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Socio-Institutional Environment and Innovation in Russia

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This article investigates the impact of social capital and institutions on innovation outcome in Russian regions in 1997–2011. The novelty of the article also lies in the use of two metrics of innovation: the number of new technologies developed and patents filed. The findings provide strong support for the argument that social capital (proxied by social tension) and institutions (proxied by institutional potential) influence innovation activity. Furthermore, different types of innovation outcome are affected differently: the effect of social tension on technology development is significantly negative but insignificant with patenting, while institutional potential affects patenting negatively but its effect on technology development is insignificant.

KEYWORDS institutions, patents, Russia, social capital, technologies

INTRODUCTION

Creating competitive advantage through innovation (e.g., the ability to develop technologies to enhance productivity) is an increasingly important factor in explaining rising prosperity and economic efficiency among countries (Vernon 1970; Porter 1990; Krugman 2000; Cantwell 2005). This said, only a small fraction of countries are capable of initiating and implementing technological change, decreasing the gap with the world's

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technological leaders. The progress of other countries is rather slow. There are many conditions that make innovation possible.

The focus of this study is on the socio-institutional environment for innovation. Although the role of institutions in innovation is vital (Mathews 2001), innovation involves collaboration between people and firms; it is also a lengthy process: it takes time for a creative idea to develop into a viable economic outcome (e.g., patent, technology). It often requires marrying or "colliding" partial and unrelated ideas, resting on hunches and residing in two or more separate individuals. Unless these hunches are brought together and connected, the innovation goes undiscovered.

To "unlock" innovation, it is crucial to create environments for people and firms to work together (i.e., "innovation-prone environment," see Rodr´ıguez-Pose 1999; Iammarino 2005). The role of social capital (resources accessed in social networks; see Lin 1999) in the innovation process becomes critical: when people belong to networks with a higher level of social capital, they may be willing to work together and to take chances on risky ideas. It follows, therefore, that a higher level of social capital fuels innovation (Putnam, Leonardi, and Nanetti 1993; Fukuyama 2001; Florida 2002a,b).

Location matters for innovation because technological, entrepreneurial, and economic activities tend to agglomerate in certain places, nationally and regionally (Krugman 1991; Porter 1998; Audretsch and Feldman 2004). Although the ability to innovate varies across and within countries (Acs, Anselin, and Varga 2002; Fritsch 2002; Doloreux 2004), the degree to which differences in regional innovation output are attributed to the variations in socio-institutional environment remains unclear. This study aims to bridge this gap, by examining innovation in Russian regions.

Russia is an interesting case to study innovation. It is a large and heterogeneous transition economy, characterized by economic and technological disparities that remain widespread across Russia's 83 regions (Rosstat). Since the beginning of transition, despite Russia's fluctuations in gross domestic product (GDP)[1], economic growth has been evident but attributed merely to Russia's large product market and natural resource abundance. This is worrying given that the country has accumulated some considerable innovation potential and capabilities during the Soviet era (Liu and White 2001; Radosevic 2002).

In 1998–2008, the gross domestic expenditures on research and development (R&D) in Russia nearly doubled (at constant prices). However, the production of complex innovative products is limited, the share of value-added production is at a trivial 0.5% (the World Bank), Russia invests just over 1% of its GDP on R&D, lagging behind other emerging markets (e.g., India and China) (Gianella and Tompson 2007), and its innovation environment in recent years has deteriorated: the global innovation rankings have worsened as Russia has been gradually falling from the 59th place in 2006–07 to 66th place in 2010–11 and 67th place in 2012–13 (the World Economic Forum Global Competitiveness Reports 2007–13).

The analysis presented in this article is based on panel data covering the period of 1997–2011. The novelty of the article lies in the use of two metrics of innovation: the number of new technologies developed and patents filed. Two models were built and examined that included social capital (proxied by social tension), institutions (proxied by institutional potential), R&D expenditures and personnel and number of people with secondary and higher education (to account for human capital), small and medium-sized firms (SMEs) and inward foreign direct investment (FDI; to account for spillover effects), urbanization and migration (to account for urban diversity).

The study finds a significant relationship between innovation (measured by both proxies), social capital, and institutions but the effect varied depending on the measure of innovation used. The impact of social capital on the number of new technologies developed was significantly negative, while its effect was insignificant in the case of patenting. The effect of institutions was significantly negative for patenting, whist it was insignificant for new technology development. Results also revealed that innovation in Russia has been fostered by urbanization and migration and has been higher in regions with a higher number of R&D personnel.

Foreign direct investment was found to have a significantly positive effect on technology development; while the impact of SMEs was significantly positive on the number of patents filed. The direct effect of migration was positive on the development of new technologies but negative on patenting. The indirect effect of migration through urbanization was positive on the number of patents filed but negative on the number of technologies developed.

The article is organized as follows. The next section begins by reviewing the key regional innovation literature. It then discusses the literature focusing on the two variables of interest—social capital and institutions. The following section presents the empirical analysis. It is then followed by a discussion of results. The final section concludes and discusses the policy implications.

CONCEPTUAL FRAMEWORK

The Regional Systems of Innovation

In the last few decades, the literature on regional systems of innovation (RSI) has produced an extensive body of research and has been used as a framework for the design and implementation of innovation policies in a variety of regional contexts. It combines two main fields of theory: the innovation system strand and insights from regional science (Doloreux and Parto 2005, 134–35). Its theoretical foundations are found in the previous economic geography contributions (dealing with the regional scaling of economic processes) and, more recently, in systemic and evolutionary approaches to innovation and learning (Cooke and Morgan 1994; Asheim and Isaksen 1997; Baptista and Swann 1998).

The RSI[2] framework is based on the idea[3] that the economic performance is a result of both individual firms' efforts and the external innovation environment. Indeed, it is the presence of a complex system of institutions, research infrastructures, education and training systems, and innovation policies that determines innovation in a particular location (Iammarino 2005). That is, the capacity of any location to innovate depends closely on the presence of the RSI.

Knowledge becomes viable (e.g., patent, technology) by means of complex networks of interaction between socioeconomic actors. One of the best ways to generate innovation is through socio-institutional mechanisms (Bathelt, Malmberg, and Maskell 2004). Surprisingly, however, regions with a similar institutional framework may show different abilities to innovate (Iammarino 2005). It is the "social capability"[4] that determines to what extent any given region is "innovation prone" or "innovation averse" (Rodríguez-Pose 1999). Local socio-institutional environments that favor entrepreneurship are more likely to generate systems, which will be innovation enhancing.

Therefore, innovation has become a territorially embedded process (Rodríguez-Pose and Crescenzi 2008, 54) but true territorial embeddeness is considered to be "feasible only at regional level" (Cooke 2006, 6). Indeed, the regional dimension allows economic actors involved in innovation to work together, making the region "the best geographical scale for an innovation-based learning economy" (Doloreux and Parto 2005, 136). With an understanding of innovation being socially and territorially embedded, a strong case is made that the regional level is growing in importance as a mode for innovation systems research.

Socio-Institutional Environment for Innovation

The contribution of social capital (defined as a resource contained in social networks and accessible to its actors; see Putnam et al. 1993) to innovation lies in the fact that it increases efficiency in the innovation process (by reducing transaction costs between firms and other actors through, e.g., shared norms and codes, and management costs; see Maskell 2001). Social capital helps reduce malfeasance, induces the volunteering of reliable information, and enables employees to share tacit information (Maskell 2001). A low level of social capital can lead to duplications of effort due to lack of coordination and costly contractual dispute (Fountain 1999).

Innovation is not generated in isolation. Indeed, it depends on the successful sharing of information (especially in high-technological fields; see Fukuyama 2001) but requires a high degree of trust between partners and common cultural, institutional, and entrepreneurial activities (Doloreux 2002; Doloreux and Parto 2005). The success of innovation depends not only on the individuals involved in collaboration but also on the wider social setting (beliefs, norms, and attitudes of the citizens towards each other) (Lundvall 2007).

Not surprising then that the empirical literature has observed a significant impact of social capital on innovation (Murphy 2002; Cainelli, Mancinelli, and Mazzanti 2007; Hsieh and Tsai 2007; Carmona-Lavado, Cuevas-Rodríguez, and Cabello-Medina 2010). For example, social capital is found to have a significant impact on growth (Chou 2006; Woodhouse 2006; Ahlerup, Olsson, and Yanagizawa 2009; Akçomak and ter Weel 2009) by assisting in the accumulation of human capital. It can also affect financial development through its effects on collective trust and social norms, and networking between firms, resulting in technological innovation (Chou 2006; Rutten and Boekema 2007; Akçomak and ter Weel 2009; Kaasa 2009; Pérez-Luno et al. 2011).

The role of institutions in the innovation process has been acknowledged. Institutions consist of cognitive, normative and regulative structures and activities that provide stability and meaning in social behavior (Scott 2008). Institutions instil trust into firms and markets and assist in building local innovation capabilities (Busenitz, Gomez, and Spencer 2000; Licht and Siegel 2006; Mathews 2007; Lam and Lundvall 2007). Institutions determine the rules of the game in a society and function as "constraints and opportunities shaping human interaction" (North 1990).

Empirical studies examining the impact of institutions on innovation indicate that although cultural-cognitive and normative institutions influence innovation through affecting behavior and attitudes (Shane, Venkatarman, and Mac-Millan 1995), legal institutions have effect on partner collaboration (Oxley 1999; Teece 1986; Luo 2005). Institutions play an important role in transforming a body of technical knowledge into a well-performing set of economic practices and determine a country's ability to master and advance technology (Nelson and Nelson 2003).

This said, institutions vary between and within countries. On the one spectrum, there are "innovation-prone" economies and regions. On the other, there are those that are "innovation-averse," with institutions deterring innovation. In particular, corruption, lawlessness, and government predation erode social capital (i.e., trust in institutions and among individuals). In turn, weak institutions suppress investments in social capital and cultural transmission of pro-social norms and civic virtues (Tabellini 2008), while entrenching social practices of adjustment to bad institutions.

INNOVATION IN RUSSIA

Russia has an exceptionally large science base, spending more on inputs into knowledge-creation processes than other countries at similar levels of GDP per capita, including other emerging economies (Gianella and Tompson

2007). It has more than 3,600 R&D firms and almost 400,000 researchers and highly skilled R&D personnel trained by more than 1,100 universities (Todosiichuk 2011).

However, there is still a striking imbalance between innovation inputs and outputs and there are some significant differences in innovation capabilities across Russian regions (Rosstat). In 2008, for example, Russia's share of the international market for high-tech products was less than 0.3%, compared to 36% in the United States, 30% in Japan, and 17% in Germany (Todosiichuk 2011). In 2009, only 8% of Russian firms innovated, compared to 64% in Germany, 47% in Finland, and 39% in Czech Republic; and the share of SMEs that conducted innovation was 3.1%, compared to 62.6% in Germany and 52.2 and 51.4% in Belgium and Finland, respectively (Dezhina 2011).

This said, there is evidence of the ongoing transformation process (Gokhberg and Kuznetsova 2011; Organization for Economic Co-operation and Development (OECD) 2013). Today Russia is a signatory to the Paris Convention and a member of the World Intellectual Property Organization; it has joined the World Trade Organization in 2012. Russia has undoubtedly made considerable efforts to develop its national innovation system (OECD 2013). For example, it introduced state policies on matters of ownership, use, and disposal of intellectual property, restricting unfair competition and elimination of administrative barriers. A number of measures to target major state-owned enterprises (e.g., the Innovation Enforcement Initiative 2011–12) have been put in place to oblige firms to carry out innovation activities (OECD 2013).

Despite these transformational changes, however, the innovation environment in recent years has deteriorated vis-a-vis the trends with major global competitors (Gokhberg and Kuznetsova 2010). In particular, the export share of the natural resources sector has increased. In 2000, oil and natural gas were less than half of Russia's total exports. By 2010, however, this figure had grown to almost 70% with an additional 15% coming from other extractive commodities (Gerasimenko 2012). Innovation policy in Russia has overly focused on high-tech sectors neglecting large parts of the Russian economy (OECD 2013).

One of the key current strategic priorities for Russia is to modernize the economy, to improve productivity, and to increase prosperity and living standards of citizens through innovation (Golichenko 2011). Three strategic directions for Russia were outlined at the World Economic Forum in 2007: diversification of the economy and exports, creation of modern infrastructure, and the development of human capital. It was noted that institutional reforms were needed to ensure Russia builds on the national innovation potential by strengthening institutions and social capital.

Indeed, historical preconditions (i.e., the Soviet legacy) that influenced Russian society created the conditions that resulted in a low trust (Mishler and Rose 2001, 2005) making cooperation with strangers for the purposes such as business deals or civic action difficult (Miszal 1996). For example, during the Soviet era the Communist Party consciously sought to undermine all forms of horizontal association (between the members of the society) in favor of vertical ties (between party-state and individual) (Fukuyama 2001). However, according to empirical evidence, network capital was unquestionably high both under the pre- and post-Soviet society (Miszal 1996): many authors reflected on strong, close, multi-stranded character of links and connections in Russian smaller communities with dense networks (Wedel 2001).

After the breakdown of the Soviet Union, the persistence of networks was emphasized (Mishler and Rose 2001) but during economic transition social capital in Russia has significantly eroded (Aghion et al. 2010). Lack of trust of social capital in contemporary Russia (the World Values Survey) is consistent with the conjecture posited by Putnam and colleagues (1993) and later supported by an in-depth econometric analysis for countries and regions (Tabellini 2008).

METHODOLOGY

The empirical examination presented in this article is based on the data collected from Rosstat (Russia's Statistical Agency) and Expert RU (Russia's Rating Agency). The study used two proxies for innovation outcome: *TECH* and *PAT*. *TECH* refers to new technologies developed in Russia for the first time. These technologies have neither domestic nor foreign counterparts and have qualitatively new characteristics that meet the requirements of the current or superior level (Rosstat). *PAT* includes the total number of patents filed in a region. The data on patent applications rather than patents granted were used (for a supporting argument see Crosby 2000).

The innovation literature (e.g., Campbell et al. 2009) has emphasized that, to improve the understanding of the innovation process, the need to use additional (to patents) innovation metrics in empirical studies is critical. The use of alternative (additional) measures of innovation output allows the following. First, it helps to explore the variance unique to each variable. Second, it helps to mitigate the deficiencies when one measure is selected to the exclusion of the other.

The innovation process begins with an invention. An invention is a pillar of technology. New technologies in this process are a pillar of patents. The data on technology development in particular can represent firms' innovativeness, as knowledge embodied in the development of such technologies can explain both a decision to innovate and develop more radical innovations (Rogers 1998). Of 83 regions, data on new technologies developed (*TECH*) were available for 75 regions. Data on patents filed (*PAT*)—for 81 regions. The following two models were built and estimated:

$$TECH_{it} = a + b_1 SOCIO_{it-3} + b_2 INST_{it-3} + b X'_{it-3} + e_{it} \quad (1)$$

$$PAT_{it} = a + b_1 SOCIO_{it-3} + b_2 INST_{it-3} + b X'_{it-3} + e_{it} \quad (2)$$

where TECH is the number of new technologies developed in a region i in time period t and PAT is the number of patents filed in a region i in time period t. *SOCIO* is used to examine the effect of social capital (measured by social tension); *INST* is used to examine the effect of institutions (measured by institutional potential); *X'it* is a vector of control variables affecting innovation; e_{it} is an error that is modelled as $= g_t + m_t + k_{it}$, where g and m are time- and regional-invariant effects, respectively; and k is a random disturbance. All the control variables were lagged 3 years (as their effects on innovation may not be immediate; see Fritsch and Slavtchev 2007, 2011; Smith, Thomas, and Antoniou 2014). This means that the innovation output in a given year is reflected in the innovation outcome generated three years in the future.

One possible way to compare the regional socio-institutional capacity is to use an indicator of social and business climate and/or investment attractiveness, which have been computed in recent years for Russia's regions (Popov 2001). This study used two indices developed by Expert RU: Index of Social Tension to proxy social capital (*SOCIO*)[5] and Index of Institutional Potential to proxy institutions (*INST*). *INST* and *SOCIO* are rankings from 1 (assigned to a region with the highest institutional potential/lowest social tension) to 83 (assigned to a region with the lowest institutional potential/highest social tension).

If stable and non-corrupt regional governments are more conductive to the process of new business start-ups, new entrepreneurial activities would then contribute to better innovation performance (Popov 2001). To account for this, the number of SMEs (*SME*) was added to the model (see Popov 2001; Berkowitz and Dejong 2005). It approximates the regional year stock of SMEs (since regional governments typically require their firms to register on an annual basis). As legal start-ups and spin-offs began to appear in the former Soviet Union in the late 1980s (Aslung 1997), this measure was intended to capture the accumulated regional stock of legal entrepreneurial activity, which is a vital source of innovation, employment, and growth (Carree and Thurik 2003; Parker 2004; van Stel, Carree, and Thurik 2005).

An effective educational and training system is an important element of innovation systems: it can raise productivity and foster economic growth by building knowledge. The development of human capital fosters civic culture and pro-social values (Glaeser et al. 2004; Glaeser, Ponzetto, and Shleifer 2007). It is, therefore, essential to boost human capital by providing access to new knowledge and training (Lall 2004). Indeed, the availability of human resources in science and technology or R&D personnel (e.g., researchers, engineers, and technicians) and the provision of educated people are important for innovation (Wolff 2002; Falvey, Foster, and Greenaway 2007).

There is strong evidence that investments in human capital generate spillovers and increasing returns (Romer 1990). Countries that continuously invest in creating a well-developed infrastructure for education grow faster (Porter 1990).[6] To proxy human capital, two variables were used in the study: *DEGCAP* is the number of (per capita) graduates with secondary and higher degree qualifications and *RDCAP* is a number of people (per capita) involved in R&D (or R&D personnel). Monetary R&D efforts were proxied by R&D expenditures (*RDEXP*).

Domestic firms can benefit from the presence of foreign firms—an important channel for international technology diffusion through productivity spillovers (Crespo and Fontoura 2007). As foreign firms often invest abroad in technological areas in which they are strong in their home country, this can be beneficial to the development of domestic indigenous innovation capabilities (Driffield 2001). Technology transfer from foreign firms may facilitate local R&D activities, i.e., domestic firms would require building their knowledge in order to adapt new technologies (Lall 1983; 1998).[7] In this article, the regional knowledge spillovers emanating from FDI were controlled by adding the inflows of FDI (*FDI*) to the model.

Finally, a dummy variable (*URB)* for large cities (with population over one million) accounts for the possibility that more innovation take place in urban locations; while a coefficient of migration (*MIGR*) tests whether migration can boost innovation in Russia (through positive spillovers, for example, on fellow researchers, achievement of critical mass in specialized research areas, and provision of complementary skills such as management and entrepreneurship). As the impact of urbanization on innovation can go hand in hand with migration, an interaction term *URB***MIGR* was used to test whether the effect of urbanization was significantly different in the regions with a higher level of migration.

Description of variables used in the study is in Table 1; descriptive statistics of the variables is in Table 2, and their correlations are in Table 3.

TABLE 1 Description of Variables Used in the Study

TECH: Number of new technologies developed
PAT: Number of patents filed
RDEXP: Expenditures on R&D
RDCAP: Number of people involved in R&D per capita
DEGCAP: Number of people with secondary and higher degree per capita
SOCIO: Index of Social Tension
INST: Index of Institutional Potential
SME: Stock of SMEs
FDI: Inward flows of foreign direct investment
URB: Dummy taking a value of 1 for regions with cities over 1 million people and 0 otherwise
MIGR: Coefficient of migration
URB*MIGR: Interaction term between URB and MIGR

Note. All data except for SOCIO and INST (that are taken from Expert RU) are from Rosstat.

TABLE 2 Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
TECH	1245	9.655	23.061	0	254
PAT	1245	381	1020.204	0	13180
RDEXP	1285	22254	66282.980	0.072	1611623
RDPCAP	1250	0.003	0.005	0.000	0.036
DEGCAP	1353	0.006	0.004	0.000	0.092
SOCIO	1410	43.39	24.91	1	83
INST	1410	42.63	23.96	1	83
SME	1476	111063	268647	100	3444500
FDI	1231	377575	6276190	0	214000000
URB	1325	0.374	0.484	0	1
MIGR	1412	−8.484	124.213	−1170	2523
URB*MIGR	1325	5.941	29.759	−117	239

Note. For the abbreviations of variables see Table 1.

The choice of the method was determined by the nature of the dependent variable, i.e., a non-negative count over-dispersed measure. Therefore, a negative binominal regression (Greene 2008)[8] based on a panel data methodology designed to account for possible unobserved heterogeneity (frequently a source of autocorrelation and heteroscedasticity; Hausman et al. 1984; Cameron and Trivedi 2005)[9] was utilized.

To rule out some plausible alternative explanations that might have influenced the volume of regional innovation, regional- and time-specific characteristics were controlled for by adding time and regional dummies. In the main analysis, human capital was measured by the number of people with secondary and higher qualifications (in the total regional population). To test the robustness of the results, it was measured by the number of people with technical qualifications (in the total regional population).[10] The robustness was confirmed.

TABLE 3 Correlation Matrix

	TECH	PAT	RD	RDPCAP	DEGCAP	SOCIO	INST	SME	FDI	URB	MIGR	URB* MIGR
TECH	1											
PAT	0.807	1										
RD	0.389	0.422	1									
RDPCAP	0.728	0.675	0.274	1								
DEGCAP	0.441	0.544	0.410	0.349	1							
SOCIO	−0.295	−0.275	−0.215	−0.276	−0.133	1						
INST	−0.472	−0.416	−0.333	−0.419	−0.203	0.345	1					
SME	0.778	0.947	0.486	0.630	0.625	−0.283	−0.433	1				
FDI	0.303	0.127	−0.007	0.200	0.032	−0.024	−0.066	0.068	1			
URB	0.327	0.268	0.247	0.228	0.206	−0.229	−0.552	0.283	0.043	1		
MIGR	0.383	0.405	0.204	0.355	0.132	−0.451	−0.465	0.388	0.039	0.245	1	
URB*MIGR	0.520	0.573	0.210	0.442	0.293	−0.303	−0.267	0.563	0.061	0.228	0.530	1

Note. For the abbreviations of variables see Table 1.

RESULTS

The results discussed next are based on the final specifications 6 (Table 4) and 12 (Table 5) that include all the innovation determinants specified.

Although the significant effect of social capital and institutions on innovation is confirmed, the sign of the effect varied depending on the measure of innovation used. The impact of social tension on technology development was significant (*b*¼0.4, $p < 0.01$; in line with Hult 2002; Hult, Hurley, and Knight 2004; Lu and Shyan 2004; Song and Thieme 2006) and negative: in Russia, the regions with lower levels of social tension had facilitated more technology development but not patenting as the impact of social tension on patenting was insignificant. FDI is found to increase the number of technologies developed in a region (*b*¼0.06, $p < 0.01$; in line with Holland and Pain 1998; Javorcik 2004), while SMEs are observed to contribute positively to the patenting activities¼*b* 0.4, $p < 0.05$).

Results suggest that social capital may have played an important role in knowledge sharing (between foreign firms and SMEs), resulting in the development of new technologies (Tsai 2002). A higher level of social capital may

TABLE 4 Results with the "Number of Technologies Developed" as a Dependent Variable

	(1)	(2)	(3)	(4)	(5)	(6)
RDEXP	0.097**	0.079**	0.074**	0.069**	0.055**	0.037
	(0.027)	(0.028)	(0.028)	(0.027)	(0.027)	(0.027)
RDCAP	0.315**	0.281**	0.266**	0.199**	0.126***	0.112***
	(0.062)	(0.064)	(0.063)	(0.063)	(0.065)	(0.063)
DEGCAP		0.428**	0.421**	0.365**	0.204	0.202
		(0.136)	(0.135)	(0.132)	(0.136)	(0.145)
SOCIO			−0.359**	−0.362**	−0.369**	−0.364***
			(0.142)	(0.139)	(0.139)	(0.137)
INST				−1.145**	−0.699**	−0.525
				(0.289)	(0.369)	(0.365)
SME					0.297**	0.166
					(0.127)	(0.137)
FDI					0.058**	0.059***
					(0.020)	(0.020)
URB						0.604**
						(0.216)
MIGR						0.003**
						(0.001)
URB*MIGR						−0.003**
						(0.002)
Const	1.616**	3.833**	3.908**	3.694**	−1.196**	−1.139**
	(0.536)	(0.898)	(0.887)	(0.849)	(1.871)	(1.920)
N	953	951	951	951	911	879
Wald 1	80.96***	92.64***	100.17***	123.96***	139.10***	140.84***
Wald 2	47.70***	58.27***	52.65***	88.22***	100.39***	112.03***

Note. Robust standard errors clustered by region in parentheses; *significant at 5% level; **significant at 1% level; ***significant at 10% level; for the abbreviations of variables see Table 1.

TABLE 5 Results with the "Number of Patents Filed" as a Dependent Variable

	(7)	(8)	(9)	(10)	(11)	(12)
RDEXP	0.055**	0.044**	0.046**	0.043**	0.006	0.008
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.010)
RDCAP	0.158**	0.141**	0.084**	0.141**	0.053**	0.052**
	(0.027)	(0.028)	(0.026)	(0.028)	(0.028)	(0.026)
DEGCAP		0.263**	0.306**	0.260**	0.100**	0.020
		(0.058)	(0.056)	(0.058)	(0.051)	(0.058)
SOCIO			−0.062	−0.054	−0.010	−0.019
			(0.051)	(0.055)	(0.050)	(0.048)
INST				−0.014	−0.233***	−0.213***
				(0.128)	(0.127)	(0.119)
SME					0.552***	0.449**
					(0.058)	(0.070)
FDI					0.001	0.002
					(0.007)	(0.006)
URB						0.638**
						(0.146)
MIGR						−0.002**
						(0.001)
URB*MIGR						0.001***
						(0.001)
Const	2.351**	3.954**	4.309**	4.152**	−3.073**	−2.504**
	(0.222)	(0.405)	(0.388)	(0.388)	(0.829)	(0.928)
N	978	976	976	976	922	903
Wald 1	361.56***	368.45***	633.90***	369.86***	470.43***	527.02***
Wald 2	67.22***	81.18***	73.00***	82.51***	150.83***	186.63***

Note. Robust standard errors clustered by region in parentheses; *significant at 5% level; **significant at 1% level; ***significant at 10% level; for the abbreviations of variables see Table 1.

have, indeed, been associated with learning and knowledge acquisition in a region (Yli-Renko et al. 2001) possibly by improving access to external sources of knowledge (i.e., foreign technology). The results may also imply that foreign inventors in Russia have been discouraged to file patents because of poorly established intellectual property rights (IPR) protection and=or trust in Russia's institutions.

At the core of most investment decisions, particularly those made by foreign firms, is the IPR protection that increases the rate of international technology transfer (Glass and Saggi 2002; Dinopoulos and Segerstrom 2010; Glass and Wu 2007). While making some initial progress following the 2006 Bilateral Agreement on IPR, enforcement of IPRs in Russia remains a significant problem (with respect to notorious markets selling physical goods and IPR-infringing content on the Internet). This can explain the insignificant impact of social capital and FDI on patenting and insignificant impact of institutions on technology development.

That said, a significant (in line with Busenitz et al. 2000; Licht and Siegel 2006) but negative association between institutions (i.e., institutional potential) and patenting was observed (b¼0.2, $p<0.01$). That is, more patents have been filed in the regions with weaker institutions. If corruption (abuse of public power for private benefit) is assumed to be higher in these locations, then it is possible that in weaker institutional settings corruption has been beneficial to local entrepreneurial endeavors (Levy 2007; Méon and Weill 2010; Smith et al. 2014) in that it may have helped domestic firms to circumvent bureaucratic obstacles, inefficient public procurements, and rigid legislation (Leff 1964; Huntington 1968). Linking this result to the results discussed so far, one of the possibilities can be (again) that foreign inventors (that contributed positively to the development of new technologies) may have been discouraged to file patents in Russia. Local entrepreneurs, on the other hand, have been able to do so despite the weak IPR protection.

Indeed, the evidence is clear that SMEs in Russia have been strong contributors to patenting activities (in line with Berkowitz and Dejong 2005) but, surprisingly, in the institutional environments that are unsupportive of their activities (i.e., with weaker institutions). It is possible that in such environments SMEs may have used corruption to deal with institutional weaknesses (e.g., when they have not been able to benefit from the opportunities in the market such as financing their activities from well-organized and smoothly operating markets, from intra- and inter-industry linkages and, in the case of business failure, from institutionalized safety nets).

Although the impact of R&D expenditures is not found to be significant for innovation in Russia (contradicting Fritsch 2002 among others), the impact of human capital measured by the R&D personnel has been a significant determinant of innovation ($b = 0.1–0.3$, $p < 0.01$). A significant impact of both urbanization and migration on innovation ($b = 0.60–0.64$, $p < 0.01$) is also evident (in line with Jacobs 1985; Glaeser 2011), confirming that innovation in Russia has been fostered in more diverse and open (to migration) places (Glaeser et al. 1992; Quigley 1998; Frey and Zimmer 2001).

As expected, the level of urbanization and migration did interact in their effect on innovation. Interestingly, with technologies the effect was negative (i.e., urbanization negatively affected the volume of technologies via the interaction with migration), but positive—when patents were used as a measure of innovation output (i.e., urbanization negatively affected the volume of patents filed via the interaction with migration). That is, the results confirm that, along with urbanization, labor mobility has been beneficial for innovation in Russian regions.

As the number of innovations as an indicator for the success of R&D activities was used, the resulting constant term should denote how many innovations have been generated without a corresponding R&D input on behalf of the inventors during the period for which R&D input was measured. When SMEs and FDI were added to the basic model (Model 5 in Table 4 and Model 11 in Table 5), a change from a positive to a negative constant term was clear.

The sign did not change when urbanization and migration were controlled for (in Models 6 and 12). Assuming that innovations require some R&D input, one explanation would be that innovation in Russia has, indeed, been so far based on the current inputs and "new knowledge" (generated by SMEs, FDI, and in more diverse urban places) and not the existing stock of "old knowledge," i.e., the respective input had been spent in earlier periods (Fritsch 2002).

CONCLUSION

This study examined empirically the effect of social capital and institutions on innovation in Russia, controlling for a number of other innovation determinants specified from the literature. Although the significant effect of social capital and institutions on innovation was confirmed, the effect varied depending on the measure of innovation used. It is hoped that these findings will stimulate a debate on the nature of Russia's innovation, and more generally about the process of technology development at the national and especially regional level.

Innovation involves collaboration, network building, and sharing of ideas, i.e., social interactions between people and firms. The findings of this study indicate that (further) development of social capital in Russia along with institutions is vital. As the basis for social capital is people's relations with their closest surrounding and their community, government reforms should focus on building an effective and flexible institutional system that would allow for the necessary level of social tension and conflict, which should help reduce regional complaints and tensions.

When institutions are of poor quality, social capital can be a good substitute (Durlauf and Fafchamp 2005; Easterly, Ritzen, and Woolcock 2006. At the same time, without sufficient social capital, institutions could be either idled or captured and subverted by narrow interests, in which case institutional reforms will not bring about the desired results. Therefore, an important policy agenda for Russia is to strengthen its institutions by replacing those that for decades have suppressed investments in social capital and delayed cultural change of pro-social norms and civic virtues, while rooting anti-modern social practices of adjustment to bad institutions (Tabellini 2008).

The strong empirical evidence of the importance of human capital along with urbanization and migration for innovation suggests that more diverse regions with lower barriers to entry for human capital should have the characteristics required to attract talent and thus generate innovations. In this respect, policymakers in Russia should focus on the development and strengthening of the socio-institutional environment, facilitating the development of new talent, especially from universities. Improvements in the curricula in Russia's education system, for example, should encourage greater engagement of employers and adult learners to better match skills' demand and supply. If improved, educated and skilled labor in Russia would enrich the country's workforce.

Russia's immigration system can become an effective tool by accepting the entry of workforce able to make the real impact on innovation rates. Labor mobility in Russia has been restricted by regulations concerning the movement to the federal cities (Andrienko and Guriev 2004) as well as by the poverty trap (Bekowitz and Dejong 2003). Russia suffers from an exceptionally high regional income inequality and poor health outcomes. Thus, along with investments in human capital, Russia would benefit from a more efficient and better-funded public healthcare system, which should help to reduce high poverty.

The article presents strong evidence that urban diversity is beneficial for innovation. It suggests that the regional economies could, indeed, benefit from openness to migration. As diversity creates low barriers to entry for talent, thereby increasing the potential for talent to flow into a region (Florida and Gates 2001; Florida 2002a, 2002b), urgent reforms promoting greater diversity are, therefore, needed. Thus, if Russia's urban system is further reformed, this might promote the generation of greater productive force (Sun 2000).

The evidence presented is convincing that urbanization facilitates innovation, as big cities in Russia have become the playgrounds for entrepreneurs (Jacobs 1985). Openness to diversity can, therefore, provide an additional source of advantage and supports the view that knowledge transfer in cities fuels innovation. Cities create a positive "feedback loop" that can fuel continued innovation: growing cities can make people more productive and creative, which in turn can motivate more people to move to the cities.

It is equally critical that Russia's innovation capability is (further) strengthened by technology transfer (between foreign and domestic firms). This said, it has become well acknowledged that Russia's institutions need continuous improvement. Some latest empirical research shows, for example, that innovation capacity in Russia mediates the effects of the institutional environment on firm performance and that regulatory quality, rule of law, and corruption have negative impact on innovation capacity of firms in Russia (Chadee and Roxas 2013).

There is also evidence that in the environments with high political risk (e.g., in Russia), corruption may act as a hedge against such risk, boosting the scope and scale of innovation (Smith et al. 2014). Nevertheless, unless institutions in Russia start working along with innovators and not against them (and clear rules and protection are established), further investments in Russia will be discouraged (Radygin and Entov 2003), the social capital will erode even further, and incentives to innovate will probably diminish, delaying the much-needed modernization of the economy.

NOTES

1. Especially in 1992–98, during the period of some major structural changes in the economy and of financial crisis that caused GDP to fall (nearly) two-fold.
2. Defined as the agglomeration of firms and other institutions devoted to the creation of new and improved technology (Nelson and Nelson 2003).
3. Developed in the 1980s by evolutionary theorists (see Iammarino 2005).
4. Defined as the capacity of a region to shape institutional framework (required for the generation of innovation) in order to support the emergence of the "socio-institutional environment" or "innovation-supportive culture" (Doloreux and Parto 2005, 135).
5. To the best of the authors' knowledge, this is the closest match to an indicator of social capital that is available in the context of Russia.
6. For example, Japan, Finland, Sweden, Korea, Taiwan, and Israel clearly show that education has been a particularly important driver in the development of their innovation capacity.
7. This said, a local affiliate firm may only benefit from technology transfer if its foreign parent wants to exploit its firm-specific assets in a host country (Markusen 1995).
8. Count data models have been previously applied to the patent-R&D relationship in many econometric previous (e.g., Hall 2000; Hall, Jaffe, and Trajtenberg 2005; Mohnen, Mairesse, and Dagenais 2006; Raymond et al. 2009).
9. For example, Fritsch (2002) compared the quality of regional innovation systems based on the negative binominal estimations.
10. Due to data limitations, it was not possible to use any alternative measures for neither social capital nor for institutions.

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