Chapter 1. Introduction

The Europe and Central Asia (ECA) Knowledge Economy Study aims to offer ECA policy makers options to increase and maintain productivity and growth by creating an environment conducive to the application of knowledge in the economy via innovation and learning. The tradition of excellence in learning and basic research in several ECA countries provides some basis for hope that commercial innovation could be adopted and built "on the shoulders" of the past. Translating this research foundation into economically productive commercial applications, however, remains a critical missing link in ECA countries. Against that background, this study focuses on public policies for building institutions and creating an incentives framework for the support of commercial innovation. Basic research policies are outside our scope.

Part I of the ECA Knowledge Economy Study (ECAKE I), which is submitted in this report, focuses on the rationale, financial instruments, and institutional requisites for effective public support for commercial innovation. We review the set of institutions and conditions in the various ECA countries with the aim of determining which countries are ready for public support for commercial innovation and which are missing some critical institutional requisites. We evaluate the appropriateness of the financial instruments that have been used in Organisation for Economic Co-operation and Development (OECD) countries and internationally to encourage innovation by the private sector. The planned follow-up study, ECAKE II, will cover absorption and diffusion of knowledge. Improving the absorptive capacity—the ability to tap into the world technology pool—is an important channel to increase productivity growth. The effectiveness of trade flows, mobility of people, licensing of codified knowledge, and foreign direct investment as conduits of knowledge absorption will be studied in the proposed ECAKE II study.

The distinction between innovation and absorption in this study is as follows. *Innovation* is the development and commercialization of new unproven technologies and untested processes and products. *Absorption* is the application of existing technologies, processes, and products proved and tested in a new environment in which the processes have not yet been tested and the markets and commercial applications are not fully known. This distinction does not preclude important complementarities between innovation and absorptive capacity. Innovation promotes absorptive capacity because human capital generation and knowledge spillover effects associated with the innovative process build absorptive capacity. The ability of an economy to research and develop new technologies increases its ability to understand and apply existing technologies. Vice versa, the absorption of cutting-edge technology inspires new ideas and innovations. Yet, the adoption of existing technology via trade, FDI (Foreign Direct Investment) or licensing is not guaranteed or cost free.[1] Firms and countries need to invest in developing "absorptive" or "national learning" capacity, which in turn is a function of spending on research and development (R&D). Therefore, domestic R&D has a role in developing a firm's ability to identify, assimilate, and exploit knowledge from the environment, i.e., enhancing the *absorptive capacity* of the economy. The latter will be a major topic of analysis in the proposed ECAKE II follow up to this study.

[1] Cohen and Levinthal (1989); Kinoshita (2000).

In addition to distinguishing between innovation and absorption, it may be helpful to clarify the differences between innovations undertaken by individual entrepreneurs or de novo firms, with no existing market power, versus those by incumbent firms with market power. It is the new entrants or the firms with no existing market power that are popularly claimed[2] to be more likely to undertake the most dramatic and revolutionary innovations. However, worldwide, most successful innovations are born, bred, and brought to market in larger incumbent firms with market power; often these innovations are more evolutionary, but nonetheless critical for sustained growth and job creation.

Integrating the complementarities and distinctions between innovation and absorptive capacity discussed above, we use the widest definition of R&D, which includes improvements in existing processes or products as well as the imitation and adoption of knowledge and it is not restricted to original innovation. The OECD defined R&D to "comprise creative work undertaken on a systemic basis in order to increase the stock of knowledge and the use of this stock of knowledge to devise new applications." Following the literature, R&D should be understood as "the process by which firms master and implement the design and production of goods and services that are new to them, irrespective of whether or not they are new to their competitors—domestic or foreign." R&D is to be differentiated from commercialization of R&D. *This study will focus on R&D and on commercialization, and it will differentiate instruments by their applicability in both stages of the innovation process.*

The choice to focus on public support of commercial innovation in ECAKE I is driven primarily by the increasing attention policy makers in the ECA region are directing toward enhancing investments in R&D in their respective countries, in other words, "client demand" for an analysis of the R&D commercialization support systems. The European Union's (EU) Lisbon Strategy has prompted the EU accession countries and other ECA countries to consider implementing financial instruments to promote innovation, especially venture capital schemes, with little consideration for the necessary institutional requisites or appropriateness of the instrument. In a number of countries in the former Soviet Union (e.g., Russia, Ukraine, Kazakhstan) and its satellites and in the former Yugoslavia (Serbia, Croatia), the legacy of research and human capital also provides an incentive to revive their research capacity. However, absorptive capacity remains an issue in all ECA countries. Some of the countries are likely to have higher productivity returns from investments in building absorptive capacity than in commercial innovation.

The current allocation of research funding contributes to the apparent lack of collaboration between the science and business sectors. The aim of the financial instruments recommended in this study is to address those problems through the encouragement of private R&D in companies by providing incentives for collaboration through the cofunding of "consortia" of firms and universities/research institutes to implement innovative projects. Nonfinancial instruments, such as business support services, incubators, and economic support zones, are discussed in the study as complementary components of the financial instruments. However, a full review of these types of instruments that support knowledge and technology transfer will

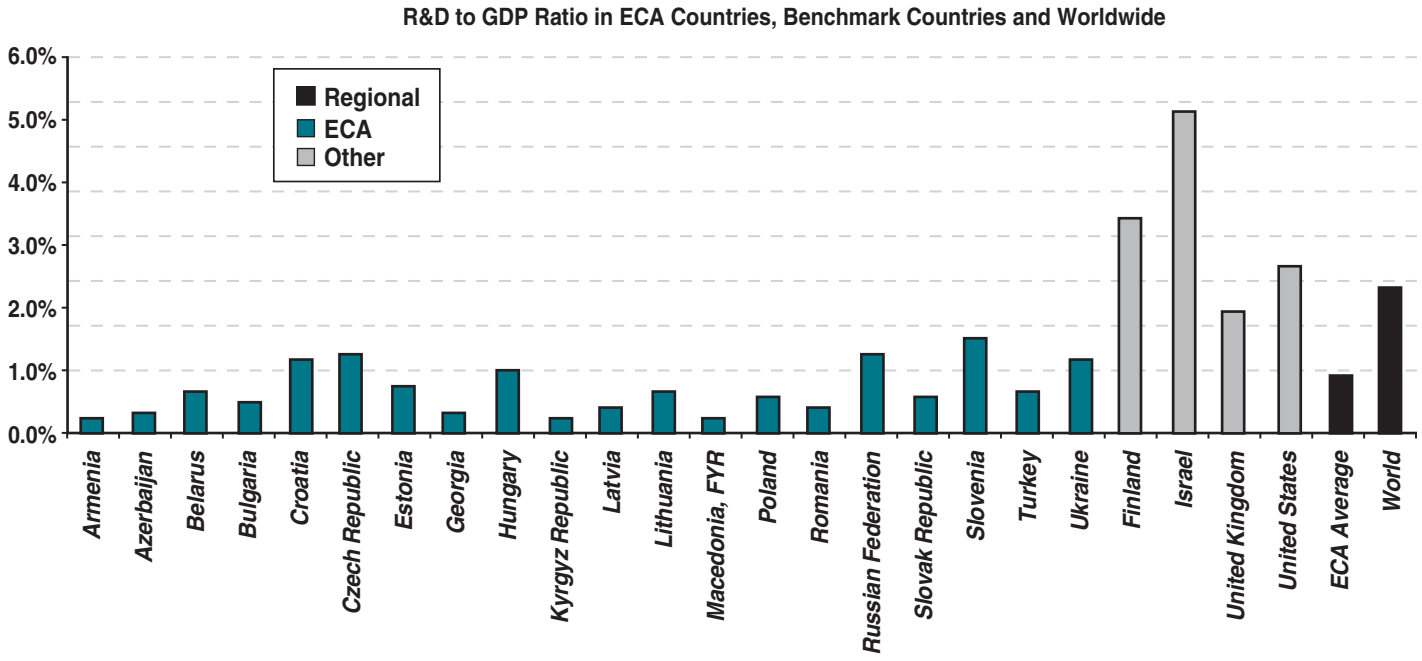
[2] A recent article in *The Economist* on Japanese innovation (Dec 17, 2005) highlights the distinction between U.S.-style blue-sky research approaches that foster many start-ups to experiment with new techniques and business models versus the more incremental learning-by-doing found inside large Japanese companies, with these two types of innovation possibly being appropriate for different technologies—software and biotech versus cars and electronics—with corporate Japan now also focusing on robotics, aerospace, and environmental technologies.

be undertaken in the ECAKE II study. Further elaboration on the different types of innovation and a more detailed analysis of the complementarities (and differences) between innovation and absorption as well as the policy implications of these differences and complementarities will be undertaken in the next ECAKE II study.

The focus of this study on R&D and on commercialization is consistent with the view, which will be elaborated in chapter 2, that commercial innovation and R&D are key factors driving *self-sustained*, long-term economic growth and, moreover, that these factors are generated from within the economic system, responding to economic incentives. In figures 1 and 2, ECA countries are compared with the rest of the world in regard to the share of R&D in gross domestic product (GDP) and the share of researchers in the population. The average R&D-to-GDP ratio in ECA is 0.9 percent. Of the 28 ECA countries, only 6 countries had a ratio of 1 percent or more.

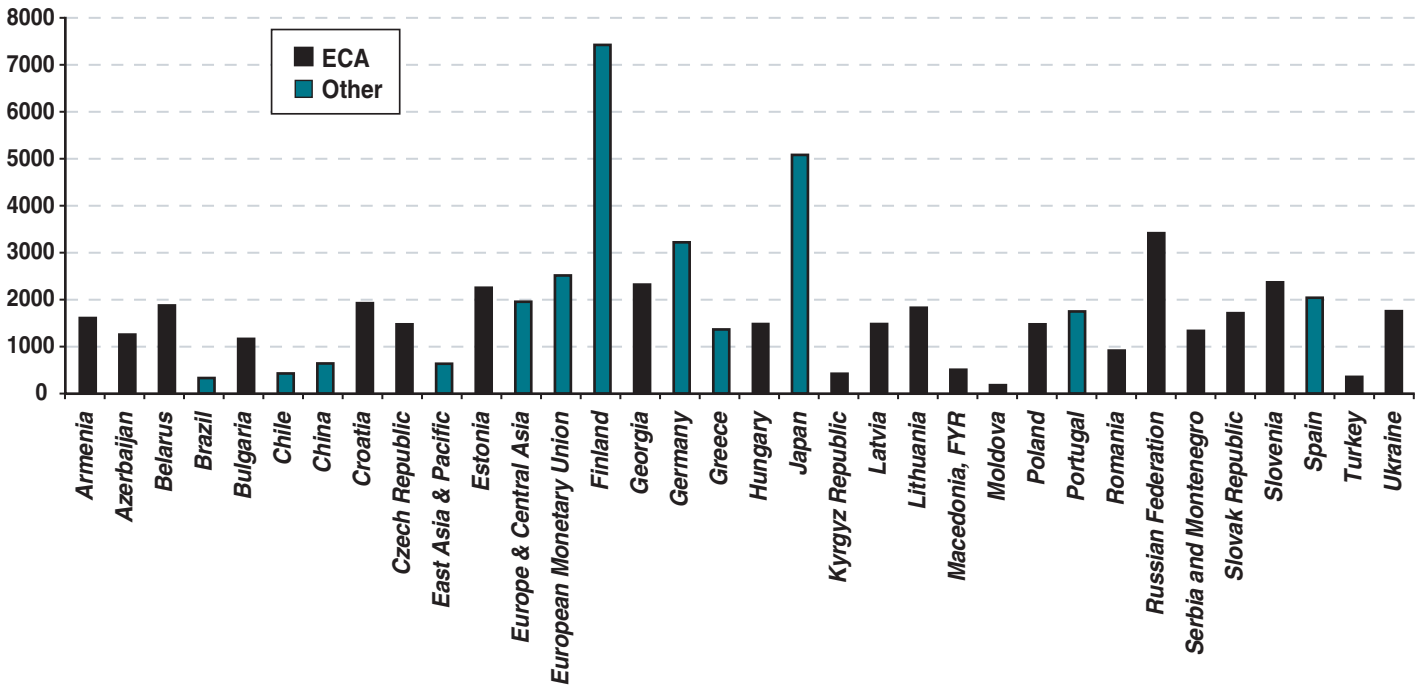
Financial support to stimulate commercial investment in R&D by firms is important in ECA because the average R&D-to-GDP ratio mentioned above does not reveal the whole picture of the structural misallocation of resources between private and public sectors and between basic and commercial R&D in the transition economies. Typically, the bulk of R&D spending in ECA, as much as 2/3 of the 0.9 percent of GDP, is financed by governments; whereas only about 1/3 is financed by the private sector. By contrast, in countries with high rates of R&D expenditure, such as Japan, the United States, Sweden, Finland, Ireland, and Germany, the share of industry-related R&D spending ranges from 65 percent to 70 percent, whereas government spending amounts to only 20 to 30 percent (OECD 2002). The share of researchers remains relatively abundant in the ECA region, with an average of nearly 2,000 R&D researchers per million. Russia continues to have the highest ratio of researchers to its population,

Figure 1. R&D-to-GDP Ratio—ECA and the World, 2002



Source: World Development Indicators

Figure 2. Researchers per million of the population, 2002



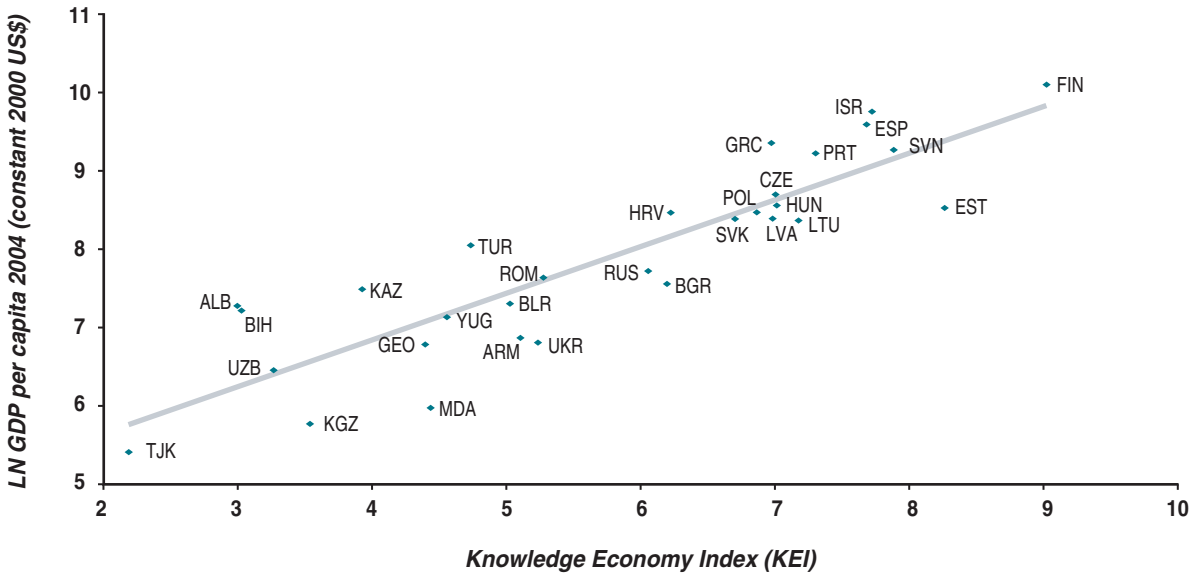
Source: World Development Indicators

with more than 3,400 per one million people. In chapter 4, we will elaborate on the relationship of growth, innovation, and R&D to economic incentives, education, and infrastructure.

The study's major goal is to provide countries with a general guide for evaluating the instruments to support innovation and the necessary institutional requisites for its effective application. Another key message of the study is that ECA countries need to analyze the state of their national innovation systems before embarking in the adoption of many of the financial instruments pursued by EU countries to support innovation. Some countries may not meet the basic institutional requisites, such as economic incentives, education, and information infrastructure, to absorb innovation instruments effectively. Other countries may have institutional bottlenecks that need to be addressed before or concurrently with embarking on an innovation program. As illustrated in figure 3, by using knowledge economy index (KEI) indicators from the World Bank's knowledge assessment methodology, the study provides a grouping of ECA countries according to their readiness for various innovation instruments. The readiness is based on an average KEI *and* on the scores in the individual institutional requisites mentioned above to identify and prioritize interventions targeted at specific *bottlenecks*. This graph, elaborated on in chapter 4, shows the KEI for different levels of per capita income.

This report is organized as follows: The second chapter provides a theoretical framework for examining the rationale for public participation in the funding of private industrial R&D and commercialization of innovative ideas. We begin with a brief description of how innovation and knowledge affect growth (endogenous growth theory) and therefore poverty reduction. We discuss in detail several market failures that may justify government intervention: the partial

Figure 3. Relationship between GDP per capita and KEI



appropriability of knowledge creation and information asymmetries leading to funding gaps at early stages of commercialization. We discuss how these market failures apply to developing countries, particularly highlighting the risk of "government failures" in attempting to resolve market failures. We conclude that although two market failures, partial appropriability (spillovers) and information asymmetries (funding gap), provide a well-grounded economic rationale for government support of innovation, the risk of government failures needs to be taken into account, as explained in chapter 3.

Accepting that there is a rationale for government intervention, we discuss in chapter 3 the most effective and least-distortive instruments for public support for commercial innovation. This chapter is based mainly on the analysis of different support mechanisms in OECD countries and its applicability to the ECA countries. As a start, we identify three key principles for the design of any support system:

1. *Attention to the institutional environment*: Especially in ECA countries, the institutional design should aim to immunize, as much as possible, the funding allocation from interference by political actors, corruption, and other state or specific interests capture.
2. *Additionality of funds*: Government interventions need to be carefully designed to promote private risk taking instead of rent seeking and to stimulate markets for private risk capital, so as not to crowd out private investment and other funding sources.
3. *Neutrality of intervention*: The government should not decide ex ante which technological sectors, firms, or projects to support, but rather should respond to the demands coming from the market.

We then discuss the different instruments used in OECD countries (grants, loans, tax incentives, procurement preferences). We describe in detail the most appropriate instruments for transition economies: grants (minigrants and matching grants) for early-stage R&D and commercialization and venture capital leverage at a later stage, as well as the role of business support services to complement these instruments. We

discuss the need for, and possibilities of, adapting these instruments to the conditions prevalent in many countries, also in ECA (e.g., state capture, corruption, and weak courts). In this context, the role of the World Bank advice on the selection of funding instruments is quite timely, because many ECA countries plan to adopt funding programs designed in OECD countries without proper attention to the transferability of those instruments to transition countries (e.g., R&D tax benefits complicate prevailing weak tax enforcement). The study concludes that the utilization of instruments such as matching grants and venture capital—with as much private sector participation in risk sharing and selection as possible—will be needed in ECA countries to ensure transparency and commercial viability and mitigate the risks of government failure. In situations in which the government is actively involved in selection, such as early-stage grants, the selection process needs to be carefully designed to include outside expertise. Business support services are important complementary instruments to support financial instruments, such as grants and venture capital, but have a weak track record on a stand-alone basis.

Following the theoretical discussion of the rationale and instruments for public support for innovation, we turn in chapter 4 to a specific empirical analysis of the requisite institutional framework for that type of intervention. We present a classification of countries according to knowledge indicators that might help determine the readiness of a country to start an innovation support program. A word of caution is important at this stage. The core of this study is not to assess ECA countries in regard to their readiness to start innovation support programs or to determine which reforms in their national innovation systems are most urgent. That assessment needs an in-depth analysis on a country-by-country basis and is well beyond the scope of this study. In this sense, the World Bank has collaborated in preparing knowledge economy assessments (KEAs) in a number of ECA countries—Russia, Poland, the Slovak Republic, Latvia, Lithuania, and Turkey. The classification of countries according to knowledge indicators serves mainly two purposes:

1. To elaborate on the main complementary elements and to identify bottlenecks that a country should be aware of in designing innovation support programs (although the list might not be comprehensive—again it will depend on country).
2. To show the wide differences in ECA countries. Some countries just might not be ready to engage in designing and implementing such policy instruments and might be better advised to follow a different route to acquire and absorb knowledge.

The institutional requisites have been selected on the basis of empirical work in the literature (described in chapter 4), which identifies the determinants of the national innovation capacity. To assess ECA countries we use the knowledge assessment methodology (KAM) developed by the World Bank Institute[3], although many other institutions developed similar indicators (the EU, United Nations Industrial Development Organization [UNIDO], United Nations Development Programme [UNDP], World Economic Forum [WEF]). This instrument assesses the readiness of the national innovation system (NIS) in each country and compares it with other countries.

We provide in chapter 4 a grouping of countries which is intended to be a guide for countries considering whether to invest public capital in the specific financial instruments to support innovation or to invest in building the institutional requisites for an innovation system but, again, it does not replace an in-depth KEA. In particular, countries can use this analysis to identify and prioritize interventions targeted

[3] The KAM can be found in www.worldbank.org/wbi

at specific *bottlenecks* and to identify particular *institutional strengths* that might improve the potential for success in enhancing their innovation system. It might well be that a country has a fairly high education level and a fairly well developed information infrastructure but its economic incentives regime is so weak that it presents a severe bottleneck to the commercialization of such research. In that case, the country might consider aggressively addressing the bottleneck before engaging in public financial interventions in innovation.