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Are systems of innovation in Eastern Europe efficient?

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ABSTRACT

This paper explores the determinants of productivity in the countries of Eastern Europe (EE) through the perspective of 'narrow' and 'broad' national systems of innovation (NSI). Based on panel econometrics, it examines the extent to which systems in EE could be considered '(in)efficient'. Our results suggest that the EE countries have lower levels of productivity than might be expected given their research and development (R&D), innovation and production capabilities. The inefficiencies of 'broad' NSI are compounded by the inefficiencies of 'narrow' NSI in terms of generating numbers of science and technology publications and resident patents relative to R&D employment compared to the rest of the world. Our results point to an important distinction between technology and production capability as the drivers of productivity improvements and provide some policy implications.

1. Introduction

Innovation and technical change are the main drivers of economic growth, although it is difficult empirically to show the link between them (OECD, 2001). Differences in the abilities of countries to generate technical change are crucial for determining the speed and nature of the catching-up process. In this paper, we address some of the factors behind the differences in the drivers of productivity by looking primarily at the impact of production and technology (innovation and production) capabilities of Eastern Europe (EE).

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The type of growth experienced by the countries of EE after 1989 seems to have been a spurt rather than progressive catch-up, and the 2007–2009 global financial crisis in particular has demonstrated the fragility of this growth. At the same time, there are several growth accounting exercises which suggest that growth in this region during the late 1990s and early 2000s was based mainly on total factor productivity (TFP), which from a conventional economic perspective suggests that this growth should be sustainable since it is based on technical change. For example, a World Bank study (see Alam et al., 2008) on productivity in EE demonstrates that it is largely attributable to TFP. However, a high TFP share does not necessarily reflect investment in R&D and innovation, which makes the sustainability of this growth questionable. We argue here that productivity growth in the region is based mainly on production, not innovation capability. Whether this production capability can be converted into greater productivity as well as S&T outputs depends largely on the efficiency of the national systems of innovation (NSI). So, in institutional terms, the long-term growth of EE countries will depend on whether their 'broad' and 'narrow' NSI can become efficient and effective carriers of innovation based growth.

We explore the technological determinants of productivity (research and development—R&D, and innovation and production capability) in EE through a system of innovation perspective. We present a quantitative analysis, which by definition means that we abstract from qualitative issues including the institutional complexity of this mega-region. In conceptual terms, we distinguish between 'narrow' and 'broad' NSI based on the distinction introduced by Lundvall (1992) and Freeman (1987, 2006), which has become accepted in the systems of innovation literature (see Edquist, 1997). This concept stems from the understanding that technical change is inextricably linked to the overall institutional fabric of society rather than only to the narrowly defined R&D/S&T (science and technology) system. A narrow NSI embraces those institutions that are directly and explicitly involved in R&D and the dissemination of its results. In the broad sense the NSI embraces the social, economic and political contexts of technical and organizational innovation (Freeman, 1987, 2006). Thus, we distinguish between the inefficiencies of narrow and broad innovation systems. The inefficiencies of the former lie in the process of conversion from R&D/innovation inputs into R&D/innovation outputs. The inefficiencies of broad NSI lie in the process of conversion of production and technology inputs into productivity.

The issue of 'inefficiencies' in NSI is quite controversial (see Niosi, 2002) and especially so in the case of EE where increases in productivity and high share of TFP during the 1990s and early 2000s have been accompanied by declines in R&D, which suggests that productivity increases have been generated by non-R&D factors. Naturally, there is a plethora of non-production (cf. institutional and cultural) factors that affect productivity, but we are interested in the impact of production and technology capabilities (R&D and innovation) on productivity in these economies.

The distinction between production and technology (R&D and innovation) capabilities is important for understanding technical change in developing countries. Production capabilities are resources used at *given* capital-embodied technology, labour skills, product and input specifications, and the organizational methods and systems used. Technological capabilities are those that *generate and manage technical change*, including skills, knowledge and experience, and institutional structures and linkages (Bell and Pavitt, 1993). Industrial dynamics increasingly depends on technological, not production capability. Economic growth based on passive learning or learning by doing, which is at the core of production capability, is bounded (Thompson, 2010). In addition, mastery of production capability does not automatically lead to mastery of technology capability. Knowledge for technology becomes increasingly differentiated from knowledge for production, while increasing production scale has reduced opportunities for further technological upgrading.

The bulk of the technical change activities in catching-up economies is related to improvements to production capability rather than R&D and innovation (see, e.g., Dahlman et al., 1987; Lall, 1990; Evenson and Westphal, 1995; Bell, 1997; Katz, 1987; Dutrenit, 2000; Bell and Pavitt, 1993). Because EE countries are catching-up economies this distinction is highly relevant for them.

Unlike R&D and innovation capabilities which are 'captured' in the OECD Frascati (OECD, 2002a) and Oslo (OECD, 2005) statistical manuals, production capability belongs to the realm of qualitative and case study research. In this paper we use ISO9000 certification data as a macro-proxy for production capability and R&D, and patents as a proxy for technological capability. Our analysis is based on a sample of 154 developed, developing and EE countries.[1]

The main conclusion from our study is that EE countries have lower levels of productivity than might be expected given their R&D and production capabilities, and lower levels of S&T outputs (papers and patents) given the numbers of their researchers. Hence, there are inefficiencies in both the 'narrow' and 'broad' NSI. In view of their growth, which so far has been based predominantly on production rather than technological capability, we conclude that policy in EE should distinguish better between technology generation and technology use, i.e. absorptive capability.

In Section 2 we introduce the issues of productivity and R&D in EE, drawing on broader evidence and elaborating on the notions of production and technology (innovation and R&D) capability, which are necessary to interpret the data on R&D, patents and ISO900 certification. We test whether the sizes of the R&D systems in EE countries correspond to their income levels given the inherited 'oversized' socialist system. In Sections 3 and 4, respectively, we explore the issues of broad NSI and narrow NSI efficiencies in EE. Section 5 summarizes some key conclusions and discusses the policy implications of our findings.

2. Productivity and technical change in Eastern Europe: introduction and conceptual framework

In the transition period, growth in EE was based mainly on removing distortions and introducing macro- and micro-organizational innovations (see Havrylyshyn et al., 1998; Havrylyshyn, 2008; Berg et al., 1999; Christofferson and Doyle, 1998; Mickiewicz, 2005; Chakravarti et al., 2005). In this period, reallocations and restructuring were more important for growth than factor accumulation; for example, aggregate investment ratios had no explanatory power. Efficiency gains appear to be the main, if not the sole, source of growth in EE (Zukowski, 1998). Extensive econometric work undertaken by World Bank, EBRD and IMF staff shows that the major factors explaining recovery and growth in EE are the initial conditions, i.e. inherited differences from the socialist period, macroeconomic policies, and structural reforms (e.g. see Havrylyshyn, 2001; Fischer et al., 1998; Berg et al., 1999; Falcetti et al., 2006; Kravtsova, 2008; Kutan and Yigit, 2009; Abegaz and Basu, 2011).

In the long term, growth in EE will depend increasingly on the expansion of physical and human capital, and especially on technology accumulation. Crafts and Kaiser (2004) show that during the 1990s, in three out of five central European economies, the contribution of TFP was relatively high at 2.3–2.4%.[2] In relative terms, TFP in four out of five central European countries has contributed to a GDP growth from 55% to 121%.[3]

A World Bank study conducted by Alam et al. (2008) demonstrates that TFP growth accounted for over 80% of total output growth in EE in 1999–2005, which is much higher than in other world regions. These estimates may be exaggerated as a result of higher capacity utilization as growth rebounded after the sharp contractions during the early years of transition. However, estimates for some countries (cf. Russia) where it is possible to adjust for capacity utilization show that even after adjusting TFP gains for employed resources, TFP shares still account for nearly two-thirds of overall growth during 1999–2005 (Alam et al., 2008, p. 75).

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[1] EE countries include all the so-called transition economies, i.e. the countries of central, eastern and south-eastern Europe, including the CIS countries. For a list of countries see Annex 1. We exclude from the OECD group countries belonging to EE. The notion of EE includes central Asian countries, which geographically may be incorrect, but has come to be accepted in the political economy literature. We do not use the term transition economies, which has lost its relevance. EE economies are characterised by their undeveloped and semi-developed status. In institutional terms they represent a variety of capitalisms rather than economies which are on the way to capitalism.

[2] However, for 1991–(95)97, Campos and Coricelli (2002) show that the contribution of TFP to growth was negative in four (Slovakia, Czech Republic, Croatia and Bulgaria) and positive in three EE economies (Hungary, Poland and Slovenia). These differences in TFP are partly due to the different periods considered, which extend to 1995(1997) and 1999, respectively, and partly to different assumptions about shares of labour and capital. Campos and Coricelli (2002) assume labour and capital shares to be 0.7 and 0.3, respectively, while Crafts and Kaiser (2004) assume shares of 0.65 and 0.35. Higher shares of labour in conditions of radical reduction possibly exaggerate the weight of TFP, which in conditions of overall output decline produce strong declines in TFP. However, these differences are too small to explain the huge variation in the contributions of different components to GDP, which suggests caution in making generalizations based on growth accounting exercises.

[3] The literature suggests that on average TFP contributes to half of the cross-country differences in per capita income (Lederman and Maloney, 2003), which makes the contribution of TFP to growth in EE quite substantial.

On the contrary, Deliktas and Balcilar (2005) estimate that up to 50% of the communist-era capital stock was destroyed in the early transition period, leading to a methodological problem in accounting for the capital stock and therefore causing a wide divergence in estimates of TFP growth and levels during the transition period.

The literature on the determinants of productivity suggests several related reasons for productivity growth: increased capital intensity, human capital, technological change, and competition (OECD, 2001). The key problem in trying to explore the determinants of productivity growth is whether it is appropriate to consider each individual component as a separate factor, since their contributions are closely interrelated (OECD, 2001). One of the most important drivers of technological change is R&D. Hence, as is the case with other factors, the issue is whether it is appropriate to isolate R&D as a driver of productivity growth from other factors. Aggregate studies often find that R&D provides a positive contribution to productivity growth. For example, Verspagen (2001) finds that in the last 10–20 years R&D has become a crucial part of catch-up strategies, that is, R&D is no longer associated only with the global technology frontier. Another reason is that differences among countries in terms of 'pure' technological competitiveness (patents) are becoming more and more important for explaining differences in growth. At the aggregate level, R&D expenditure tends to show a statistically significant relationship to productivity growth, but explains only a relatively small part of overall annual movements in multi-factor productivity, which points to the influence of other factors (OECD, 2001, p. 113).

As pointed out in EC (2002), R&D supply is only a part of the overall process of innovation that ends with a finished product placed in the market or national economic growth. The degree of technology and knowledge flows across public and private sectors strongly affects the impact of technology on the economy (OECD, 2002b). Therefore, if we want to understand the effects of R&D and innovation on productivity, we must look beyond the R&D sector. Since EE countries are catching-up economies, their growth depends on both R&D and on production and innovation capability. In addition, the relationship between R&D, innovation and productivity has been changing in the EE region.

The socialist period was specific in terms of technology (R&D and innovation) accumulation not leading to increased TFP (Gomulka, 1990). In the post-socialist period, however, we have seen a tendency towards increased TFP but declining R&D (Alam et al., 2008). Hence, EE seems to be an interesting case which illustrates that technological change does not automatically follow from increases in productivity and *vice versa*.

The stagnation of EE since the mid-1970s was driven by ineffective investments in capital goods and technology such that extensive investments in capital inputs were accompanied by slow TFP growth (Van Ark, 1999). In the early transition period, TFP deteriorated, but by the end of the 1990s, the overall contribution of TFP was significantly positive, and productivity growth was being driven mainly by the shedding of labour (Van Ark, 1999). van Ark and Piatkowski (2004) show that reductions in labour inputs made substantial contributions to labour productivity during the 1990s: inefficient firms exited or laid off labour, which enabled the remaining firms to restructure. This led to much larger declines in per capita GDP than in labour productivity. van Ark and Piatkowski (2004, p. 5) calculate that only 20% of the relatively strong productivity convergence between the 10 new EU member states from the EE and the 'old' EU-15 has been driven by faster output growth in the EE countries, while 80% is due to job cuts. This poses the question of what will be the sources of further productivity growth as productivity – driven mainly by labour savings – exhausts its potential.

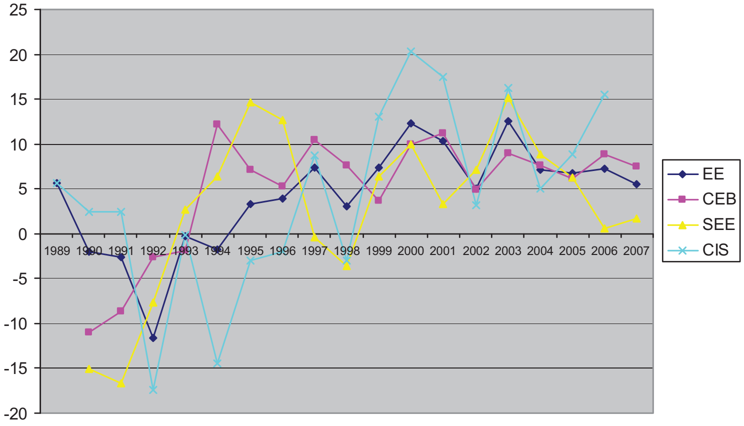
Hall and Jones (1999) attribute high TFP levels to better institutions. Even though the new EU members have already undertaken many of the reforms needed to create functioning market economies and to meet the institutional and legal standards of EU membership, some institutional improvements may still be possible. It is argued that the pace of these reforms and TFP growth may be much slower than it was in the past years.

There are many different drivers of productivity and we do not try to account for them all. We explore the role of technological capability composed of R&D and innovation capabilities (proxied by patents) and of production capability (proxied by ISO9000 certification) to explain levels of productivity. In the EE catching-up countries, growth is based much more on the use of foreign technology than on own technology development. Technology use capabilities are composed of basic operating skills and capabilities and technician and craft skills and capabilities, while technology development is based on R&D, design, and engineering (see Arnold et al., 2000). Hence, it is important to distinguish between the capabilities for developing (R&D and patenting) and using (production) technology. R&D and patents are proxies respectively for the capabilities for developing technology or generating change. We use ISO9000 certification as a proxy of technology using or production capabilities. These are the capabilities required to produce efficiently (on a level with best practice) using the existing equipment. There is a lack of research on the relationship between production capability and innovation (see Abrunhosa et al., 2008; Lopez-Mielgo et al., 2009a,b, which are rare exceptions).

We assume that the dominant focus of EE enterprises on mastering production capability explains why growth is not automatically accompanied by recovery in R&D and domestic innovation. Moreover, the disjunction in EE countries between the accumulation of production vs. technology capability could persist for some time due both to the weak technological and R&D capabilities of enterprises and the weak systems of innovation that cannot meet the challenges being posed by the emerging knowledge-based economy (Piech and Radosevic, 2006). A shift from technology using to technology generating capabilities is neither automatic nor linear: it is a non-linear, threshold type process, whose progression requires new ranges of institutions and technological capabilities.

Innovation surveys in EE show that innovation to improve product quality is ranked as important by the highest percentage of firm innovators (Radosevic, 1999). Majcen et al. (2009) report on research based on 435 foreign subsidiaries in five EE economies. Their study suggests that quality (production capability) is the most important factor in productivity growth. Subsidiaries established through foreign direct investment (FDI) are the most productive firms in EE, hence the broader relevance of this result, which we want to explore in this context.

Before analysing the relationship between productivity, production and technology capability, we examine trends in labour productivity. A recovery and return to growth in EE has been accompanied by rising labour productivity in the industry sector since the mid-1990s (see Fig. 1). However, the initial increase in productivity rates was followed by stabilization in all three EE sub-regions (Central and Eastern Europe and the Baltic States, South East Europe, CIS) to a level of just over 5%. Strong fluctuations in the labour productivity growth rates in most EE economies suggest that seeming improvements are being driven more by uneven patterns of layoffs, closure of unproductive businesses and reactive restructuring than by continuous technological improvements.



Source: CUBE dataset, EBRD

Legend: CEB: Central Europe and Baltics; SEE: South Eastern Europe; CIS: Commonwealth of Independent States

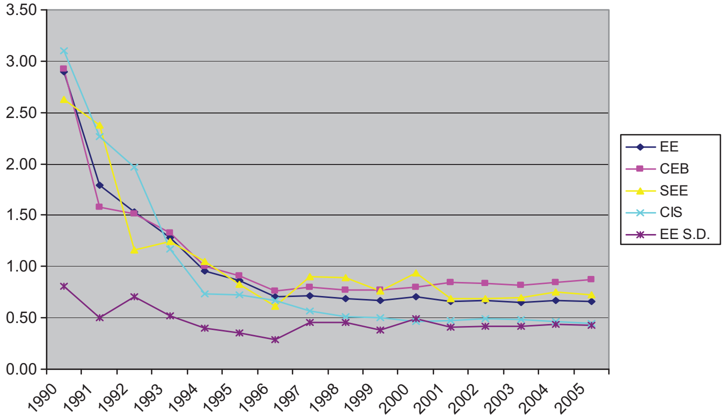
Fig. 1. Labour productivity in manufacturing, annual changes. CEB: Central Europe and Baltics; SEE: South Eastern Europe; CIS: Commonwealth of Independent States.
Source: CUBE dataset, EBRD.

Table 1
Average standard deviation of annual changes in productivity.

	1991–1996	1997–2001	2002–2007
EE29	13.9	8.4	6.5
CEE	12.9	6.2	5.1
SEE	6.9	9.1	5.8
CIS	12.4	7.0	7.5[a]

Source: CUBE dataset, EBRD.

[a] 2002–2005.



Note: Year to year data are limited prior to 1997 and especially for 10 out of 22 countries for the period 1991-1993.

Source: EBRD (CUBE dataset), Eurostat (New Cronos) and OECD (MSTI)

Fig. 2. Share of GERD in GDP in EE and sub-regions and standard deviation for EE. *Note*: Year to year data are limited prior to 1997 and especially for 10 out of 22 countries for the period 1991–1993.
Source: EBRD (CUBE dataset), Eurostat (New Cronos) and OECD (MSTI).

In the early transition years, productivity growth in EE showed big cross-country differences. But since the early 1990s to 2007, differences in yearly growth rates between countries, measured in terms of standard deviations, have been falling continuously (see Table 1).[4] This suggests an emerging 'convergence club', which is a bad sign as catching-up by the EE to the EU average will require much higher rates of productivity growth and differentiation among individual countries.

3. R&D and productivity growth in EE

Economic transition in the EE countries has been accompanied by sharp falls in relative R&D expenditure. As other studies show (Radosevic and Auriol, 1999), downsizing of the R&D systems in EE has not been linked systematically to any specific demand or supply side factors. It is likely the combination of demand side factors (annual changes in GDP and investments) and supply side policies (budgetary R&D) that has ultimately shaped trends in R&D spending. Neither government nor market demand for R&D could buffer these declines. Fig. 2 depicts the sub-regional averages for share of R&D in GDP and the standard deviation of shares based on individual countries' data.

These data show, first, that the sharp drop in GERD before the mid to late 1990s was followed by stabilization and recovery and, second, similar to the case of productivity (see Table 1), we observe the

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[4] Increased average standard deviation for CIS in the 2002–2007 period is influenced by 'abnormal' productivity growth of 33% in Georgian manufacturing in 2005.

emerging of a ‘convergence club’ instead of differentiation among countries. This suggests that the role of R&D may be peripheral to growth and productivity as relative R&D expenditures converge and productivity growth slows down and converges to EE equilibrium level.

The socialist countries traditionally invested disproportionately high shares of GDP in R&D (Hanson and Pavitt, 1987), which, to a large extent, was due to the closed nature of these economies, the dominant orientation, especially in the USSR, towards defence technologies, and COCOM (Anderton, 1995) restrictions which led to ‘reinventions of the wheel’. Before we analyse the issue of (in)efficiencies in the NSI it is interesting to explore to what extent EE countries have been able to shake off this heritage, that is, whether they can be differentiated, based on their R&D investments, from countries with similar levels of income. Following Gross and Suhrcke (2000), we test the relationship between GERD and GDP as a function of the level of development.

$$\frac{\mathbf{GERD}}{\mathbf{GDP_{ct}}} = \mathbf{f}(\mathbf{ln\,GDPpc_{ct}}, \mathbf{COUNTRY\_GROUP_{c\_group}}, \mathbf{FEt}) + \boldsymbol{\varepsilon}_{\mathbf{ct}}$$

where c: country, t: year; **GERD/GDP** is the share of R&D in GDP. **GDPpc** is GDP per capita. **COUNTRY_GROUP**: country-group dummies: EE: Eastern Europe; SEE: South Eastern Europe; CEB: Central Europe and Baltics; CIS: Commonwealth of Independent States (reference group). **FE**: fixed effects factor for the years considered.

Table 2 explores this hypothesis. The dependent variable in our regressions is R&D in GDP. We use the step-wise ordinary least squares (OLS) method of estimation, with fixed effects for years in Model 1 and Model 2 (year dummies are not reported in the final presentation of results). Model 1 refers to all 154 countries in the sample; Model 2 refers to all EE countries.

Regressing the share of R&D in GDP on per capita GDP (logged) for all countries and the dummy for EE produces significant results with moderate explanatory power ($R^2 = 0.39$), though with relatively large coefficients. The EE dummy is significant and negative, indicating that EE countries under-invest in R&D compared to the rest of the world.

The model for EE with dummies for the sub-groups SEE, CEB and CIS increases the explanatory power to 68% and generates significant and negative dummies. The dummy variable coefficients show the extent to which GERD/GDP in CEB and SEE deviates from the CIS, the base category. The negative coefficients suggest that at given levels of GDP, per capita shares of R&D in GDP for the CEB and SEE are lower than would be expected based on CIS levels. In other words, the level of under-investment in CEB and SEE is significantly higher than in the CIS. This is perhaps to be expected in view of the continuing post-Soviet R&D system in CIS compared to the systems in CEB and SEE (see Radosevic,

Table 2

Share of R&D in GDP and GDP per capita in East European (EE) and non-EE countries, 1990–2004.

Independent variables	Model_1	Model_2
Log of GDP per capita	0.49***	0.54***
	(19.76)	(11.39)
EE_dummy	−0.21***	
	(−3.54)	
see_dummy		−0.21***
		(−3.09)
ceb_dummy		−0.39***
		(−5.30)
_cons	−1.20***	−1.66***
	(−2.76)	(−3.95)
Number of observations	792	269
R^2	0.39	0.68

Source: EBRD (CUBE dataset), and Eurostat (New Cronos) and OECD (MSTI).

Note: Model_1: period 1990–2004 with all countries. Model_2: period 1990–2004 with all EE countries. Dependent variable in both Model_1 and Model_2 is share of R&D in GDP.

$^{*}p < 0.1$.

$^{**}p < 0.05$.

$^{***}p < 0.01$.

2003). The full magnitude of the drop in demand for R&D is not reflected in the CIS compared to the other EE countries due to the much stronger policy of preserving the R&D potential in place in the 1990s.

Our regression results suggest that R&D plays a relatively small direct role in the current performance of the EE economies (cf. negative dummy for the 1990–2004 period). However, we must not ignore the importance of the R&D system: its role is likely to increase with the return to growth, and its restructuring is a precondition for further industrial upgrading. In addition, the role of R&D cannot be evaluated only in terms of its direct contribution to innovation: it also contributes to education and the transfer of research methodologies and techniques (Patel and Pavitt, 1997) and is an important factor in absorptive capacity (Cohen and Levinthal, 1989).

Thus, the focus of our analysis of R&D should shift to viewing it as a component of the technological and production capabilities of EE countries. R&D and innovation are not synonymous, especially in countries that are behind the technology frontier. Therefore, we need to distinguish between technological (R&D, innovation) and production capabilities, proxied respectively by number of research scientists and engineers (RSE), resident patents, and ISO9000 certificates.

4. Productivity, production and technological capability

Among others, the main science, technology and innovation (STI) indicators of economic development widely used in the current literature are productivity, research and development (R&D), patents and patent citations, bibliometrics (publications and citations) and innovation surveys. Since each of the indicators has its merits and demerits (see Gambardella, 1995, for the main juxtaposes of pros and cons), general critical issues regarding the use of each of them were critically considered. As was pointed out in the seminal work of Abramovitz (1986), productivity itself, while being an estimator of economic development, carries an unexplained ‘residual’ associated with the so-called ‘black box’ (Rosenberg, 1983) of innovation. To shed light on the existing gap in the productivity and innovation literature, the role of technological capabilities (R&D and patents) and production capabilities (ISO9000 certificates) in the differences in productivity (income per capita) across a sample of countries will be examined in this section.

For innovation output we use data on resident patents. National patents are not used extensively in international comparisons as an indicator of national innovation capability.[5] In this context, US patent data are more common. However, the relevance of US foreign patenting is much less clear in the case of catching-up economies. The frequent use of US Patent and Trademark Office data for catching-up economies is misleading as world technology frontier activities are marginal for these economies. It is not until they reach a certain threshold level that their number of US patents increases. Good examples of this are the Republic of Korea and Taiwan, whose US patents increased sharply in the late 1980s from levels lower than in the socialist countries during the 1970s (Hu and Jaffe, 2001). Because the technology efforts of these economies are mostly not at the world innovation frontier, the relatively small numbers of US patents for these economies introduces the risk that small differences in patent numbers – especially over time – are over-interpreted. Also, we would expect resident patents to capture imitative innovative effort, which accounts for a dominant share of the innovative effort in catching-up economies. Unlike R&D spending and S&T publications, patents reflect the output of innovation rather than the input (Smith, 2005). The number of researchers in R&D has been used to proxy for R&D across countries. Unfortunately, we do not have reliable data on RSE in the business enterprise sector (BES), which would have been a better proxy for the innovation orientation of R&D. EE country data on BES R&D have several limitations. A high share of extra-mural R&D, which is inconsistently grouped as BES R&D or GOV R&D, makes the use of only BES data problematic.[6] In addition, it makes it more comparable with the other indicator which is used – ISO9000 certification

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[5] We are actually unaware of any large comparative study based on national patent data. It is still assumed that differences (i) in national patent systems, and (ii) in the quality of national patents are big and do not justify this analysis. We think that the first of these arguments is not justified anymore, as the process of harmonization in patent legislation, especially within Europe, has advanced so much that meaningful comparisons are possible today. Differences in the quality of resident patents are supposedly present, although we have not come across a systematic analysis which looks at this issue.

[6] For a methodological analysis of these issues, see Radosevic and Auriol (1999).

data. Since a high share of ISO certificates is issued in services and includes public organizations it would require use of the overall R&D manpower proxy as a counterpart rather than only BES.

Unlike patents, which lack information about the commercial use or value (many patents are never used), ISO9000 certificates are by definition used in business processes. They first appeared in 1987, spread rapidly in the 1990s, and have become a common business practice. Quality standards are concentrated on customer focus, people involvement and continuous improvement, which are elements associated with incremental improvements and soft (organizational) changes which are at the core of production capability. Our assumption is that ISO9000 certificates are indicators of production, not technological capability. The literature on the relation between quality management and innovation suggests that the relationship is rather controversial; the impact of different quality dimensions on the various types of innovation is difficult to generalize (Lopez-Mielgo et al., 2009a; Abrunhosa et al., 2008). For example, Guler et al. (2002) find that the availability of scientific and technical knowledge about operations, engineering, manufacturing, or quality as measured by S&T publications is not related to quality certificates. This is expected from our perspective, as quality standards are not proxies or determinants of R&D capability.

On the other hand, like any indicator, they are not without drawbacks. For example, there is the argument that certificates are used to communicate to buyers organizational quality attributes that otherwise would be difficult to observe, i.e., they have a strong signalling effect (Terlaak and King, 2006). We recognise these weaknesses of ISO certificates, which closely resemble the drawback of patents, which are also used as signalling devices. We try to correct for the most significant drawback of ISO certificates, which is that they are often imposed by MNEs as contemporary standard of business practice. Guler et al. (2002) show that the number of certificates significantly increases with the presence of foreign multinationals in the economy, as measured by inward foreign direct investment. In order to control for this structural effect we standardize data on ISO certificates by FDI.

The formal model of productivity level as a function of investment in R&D, innovation and production capability is presented below:

$$\mathbf{GNI\,pc_{ct}} = \mathbf{f}(\mathbf{ln\_RDPRSNpe_{ct}}, \mathbf{ln\_RESPAT\,pc_{ct}}, \mathbf{ln\_ISO\_FDI_{ct}}, \mathbf{EE\_DUMMY_{c\_group}}, \mathbf{FE_t}) + \varepsilon_{ct}$$

where c: country, t: year, c_group: country-group (see Annex 1 for group definition); RDPRSN is the number of researchers involved in R&D per million population, which measures the R&D intensity of the labour force and can be used as a proxy for the generation of new knowledge (World Bank World Development Indicators, 2008); RESPAT is the number of resident patent applications per capita and is the proxy for innovative capability (World Bank World Development Indicators, 2008); ln_ISO_FDI is the log of number of ISO9000 certificates per capita (The ISO Survey of ISO, 9000 and ISO 14000 Certificates 1993–2000; 2001–2004 and 2003–2007) standardised by FDI share (World Bank World Development Indicators, 2008), which is the proxy for production capability.[7]

With the spread of new business models based on contract manufacturing and fragmented value chains, quality standards have become 'entry tickets' to global production networks (Arndt and Kierzkowski, 2000). For EE countries in particular, ISO certification is indispensable for exports and integration into multinational corporation networks. Hence, we use the log of number of ISO900 certificates standardised by the relative value of FDI in the economy as a proxy for the level of production capabilities in the economy (Models 3, 4 and 7 in Table 3). This variable also captures differences in the size of economies and thus the relatively smaller presence of FDI in large economies. We also use the alternative of ISO9000 certificates per capita (Models 5, 6 and 8 in Table 3).

In order to explore whether, given their levels of R&D, innovation and quality related activities, EE economies under- or over-perform in terms of productivity, we run regressions with and without the dummies for EE and EE sub-regions.

The results are presented in Models 3–8. The dependent variable in all the regressions is gross national income (GNI) per capita. Our method of estimation is a panel data model with fixed effects (Model 3–6) and step-wise OLS (Model 7—a reestimation of Model 4 with dummies, and Model 8—a reestimation of Model 6 with dummies) with fixed effects for years (year dummies are not reported in the final presentation or results) and groups of EE countries.

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[7] An alternative proxy for ISO certificates, i.e. ISO certificates per capita, is also used in the regression.

Table 3
Determinants of productivity in EE and non-EE countries, 1993–2005.

Independent variables	Model_3	Model_4	Model_5	Model_6	Model_7	Model_8
ln_researchers_in_rd	0.34^{***} (7.39)	0.21^{***} (6.41)	0.22^{***} (6.34)	0.16^{***} (6.28)	0.42^{***} (20.27)	0.27^{***} (13.02)
ln_patent_resid	0.02 (0.47)		0.01 (0.22)			
ln_ISO_FDI	0.03^{***} (6.70)	0.03^{***} (7.52)			0.10^{***} (7.89)	
ln_ISO_per_capita			0.05^{***} (9.44)	0.05^{***} (11.08)		0.21^{***} (16.29)
cis_dummy					-0.59^{***} (−4.83)	
see_dummy					-0.55^{***} (−6.31)	-0.50^{***} (−5.72)
ceb_dummy					-0.37^{***} (−6.20)	-0.38^{***} (−6.36)
_cons	7.21^{***} (21.94)	8.22^{***} (33.64)	8.28^{***} (32.10)	8.74^{***} (45.92)	6.33^{***} (17.29)	9.61^{***} (38.13)
Number of observations	364	449	374	471	449	471
R^2	0.31	0.24	0.35	0.33	0.76	0.76

Source: EBRD (CUBE dataset), and Eurostat (New Cronos) and OECD (MSTI).
Note: Dependent variable in all models is log of PPP-adjusted GNI per capita.
$^{*}p < 0.1$.
$^{**}p < 0.05$.
$^{***}p < 0.01$.

The models including all countries (3–6) have significant coefficients for the number of R&D personnel and for ISO certificates – based on both proxies (4 and 6), while the coefficient of patents is not significant. Models 7–8, including the dummies for EE sub-regions, have improved explanatory power (R^2 = 76%) and significantly higher coefficients, including negatively significant regional dummies.[8] The negative coefficients of the dummies for all three EE sub-regions suggest that based on the number of R&D personnel and ISO certificates, EE countries have lower levels of productivity compared to the rest of the world. The models that include sub-regional dummies (7 and 8) show improved explanatory power, confirming that inefficiency of the NSI characterizes all EE sub-regions, although the CIS dummy is not significant in Model 8 when we use an alternative indicator for production capability. Sub-regional dummy coefficients are ranked in order from CIS to CEB, suggesting the ranking of inefficiency in the broad NSI.

Productivity does not change substantially when innovation capability is proxied by resident patents. This suggests that resident patents do not contribute to explaining productivity levels over time,[9] whereas ISO certification as a proxy for production capability significantly contributes to explaining the differences in productivity in both specifications. This confirms the importance of capturing both R&D and production capability for understanding productivity differences across countries. In a catching-up context, R&D denotes absorptive rather than innovative capability. This is in line with the argument about the two sides to R&D proposed by Cohen and Levinthal (1989). As our sample includes both developed and catching-up economies, a significant R&D coefficient denotes the importance of both new knowledge generation at the world technology frontier and absorptive capacity for catching-up economies.

The relevance of this model (Table 3) is also confirmed in the models with only EE countries (Table 4), whose explanatory power is increased. In all the models except Model 3.1, both the coefficient of production capability and the R&D coefficient are significant. As in Table 3 the coefficients of patents are not significant.

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[8] Note that Models 4–6 are estimated using fixed effects and therefore time-invariable dummies are excluded. The variable Patent_resid is locked-in in regressions 4 and 5 to show the differences in the fit of other regressions.

[9] We checked whether there was a significant correlation between R&D and patents which might capture similar dimensions of technological effort. However, the correlation is only 0.23 and is insignificant.

Table 4
Determinants of productivity in EE countries, 1996–2005 (reestimation of Table 3 models for EE countries).

Independent variables	Model_3.1	Model_4.1	Model_5.1	Model_6.1	Model_7.1	Model_8.1
ln_researchers_in_rd	0.17	0.20^{*}	0.22^{**}	0.23^{**}	0.08^{**}	0.14^{***}
	(1.45)	(1.81)	(2.16)	(2.44)	(2.11)	(3.86)
ln_patent_resid	0.10		0.10			
	(1.30)		(1.48)			
ln_ISO_FDI	0.09^{***}	0.08^{***}			0.11^{***}	
	(8.90)	(9.69)			(10.63)	
ln_ISO_per_capita			0.10^{***}	0.10^{***}		0.14^{***}
			(12.00)	(12.80)		(19.82)
see_dummy					-0.15^{**}	-0.26^{***}
					(−2.53)	(−7.15)
ceb_dummy					0.16^{***}	
					(2.97)	
_cons	8.32^{***}	8.65^{***}	8.01^{***}	8.46^{***}	9.68^{***}	9.63^{***}
	(9.01)	(10.24)	(10.18)	(11.79)	(25.67)	(34.31)
Number of observations	121	126	121	126	126	126
R^2	0.478	0.497	0.614	0.625	0.827	0.832

Source: EBRD (CUBE dataset), and Eurostat (New Cronos) and OECD (MSTI).
Note: Dependent variable in all regressions: GNI per capita. Estimated using panel data model with fixed effects {Model 3–6}. Step-wise OLS is used in Model 7 (re-estimation of Model 4 with dummies) and Model 8 (re-estimation of Model 6 with dummies) including fixed effects for years and groups of EE countries (note that dummies for years are not reported in the final presentation).
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

When we include sub-regional dummies (7_1 and 8_1) in the models, the size of the coefficients of production capability increases and the explanatory power improves even more to above 80%. It is interesting that compared to the CIS countries, the CEB dummy is significantly positive in model 7_1, again suggestive of somewhat higher efficiency of the broad NSI in this group of countries.

5. Testing the (in)efficiency of narrow NSI in EE

Due to the multifaceted nature of S&T inputs and outputs, the issue of productivity in narrow national innovation systems is complex. The outputs of innovation activities include both products such as patents and papers, and partly also tangibles such as machinery and equipment (for example, scientific equipment), as well as a wide range of know-how (capabilities) and skills, all of which need to be considered in trying to understand productivity in relation to innovation. Any indicator is inevitably very partial and can be understood only in a specific institutional context.

One way to explore the inefficiency of narrow NSI is to relate S&T outputs to inputs. In the empirical literature this concept has been labelled as "knowledge production function". Usually figures on R&D expenditures are used as input to the production process. Despite the criticism of some authors on the use of patent data (e.g. Griliches, 1990), this variable is the most frequently used indicator of innovation output. Several studies have examined the relationship between firms' R&D expenditures and patents and found a positive relationship between patenting and R&D activity (e.g. Pakes and Griliches, 1980; Crépon and Duguet, 1997).

To test the relationship between S&T publications/resident patents as the output variable and R&D employment as the input variable, the regressions were run controlling for possible structural biases that interfere in the relationship between S&T inputs and outputs—per capita GNI, share of high-tech in exports, and ISO9000 certificates.[10] The R&D systems in more developed countries enjoy spillover effects from their more developed division of labour and greater availability of specialty services. This cumulated advantage affects the efficiency of narrow NSI. Countries differ in terms of industry

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[10] A broader indicator of innovative activity which would go beyond R&D personnel would be inconsistent with resident patents, which is here taken as output measure of innovative activity.

Table 5
Determinants of S&T publications and patents in East European countries during 1996–2005.

Independent variables	S&T publications			Patents		
	Model_9	Model_10	Model_11	Model_12	Model_13	Model_14
ln_researchers_in_rd	0.28^{***} (2.75)	0.27^{***} (2.69)	0.22^{**} (2.26)	0.10 (0.89)	0.11 (0.99)	0.17 (1.22)
ln_HiTech_exp2		0.12^{***} (3.04)	0.09^{**} (2.16)		−0.05 (−0.90)	-0.11^{*} (−1.80)
ln_gni_pc_ppp			0.14^{**} (2.23)			0.26^{*} (1.87)
ln_iso_pc						-0.06^{***} (−3.22)
_cons	4.75^{***} (6.32)	4.69^{***} (6.45)	3.73^{***} (4.49)	5.30^{***} (6.51)	5.30^{***} (6.51)	1.99 (1.27)
Number of observations	126	124	124	129	129	121
R^2	0.064	0.137	0.175	0.007	0.014	0.146

Source: EBRD (CUBE dataset), and Eurostat (New Cronos), World Bank Development Indicators and OECD (MSTI).
Note: Dependent variable in Models 9–11 is S&T publications; dependent variable in Models 12–14 is patents. Estimated using fixed effects panel data model.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

structure, which affects the relationship between R&D inputs and outputs. Those countries that are more specialized in high-tech sectors and are exporters of high-tech products are more likely to have higher shares of patents. On the other hand, we can expect better developed production capability compared to innovation capability in catching-up or laggard economies, which will negatively affect the relationship between S&T inputs (R&D employment) and outputs (patents). As we are interested in efficiency irrespective of structure, we need to control for these structural biases.

The results of our regressions (Table 5, Models 9–11) suggest that there is a positive relationship between inputs (R&D employment) and outputs (S&T papers), although the explanatory power is quite small (R^2=6.4%). If we control for developmental (per capita GNI) and structural (high-tech exports) biases, the explanatory power of the model improves and all explanatory variables are significant. This confirms that the outputs of science systems (S&T papers) are influenced by both structural features and developmental spillovers.

Models 12–14 show that R&D does not explain innovation capability: the coefficient of R&D employment is not significant.[11] R&D employment remains insignificant when the control variables are added up, although these variables are significant. A significant negative coefficient of ISO9000 certificates suggests that innovation and production capabilities are not complementary. Better developed production capability does not automatically lead to higher technological capability. A negative coefficient of high-tech export, significant only at the 10% level, is only seemingly a puzzling result. We think that it reflects weaknesses in the OECD R&D based classification of industries which is also applied to catching-up economies. These sectors in EE are not actually R&D intensive; for example, CEB economies are specialized in low value added segments of high-tech sectors. Thus, the R&D intensity of EE electronics is lower than the average for manufacturing (see Srholec, 2006, for evidence).

Models 9_1–14_1, including all countries (Table 6), show similar results, but have much stronger explanatory power (especially in relation to R&D) and higher coefficients. The coefficient of high-tech exports is positive and significant, while the coefficient of the variable for production capability is insignificant. The models that include patents as the dependent variable have significant coefficients for high-tech. In the model for only EE the coefficient is negative (Table 5, Model 14). Production capability for all countries is insignificant but for EE it is strongly negatively significant. These differences suggest some major EE specificities:

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[11] This is compatible with the low correlation coefficient of R&D and patents observed in Section 3.

Table 6
Determinants of S&T publications and patents in all (both EE and non-EE) countries during 1990–2005 (reestimation of Table 5 models for all countries).

Independent variables	S&T publications			Patents		
	Model_9_1	Model_10_1	Model_11_1	Model_12_1	Model_13_1	Model_14_1
ln_researchers_in_rd	0.57***	0.54***	0.43***	0.42***	0.43***	0.52***
	(12.98)	(13.13)	(10.10)	(7.44)	(7.42)	(8.29)
ln_HiTech_exp2		0.15***	0.10***		0.08	0.10*
		(5.32)	(3.75)		(1.63)	(1.85)
ln_gni_pc_ppp			0.35***			0.00
			(6.62)			(0.01)
ln_iso_pc						−0.01
						(−0.69)
_cons	3.56***	3.41***	0.99**	3.63***	3.43***	2.72***
	(11.48)	(11.52)	(2.16)	(8.97)	(8.07)	(2.76)
Number of observations	435	407	407	403	385	361
R^2	0.32	0.40	0.47	0.14	0.16	0.22

Source: EBRD (CUBE dataset), and Eurostat (New Cronos), World Bank Development Indicators and OECD (MSTI).
Note: Dependent variable in Models 9_1–11_1 is S&T publications. Dependent variable in Models 12_1–14_1 is patents. Estimated using fixed effects panel data model.
* $p<0.1$.
** $p<0.05$.
*** $p<0.01$.

- R&D employment is a weaker determinant of S&T publications in EE, which suggests possibly inefficiencies in the narrow NSI;
- a negative relationship between patents and high-tech exports indicates an EE specific mode of global integration through low value added segments in high-tech sectors, as indicated elsewhere (see Srholec, 2006; Kaderabkova, 2006);
- a negative relationship between innovation (patents) and production capability (ISO9000 certificates) is suggestive of a gap between these two types of capabilities, i.e. progress in production capability may not be sufficient for progress in innovation capability.

Next, we test the previous two models for all countries and with EE dummies (Table 7). The dependent variable in Models 15 and 16 is S&T publications; the dependent variable in Models 16 and 18 is patents. Models 15 and 16 include all countries; Models 16 and 18 are all countries but with sub-regional dummies. The method of estimation is step-wise OLS with fixed effects for years and groups of EE countries.

In both models (15 and 16) with EE dummies, these are highly significant and negative, indicating that compared to the number of researchers, EE R&D systems generate fewer S&T publications and patents than the rest of the world. Also, for patents, the control variable level of development is insignificant and not reported, while the structural bias towards high-tech is positively significant. A negative and significant coefficient of production capability (ISO9000 per capita) indicates that production and innovation capability are not complements, that is, developed production capability does not automatically lead to innovation capability. We do not have a simple explanation for the negative coefficient of GNI per capita in Model 15 since it is positive in Models 11 and 11_1. It may be that the aggregate dummy for EE is too rough a proxy given the diversity of growth experiences in early transition but not later periods. This possibility is confirmed in Model 17, which includes only EE countries and sub-regional dummies and where the control variable GNI per capita is significant and positive. This model shows only the CEB dummy as significant, suggesting that compared to the number of researchers, income levels and high-tech orientation, CEB has generated fewer S&T publications compared to the other two sub-regions. In Model 18 for patents, this result applies to both CEB and SEE compared to the rest of the EE (CIS), which suggests that CEB and in part SEE produce lower numbers of publications and patents given their R&D employment, income levels and high-tech orientation.[12] Does

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[12] We should bear in mind that the high-tech orientation of CEB is a largely illusory effect of statistics, as demonstrated by Srholec (2006).

Table 7
Comparison of determinants of S&T publications and patents in all countries (Model 15 and 16) and EE countries (Model 17 and 18), 1996–2005.

Independent variables	S&T publications		Patents	
	Model_15	Model_16	Model_17	Model_18
ln_researchers_in_rd	0.98^{***}	1.50^{***}	0.94^{***}	0.04
	(7.95)	(5.40)	(7.18)	(0.12)
ln_gni_pc_ppp	-0.50^{***}	1.19^{***}		
	(−2.83)	(3.31)		
ln_HiTech_exp2	0.34^{***}		0.84^{***}	
	(3.30)		(5.95)	
ln_iso_pc			-0.20^{***}	0.18^{**}
			(−3.37)	(2.31)
EE	-1.36^{***}		-0.68^{***}	
	(−6.53)		(−2.66)	
ceb_dummy[a]		-1.04^{***}		-4.32^{***}
		(−3.81)		(−8.88)
see_dummy				-3.75^{***}
				(−7.26)
_cons	4.98^{***}	-14.37^{***}	-3.72^{***}	11.13^{***}
	(4.30)	(−4.53)	(−2.84)	(3.81)
Number of observations	400	124	358	121
R^2	0.33	0.33	0.34	0.49

Source: EBRD (CUBE dataset), and Eurostat (New Cronos), World Bank Development Indicators and OECD (MSTI).
Note: The dependent variable in Models 15 and 16 is S&T publications. The dependent variable in Models 17 and 18 is patents. All models in the table are estimated using step-wise OLS with fixed effects for years and groups of EE countries.

[a] In model 17 the CEB_dummy is the only significant dummy left in the step-wise OLS estimation and therefore reflects the relationship for the CEB group of countries against the rest of the EE countries in the sample. While in Model 18 both dummies are significant and therefore the base group here is CIS countries.

$^{*}p < 0.1$.

$^{**}p < 0.05$.

$^{***}p < 0.01$.

this suggest that their narrow NSI are more inefficient than those of the CIS? We believe that the narrow NSI in CIS are still largely post-Soviet type systems, which means that they continue to be more autonomous and have been less exposed to restructuring, that is, to demand shocks, due to the persistence of the policy of 'preservation of S&T potential' (see Radosevic, 2003). The result is that the R&D systems of CIS, especially Russia, Ukraine and Belarus, produce higher numbers of S&T publications and domestic patents, but these outputs are not necessarily linked to the new, radically transformed demand for local R&D and local innovation. Thus, the notion of (in)efficiency cannot be understood outside the specific institutional context of the post-Soviet (CIS) and the EU-ized (CEB and partly SEE) R&D systems. This is in contrast to higher efficiency or lower inefficiency of the broad NSI in CEB compared to the other two sub-regions.

6. Conclusions and policy implications

Our analysis shows that EE has lost the advantages of size of R&D inherited from the socialist period and, as pointed out in EC (2004), the problem of low efficiency of their innovation systems (R&D, education and vocational training systems) has emerged.

We can draw several conclusions. First, EE countries have lost some advantage in terms of the size of R&D. Second, production capability in combination with R&D employment explains the productivity differences within our sample. Third, EE countries have lower levels of productivity than might be expected given their R&D capacities and production capabilities, which points to possible inefficiencies in their conversion into productivity. Fourth, patents as proxies for innovation capability are not significant for explaining productivity levels in EE and other economies. This confirms our proposition that growth in EE is driven by production, not innovation capabilities. Moreover, results for all countries including EE suggest that production capability does not automatically lead to innovation capability. Fifth, productivity of the narrow NSI, proxied by papers and patents, is explained satisfactorily by the numbers of researchers in all countries including EE. However, the efficiency of the process of conversion is lower in EE. Sixth, we conclude that there are inefficiencies in both the narrow and the broad NSI.

Our conclusions suggest that policy in EE should put more focus on the distinction between technology generation and use, that is, production and absorptive capabilities. Our first results point to production capability as a neglected determinant of productivity. Our latter results confirm the relevance of Cohen and Levinthal's (1989) conclusion on the dual role of R&D.

Production capability in combination with R&D capabilities is a satisfactory explanation for productivity differences among OECD and EE countries. Our results point to the importance of quality and intra-firm productivity-enhancing activities for growth and catch-up, and to the role of R&D capabilities in knowledge generation at the world technology frontier and in the mechanisms for acquiring absorptive capabilities. From a methodological point of view, our study shows that catching-up and technology frontier activities cannot be measured by a single metric. Catching-up in EE continues to be located within production capability and, hence, metrics such as the European Innovation Scoreboard (EC, 2008), which are based on world frontier activities, are inadequate as benchmarks for economies behind the technology frontier.

Overall, EE countries are inefficient both at converting their R&D, innovation and production capabilities to appropriate levels of productivity, and converting their R&D and production capabilities to outputs such as S&T papers and resident patents. We define these problems respectively as inefficiencies in broad and narrow NSI.

The inclusion of sub-regional dummies in the models for determining productivity suggest that inefficiency of the broad NSI is a common regional characteristic, in ascending order from CEB, to SEE, to CIS. Inefficiency of the narrow NSI also applies to all three subregions and is specific to the institutional context ranging from the post-Soviet (CIS) to EU-ized R&D systems (CEB) with the SEE a kind of intermediate case.

Our analysis points to the problem of inefficient NSI in EE, but cannot necessarily detect the causes for these inefficiencies. To do this would require in depth country and inter-country comparisons. Existing analyses (Radosevic, 2006; Nemet, 2009) suggest that the problems lie not only in the S&T systems themselves, but also in the broader context of demand for technology. This applies particularly to the relationships between small and large firms and the integration of foreign firms into the local economy (McGowan et al., 2004; Damijan et al., 2003).

Our findings point to the important distinction between technology using (production) vs. technology (R&D and innovation) capabilities and have several implications for policy.

First, they point to the importance of production capability, that is, intra-firm productivity or non-R&D activities. This aspect of policy, which is addressed only through vocational training, is essential for improving the absorptive capabilities of EE. By improving their absorptive or technology using capabilities, firms can move to technology adoption and developing activities. A prominent policy feature of EE is the lack of vision related to its learning (education/training) systems, that is, poor response through policy to improving firm specific production capabilities.

Second, a key challenge for EE at firm level is how firms can make the transition from mastery of production to technological (R&D and innovation) capabilities. This process is not automatic or linear and requires changes both within firms and in the narrow NSI or innovation infrastructure, as well as changes in the broad NSI.

Third, a re-orientation of EE R&D systems from the current exclusive focus on knowledge generation to knowledge diffusion and absorption orientation is required. The capacity to diffuse knowledge throughout the economy is essential for catching-up in the knowledge based economy. By embracing the additional functions of knowledge diffusion (supply side), R&D systems would better match the changing demand for innovation and technology generated through the broad NSI.

To summarize, our analysis points to the gap between the production and technology determinants of productivity in EE and the inability of policy to close this gap. Policies that would help to close this gap are not confined only to the narrow NSI or oriented only towards the generation of new knowledge, they also need to embrace the knowledge absorption and diffusion functions of R&D systems and assist in the integration of narrow and broad NSI through effective, demand-oriented measures.

Finally, we should point out some limits of our analysis. It is primarily a quantitative analysis, the purpose of which is not to substitute but to complement comparative qualitative institutional analyses. It suffers from the usual tension between concepts and their imperfect proxies. Estimation of dynamic versions of the proposed empirical models could shed additional light on the structural heterogeneity of different issues addressed in this paper.

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Appendix A. Annex 1

List of countries of Eastern Europe and its sub-regions.

Central Europe and Baltics (CEB)	Commonwealth of Independent States (CIS) and Mongolia	South-eastern Europe (SEE)[a]
Czech Republic	Armenia	Albania
Estonia	Azerbaijan	Bulgaria
Hungary	Belarus	Croatia
Latvia	Georgia	FYR Macedonia
Lithuania	Kazakhstan	Romania
Poland	Kyrgyzstan	Serbia
Slovakia	Moldova	
Slovenia	Mongolia	
	Russia	
	Tajikistan	
	Turkmenistan	
	Ukraine	

[a] Data for Bosnia and Herzegovina and Montenegro are not available.

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