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Globalization and Technology Absorption: Role of Trade, FDI and Cross-Border Knowledge Flows

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Key Messages[1]

- **Countries in Europe and Central Asia (ECA) region can accelerate industrial development, worker productivity and economic growth by improving their ability to tap into the global technology pool.**
- **Trade flows, foreign direct investment (FDI), research and development (R&D), and labor mobility and training, are key channels for domestic knowledge absorption.**
- **Many of the Commonwealth of Independent States (CIS) and Southeast European countries (SEE) need to restructure enterprises, ease the entry and exit of firms, improve access to credit, and accelerate the "behind the border" reforms to benefit from trade openness to enable greater technology absorption.**

Introduction

Improving the ability of ECA countries to tap into the global technology pool is an important mechanism for accelerating their industrial development, worker productivity and economic growth. Trade flows, foreign direct investment (FDI), research and development (R&D), and labor mobility and training, are widely accepted as key mechanisms for knowledge absorption.

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What is Technology Absorption and Why is it Important?

Absorption is a costly learning activity that a firm can employ to integrate and commercialize knowledge and technology that is new to the firm but not new to the world. Development of new-to-the-world knowledge can be considered innovation. In other words, innovation shifts a notional technological frontier outward, while absorption moves the firm closer to the frontier. Examples of absorption include: adopting new products and manufacturing processes developed elsewhere; upgrading old products and processes; licensing technology; improving organizational efficiency; and achieving quality certification. Table 1 defines some key terms that refer to absorption and innovation.

Table 1: Taxonomy of Absorption and Innovation

Absorption versus Innovation: ***New to the Firm*** versus ***New to the World***

Absorptive capacity: a firm's capacity to assess the value of external knowledge and technology, and make necessary investments and organizational changes to absorb and apply this in its productive activities.

Examples of absorption: adoption of a new product or process; upgrading of an old product or process; utilization of a technology license.

Product innovation: development of new products representing discrete improvements over existing ones.

Process innovation: redesign of products or services; "soft innovation" (for example, reorganization of layouts, transport modes, management, and human resources).

Incremental innovation: innovation that builds very closely on technological antecedents and does not involve much technological improvement upon them.

R&D, a key input for innovation, is an input into absorption as well. There are important complementarities between innovation and absorptive capacity. Innovation promotes absorptive capacity because the generation of human capital and new ideas and the associated knowledge spillover effects help build absorptive capacity. Conversely, the absorption of cutting-edge technology inspires new ideas and innovations.

Innovation and absorption of knowledge, which are central forces behind economic growth, are in turn determined by economic conditions and policies. Trade, FDI, R&D, and patents are 'channels of absorption', providing conduits for diffusion of knowledge between countries and absorption within firms. Different degrees of exposure to international best practices through these channels affect absorption outcomes.

Properly designed economic policies can significantly influence the degree to which a country absorbs new technology, as well as the decisions by firms to undertake investments that do so. The channels of technology absorption - trade, FDI, R&D - need a stable and conducive policy framework and a business-friendly investment climate. At the same time, a firm's ability to absorb this technology and knowledge depends on its organization and the skills of its workforce.

Technological Absorption in ECA

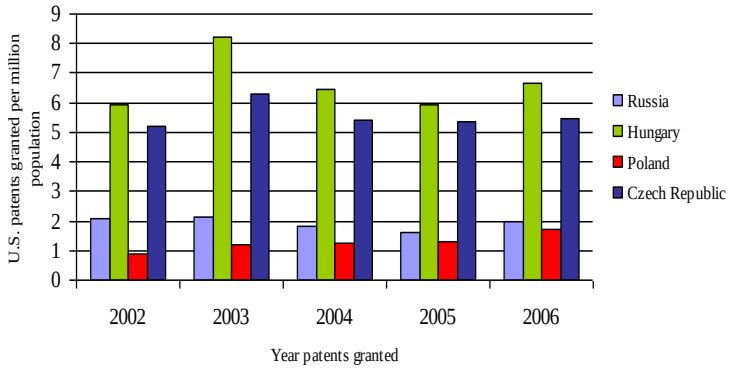
Patent Citations, International Co-invention, and Multinational Sponsorship of Local Invention

The wealth of detailed information that patents and patent citations contain offers a useful window into the technological absorption process in ECA. While patents are viewed as a form of intellectual property right over some of an economy's innovative outputs, patent citations provide a convenient metric of how existing 'pieces' of patented knowledge have contributed to the creation and appropriation of new patented knowledge. The data on patent citations from the European Patent Office (EPO) and the U.S. Patent and Trademark Office (USPTO) can be used as proxy for the knowledge absorption process in order to study flows of knowledge within ECA, and between ECA and the rest of the world. The data can also help explore the knowledge flows and 'spillovers' present by tracing the citation pathways that link ECA inventions to prior inventions created in ECA and elsewhere in the world. The extent to which ECA inventors cite new technologies may indicate the extent to which inventors are grounded in the recent state of the art. Patents created by teams that include both ECA-based inventors and those in other regions can reflect the extent to which ECA inventors are connected to the global technological mainstream.

While openness to trade and foreign investment allows firms to tap into and benefit from the global pool of knowledge, patent co-inventions can also help build these global linkages, and in turn, create knowledge spillovers.

Within ECA, there are differences across countries, with four clear leaders: Hungary, the Czech Republic, the Russian Federation, and Poland. Among these four, Hungary and the Czech Republic fare significantly better than Russia and Poland (Figure 1).

Figure 1: U.S. Patents Granted by Country (per million population)



Sources: USPTO Cassis CD-ROM, December 2006 version and World Development Indicators, World Bank

From 1993 through the end of 2006, Russia, Hungary, Poland, Slovenia, the Czech Republic, Bulgaria, and Ukraine (ECA-7) obtained 5,489 U.S. patents, whereas India-based inventors alone obtained 3,331, and China-based inventors obtained 4,063. The performance of the ECA-7 countries has been much better on a per-capita basis. However, ECA-7 patenting in the United States has not grown significantly in recent years, while India and China have surged ahead. There is also statistical evidence in many ECA countries of the relative isolation of the R&D community from international technological trends: indigenous patents generally make fewer citations to the existing state-of-the-art than comparable patents filed in other parts of the world, and they cite inventions that have a lesser impact in terms of citation patterns. Moreover, the number of indigenous patents in the ECA region is low relative to the level of R&D investment.[2]

[2] While China and India spend 1.23 percent and 0.8 percent, respectively, of their GDP on R&D expenditures (see http://www.financialexpress.com/news/India-lags-China-in-RampD-spending-Sibal/283583/), the ECA-7 countries as a whole spend under 1 percent of GDP on R&D (see http://europa.eu/rapid/pressReleasesAction.do?reference=STAT/08/34&format=HTML&aged=0&language=EN&guiLanguage=en).

On the positive side, international R&D collaboration has allowed the ECA region to partially sidestep the handicap of its own low R&D productivity, a problem rooted in the region's insufficient grounding in the recent advances in the state of the art**.** A large fraction of ECA patents obtained in the European Patent Organization are 'co-invented' with inventors in Western economies, and Germany plays a particularly important role. A co-invented patent is one where at least one named inventor is located in the ECA region, and at least one inventor is located outside the region.

Foreign firms appear to be making a significant contribution to ECA-region inventive activity. The local R&D operations of these firms, and their sponsorship of local inventors, generate a large fraction of the total patents emerging from ECA countries. This process of international co-invention not only contributes to the quantity of ECA patents, but also raises the quality of ECA inventive efforts. Whereas indigenous ECA patents lag behind other regions in terms of the degree to which they build on prior inventions and extend it, the ECA patents created through multinational sponsorship are better connected to global R&D trends and generally represent inventions of higher quality.

Science and innovation policy in the region should encourage ECA countries to promote international collaboration and should support a greater role for the private sector in knowledge generation. Governments should encourage foreign R&D investment and international R&D collaboration.

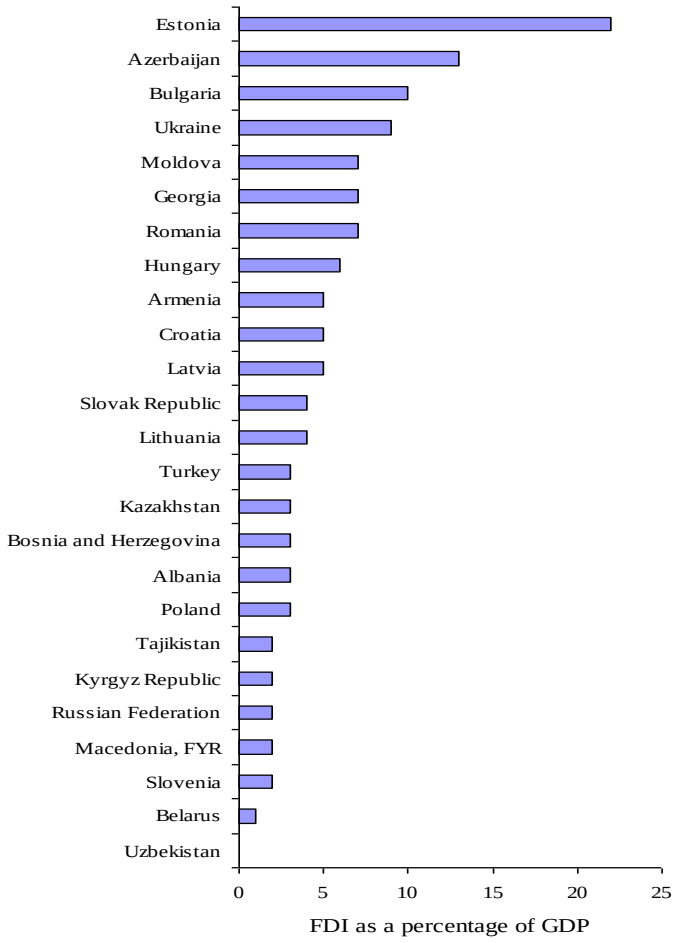
Trade and FDI in ECA and Their Link to Knowledge Absorption

Openness to foreign trade and investment is critical to the process of technological absorption and diffusion, not only for the competitive pressure it exerts on management and corporate governance, but also for the exposure to global best practice technology and management techniques provided to local firms. Exporting is another channel through which firms based in open economies can acquire foreign knowledge about technologies and products.

While tariff barriers on trade are not high in many ECA countries, there remains a large, unfinished 'behind the border' structural and institutional policy agenda that would likely increase FDI and trade, and the related technology absorption.

ECA compares poorly with innovation comparators, according to the World Bank's World Trade Indicators database. The Trade Restrictiveness Index (TRI) captures the barriers to trade, with a higher TRI implying a greater degree of restrictiveness. While the TRI averages between 4 and 5 in several ECA countries, there are negative outliers such as Romania and Russia. Their TRIs are over three times higher than newly industrializing Indonesia and the TRI of the United States. In terms of FDI inflows (see Figure 2), there is a visible intraregional disparity among ECA countries. The 10 EU member countries from Central and Eastern Europe (EU10) and Southeast Europe (SEE), such as Estonia and Bulgaria, are attractive for FDI. Resource-rich countries such as Azerbaijan, and middle-income countries including Ukraine, are also attractive FDI destinations. However, countries like Belarus and Macedonia have been unable to attract much FDI. Uzbekistan had zero FDI inflows in 2005.

Figure 2: FDI Inflows as a Percentage of GDP, 2005



Source: World Development Indicators, 2007

Survey and Case Study Analysis

Enterprise surveys in ECA show that firms that sell to multinationals or engage in cooperative activities with multinationals seem more likely to introduce new (to the firm) products and processes, upgrade existing products and processes, acquire new (to the firm) product or process technologies, and engage in a range of behaviors associated with increasing technological sophistication.

Absorption requires tough decisions and large investments, as firms need to spend resources on modifying imported equipment and technologies, and reorganizing production lines and organizational structures. Case studies of privatized enterprises in Serbia highlight the important role of foreign investors in knowledge absorption, whether acquired through capital goods imports, exporting, hiring consultants and other knowledge brokers, or from licensing technology.

The Serbian case studies targeted FDI based on acquisition of existing assets from the government (privatization), or from private owners, rather than 'greenfield'[3] FDI. The analyses suggested, in general, that companies sold to domestic investors were not able to increase exports in a significant way, while comparable firms receiving FDI did much better. In addition, more significant changes in product mix and manufacturing occurred in companies bought by foreign investors. New directors were brought in from the multinational enterprises (MNE), the domestic investors' holdings, from rival companies, or promoted from within. In companies acquired by foreign investors, the comparative advantage for R&D was in the adaptation of products and machinery to local conditions, rather than in innovation. For example, advanced formulas or product designs are transferred from the MNEs and adapted locally so that the products can be manufactured efficiently in the acquired plants.

The spillovers of FDI to other firms, or to the whole economy, whether by diffusion of technological and other knowledge, or by sharpening the incentives for domestic firms to upgrade their productivity, play a central role. The critical role of 'brownfield'[4] FDI is to restructure the acquired companies as expeditiously as possible. Early in the transition process, indigenous firms need the help of foreign investors to acquire new technical competencies. In such cases, the beneficial role of FDI is seen in the company in which the foreign firm has invested.

Reduction of the remaining barriers to FDI in ECA could increase FDI and, given the positive relationship between absorption and FDI, facilitate absorption. For example, Russia fares worse than other countries in the region, attracting one of the lowest per-capita levels of FDI inflows. World Bank research has pointed to key shortcomings in the Russian business environment. Many of these are a function of government policies that limit FDI inflows and foreign firm operations, especially in the services sector. Another ECA country where reform is needed is Kazakhstan, which has done more to lower its tariffs on goods than it has to liberalize its barriers to FDI in the service sector.

[3] Greenfield investment is *de novo* investment in a previously undeveloped site, where no facilities or plant existed.
[4] Brownfield investments are the acquisition of existing companies/facilities by foreign investors.

The Challenges Ahead for ECA

In conclusion, there is persuasive new evidence of the importance of trade openness, FDI, human capital, R&D, and knowledge flows for innovation and absorption in ECA. The countries in the region differ in their remaining reform agendas, both in general terms and in these areas in particular, as well as in the relevant resource endowments needed to effect the transition toward a more dynamic and globally competitive knowledge economy. Additional efforts toward the following objectives would contribute to knowledge absorption in ECA:

- Intensified international R&D collaboration and foreign R&D investment to enhance the integration of ECA in the global R&D community.
- Progress on the unfinished 'behind the border' trade reform agenda to increase the openness of several ECA countries to global trade networks.
- Further opening to FDI to play an important role in encouraging knowledge absorption, notwithstanding the opposition to FDI in some ECA countries.

The rapid technological catch-up experienced in the more reformed economies is indicative of the fact that within-firm productivity improvements, rather than reallocation of resources, are increasing in importance as a source of growth in ECA. The countries that are now member states of the European Union increasingly participate in FDI-driven intra-industry trade, which is conducive to technology absorption. But many of the CIS and SEE countries still need to restructure enterprises, ease the entry and exit of firms, improve access to credit, and accelerate the 'behind the border' reforms to benefit from trade openness, and thus from technology absorption.

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