the organized R&D sector. Furthermore, there is a knowledge gap with respect to comparative research focused on technology upgrading for other middle-income economies that share similar characteristics to CEE countries. As such, there are no comparative analyses of CEE economies in a broader international context. Research on these economies is firmly framed according to the EU context, within which their developmental and technological specificities are not sufficiently accounted for.

Because CEE countries are predominantly middle-income economies they are considered technology users (as opposed to innovators) and this is reflected in their patterns of technology upgrading. In order to measure progress along their specific technology path they need appropriate metrics. The current metric, the EU Innovation Union Scoreboard, is designed to measure the innovation capacity of the EU28 countries at a global level; however, due to its strong focus on science and technology frontier activities it is not suitable for the specific evaluation of technology upgrading in CEE economies. Appropriate metrics are needed, which are capable of reflecting a larger proportion of non-R&D and production related knowledge acquisition activities [2], [13].

SUMMARY AND POLICY ADVICE

In order to encourage further growth and to promote enhanced technology upgrading in CEE, the region's policy focus needs to shift from a singular emphasis on R&D based policies toward non-R&D areas. Moreover, CEE firms should prioritize the upgrading of their technology and value-added positions within EU value chains. With this in mind, EU structural funds and smart specialization strategies represent a historical opportunity for industrial modernization and technology upgrading, which should not be missed.

R&D does play a role in technology upgrading within CEE, but it is not yet the major driver for this process. Instead, greater attention should be paid to helping innovative enterprises improve their productivity by tuning public support to their actual technology upgrading needs. The resulting improved technology capabilities would indirectly create greater demand for domestic R&D, which, in turn, would lead to an increased role for private R&D and encourage stronger cooperation with public R&D. This would require adding to the current portfolio of predominantly domestic R&D-oriented support measures; additional measures should focus on supplier development, promoting technology centers that can attract local and foreign firms, or promoting technical cooperation agreements between local and foreign firms.

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Competing interests

The IZA World of Labor project is committed to the *IZA Guiding Principles of Research Integrity*. The author declares to have observed these principles.

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REFERENCES

Further reading

Dulleck, U., N. Foster-McGregor, R. Stehrer, and J. Wörz. *Dimension of Quality Upgrading in CEECs*. Vienna Institute for International Economic Studies (WWIW) Working Paper No. 29, 2004.

Radosevic S., and A. Kaderabkova (eds). *Challenges for European Innovation Policy Cohesion and Excellence from a Schumpeterian Perspective*. Cheltenham: Edward Elgar, 2011.

Key references

[1] Kravtsova, V., and S. Radosevic. "Are systems of innovation in Eastern Europe efficient?" *Economic Systems* 36:1 (2012): 109–126.

[2] Radosevic S., and E. Yoruk. *A New Metrics of Technology Upgrading: The Central and East European Countries in a Comparative Perspective*. UCL Centre for Comparative Studies of Emerging Economies Working Paper Series No. 2, 2016.

[3] IMF. *IMF Multi-Country Report German-Central European Supply Chain—Cluster Report*. IMF Country Report No. 13/263, August 2013.

[4] Ernst, D. "Catching-up, crisis and industrial upgrading. Evolutionary aspects of technological learning in Korea's electronics industry." *Asia Pacific Journal of Management* 15:2 (1998): 247–283.

[5] Gereffi, G. "International trade and industrial upgrading in the apparel commodity chain." *Journal of International Economics* 48:1 (1999): 37–70.

[6] EBRD. *Innovation in Transition*. London: EBRD, 2014.

[7] Radosevic, S., and K. Ciampi Stancova. "Internationalising smart specialisation: Assessment and issues in the case of EU new member states." *Journal of the Knowledge Economy* (2015): 1–31.

[8] Radosevic, S. "The role of public research in economic development." In: *EC. Science, Research and Innovation Performance of the EU*. Brussels: DG for Research and Innovation, European Commission, 2016; pp. 119–139.

[9] Radosevic, S. (ed.). *Synthesis Report: WP3. Innovation, Entrepreneurship and Industrial Dynamics*. Technology Upgrading and Innovation Policy in Central and Eastern Europe. GRINCOH Working Paper Series Paper No. 3, 2015.

[10] Leitner, S. M., and R. Stehrer. *Trade Integration, Production Fragmentation and Performance in Europe—Blessing or Curse?* A Comparative Analysis of the New Member States and the EU-15. The Vienna Institute for International Economic Studies, GRINCOH Project, 2014.

[11] Izsak, K., P. Markianidou, and S. Radosevic. "Convergence of national innovation policy mixes in Europe—Has it gone too far? An analysis of research and innovation policy measures in the period 2004–12." *Journal of Common Market Studies* 53:4 (2015): 786–802.

[12] Narula, R., and J. Guimón. *The Contribution of Multinational Enterprises to the Upgrading of National Innovation Systems in the EU New Member States: Policy Implications*. Paris: OECD, 2009.

[13] Radosevic, S., and E. Yoruk. "Why do we need theory and metrics of technology upgrading?" *Asian Journal of Technology Innovation* 24:S1 (2016): 8–32.

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