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Foreign Direct Investment and Regional Economic Development in Russia: An Econometric Assessment[†]

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Abstract: In this paper, we estimate the effect of foreign direct investment (FDI) on total factor productivity (TFP) in Russian regions, paying special attention to the country's investment boom and the remarkable regional gaps in terms of cumulative direct investments in and after 2003. We also examine possible synergistic effects between FDI and local R&D potential to test the absorptive capacity hypothesis. Our estimation results strongly suggest the remarkable role of FDI in the regional economic development in Russia. In addition, we found that the positive effect of FDI on TFP may increase in the regions that received larger amounts of foreign capital. Furthermore, we detected a surprisingly robust and positive synergistic effect between FDI and local R&D potential, indicating that the absorptive capability is essential for linking FDI and regional economic development in Russia.

JEL classification numbers: F21, O11, P25, P33, R11

Key words: foreign direct investment (FDI), regional economic development, total factor productivity, R&D potential, absorptive capacity hypothesis, Russia

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1. Introduction

In 2012, a series of important events took place in Russia that highlighted the country's integration with the global economy. First, Russia officially joined the World Trade Organization (WTO) in August. It took the country more than 18 years to achieve this national goal; the Russian federal government applied to join the General Agreement on Tariffs and Trade (GATT), the predecessor of the WTO, in 1993. Second, Russia hosted a summit meeting of the Asia-Pacific Economic Cooperation (APEC) in Vladivostok in September for the first time. The summit meeting culminated in a declaration by the leaders outlining the agreements, which included the liberalization of trade investment and regional economic integration, the establishment of a reliable supply chain, as well as close cooperation so as to achieve innovative growth.[1] Furthermore, Russia launched the Common Economic Space with Belarus and Kazakhstan in January of the same year as a developed version of their customs union. This series of policy events is expected to accelerate not only trade activities between Russia and foreign counties but also movement of capital and to contribute significantly to the development of the Russian economy.

It is widely believed that capital investments by foreign investors and multinational enterprises bring positive economic effects to recipient countries in various ways. For this reason, policymakers of post-communist states and developing countries that face a lack of capital or technological expertise proactively invite foreign direct investment (FDI) and direct efforts to develop their countries on the basis of FDI. The actions of these countries have stimulated in economists a keen interest in conducting research into how and to what extent FDI impacts the economies of the recipient countries, and they are conducting a variety of empirical analyses to determine the mechanisms involved. It is not too much to say that the accumulated volume and scope of this kind of research is now quite large. However, work on post-communist transition economies accounts for a very small proportion of earlier studies, and the majority of these focus on some Central and Eastern European (CEE) countries that joined the European Union (EU), with only a minority of studies focusing on Russia and the other countries of the former Soviet Union (FSU) (Iwasaki and Tokunaga, 2014).

Meanwhile, Russia, as one of the five large and fast-growing economies of BRICS, sees its economy growing and its private consumption booming in tandem with an increase in national income. In fact, the Russian economy reported an average annual growth of 6.9% for the ten years ending in 2009 after the country resolved its domestic financial crisis of 1998, during

[1] See the website of the Ministry of Economy, Trade and Industry of Japan (http://www.meti.go.jp/policy/trade_policy/apec/ index.html).

which its economy was affected by the global financial crisis and temporarily slowed. As **Table 1** shows, during this period, industrial production was also strong, consumer prices and the unemployment rate remained relatively stable, and, moreover, the country enjoyed a growing trade surplus.[2] Against the background of such brisk growth trends, direct investments from various nations increased sharply after 2003. At the end of the 2000s, Russia emerged as the largest recipient of FDI among the CEE and FSU countries, leading the others by a wide margin.[3] Therefore, a strong correlation between Russia's remarkable economic development and significant FDI inflow is highly possible. We consider it very meaningful to empirically examine this point.

However, the observation period is currently far too short to examine the relationship between inward FDI and economic development in Russia by time-series analysis using national-economic level data. Therefore, in this paper, we approach this issue by empirically testing the effect of FDI on the total factor productivity (TFP) of the constituent entities of the Russian Federation. Ahrend (2005, 2008), Brock (2005), and Ledyaeva and Linden (2008) represent major earlier studies in this field. As we will report later, however, none has successfully verified a statistically significant effect of FDI in the Russian regions in their baseline estimations. A possible reason is that the estimation period in these previous works was limited to the early 2000s and, therefore, did not cover the large wave of FDI in 2003 and beyond. Moreover, although several microeconomic studies, including Brown and Earle (2000) and Yudaeva et al. (2003), verified the significant and positive effects of FDI in Russia, such a firm-level empirical analysis has become extremely difficult due to current strong restrictions on access to the official data. In order to overcome these research shortcomings and restraints, we empirically examine the effect of FDI on TFP by using unique panel data of 71 Russian regions, paying special attention to the investment boom in 2003 and onward, as well as to the significant

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[2] According to the official data published by the Russian statistical office (http://www.gks.ru/), real GDP grew by 4.3% in 2011 and by 3.4% in 2012, recording a similar level in 2010. However, the real GDP growth rate fell to 1.3% in 2013, indicating a sharp decline in the country's sustained economic growth. In addition, the forcible accession of the Crimean Peninsula into the Russian Federation in the wake of Ukraine's political turmoil in March 2014 and the subsequent ongoing political conflict between the two nations have substantially worsened relations between Russia and major developed countries as well, which is highly likely to cause the growth rate of the Russian economy to deteriorate.

[3] In fact, data published by the United Nations Conference on Trade and Development (UNCTAD) (http://unctadstat.unctad.org/) show that the cumulative gross direct investment in Russia from 1989–2009 was 23.57 billion USD higher than the amount received by Poland, which was ranked second among the 28 CEE and FSU countries.

regional gap in terms of cumulative investments during the same period.

Here, we also attempt to estimate the synergistic effect between FDI and local R&D potential to test the absorptive capacity hypothesis in the context of the Russian regions. Lapan and Bardhan (1973) advanced the absorptive capacity hypothesis, which theoretically formulated the proposition that companies need to have a certain level of absorptive capability to benefit from a new technology developed by another company. This theory was further advocated by Borensztein et al. (1998), who applied the above proposition to the relationship between FDI and economic growth in a recipient country and concluded that there absolutely must be human capital capable of acquiring and applying advanced technologies in order to enable FDI to bring about higher productivity in the host economy. It is worthwhile to examine whether the absorptive capacity hypothesis is valid in Russia, which boasts excellent human capital even by international standards, although the country has fallen behind advanced economies in terms of production technologies. To the best of our knowledge, no study has tackled in earnest this issue in the context of the Russian regions. We will make a contribution to the literature from this viewpoint as well.

The estimation results reported in this paper strongly suggest the remarkable role of direct investment in regional economic development in Russia. In addition, we found that the positive effect of FDI on TFP may increase in the regions that received larger amounts of foreign capital. Furthermore, we detected a surprisingly robust and positive synergistic effect between FDI and local R&D potential, indicating that the absorptive capability is essential for linking FDI and regional economic development in this country. This empirical evidence implies that the latest political collision between Russia and the international community over Ukraine may cast a shadow over Russian regional development through the significant decline of FDI inflow.

The remainder of this paper is organized as follows: In the next section, we highlight the basic trends of FDI in Russia during the period between 1995 and 2011 and review related literature to discuss issues for our empirical analysis. In Section 3, we explain our empirical methodology for verifying the TFP-enhancing effect of FDI in the Russian regions, and, then, in Section 4, we report our results. In Section 5, we test the absorptive capacity hypothesis. In Section 6, we report the statistical robustness of the estimation results. Finally, in Section 7, we summarize the major findings and conclude the paper.

2. Statistical Overview of FDI in Russia from 1995–2011 and Literature Review

We begin with an overview of FDI in Russia for the 17 years between 1995 and 2011 based upon statistical data provided by the Russian Federal State Statistics Service (Rosstat). Basic characteristics of direct investment in Russia as related to its regional economy can be summarized by the following four points:

First, as illustrated in **Table 1**, FDI in Russia was generally small between 1995 and 2002, falling short not only of the amount invested in Poland—the largest recipient country in the CEE region—but also of that in the Czech Republic or Hungary. This sluggish trend, however, was significantly improved after 2003. In fact, inward direct investment in Russia reached an average of 16.2 billion USD per year from 2003–2011, as compared to an average of 3.7 billion USD per year from 1995–2002. As a result, the cumulative direct investment for the period from 2003–2011 amounted to 145.9 billion USD or 5.7 times more than for the previous eight years. Such a drastic change points to a fundamental shift in the presence of foreign capital in the Russian economy.

Second, despite a sharp increase in FDI in and after 2003, Russia still lags behind many of the CEE countries in terms of the investment per capita. According to **Table 1**, the cumulative FDI per capita was a meager 1,230 dollars in Russia for the 17 years starting in 1995, which is much less than half the amount of that for the Czech Republic and Hungary.[4] In other words, although Russia is now the largest recipient of FDI among the CEE and FSU countries, the amount invested is relatively small for the size of its national economy. This means that the impact of FDI on the Russian economy may be limited both at the national and regional levels, despite the investment boom in recent years.

Third, it is evident that FDI in Russia tended to be biased toward specific industries throughout the observation period. **Table 2** reports the industrial breakdown of FDI in Russia from 2004–2008. As shown in this table, the fuel and energy industry accounted for 33.5% of the total investment for those five years, while real estate and rental services reported 14.4%, and wholesale and retail trade plus repair services amounted to 10.8%. The combined share of these three industries totaled 58.7%. In contrast, the manufacturing industry, including all 14 subsectors, accounted for only 23.7% of the total. This does not represent a strict comparison, as the Rosstat significantly modified the country's industrial classification system in 2004 to make it more in line with international standards. However, given the fact that, during the period of 1995–2003, about 16% of the total FDI went into the fuel and energy industry, some 18% benefitted the retail and restaurant industry, and about 30% was allocated to the food and other manufacturing industries,[5] it appears that foreign investors and multinational enterprises that entered the Russian market in recent years limited their investments to securing abundant natural

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[4] Calculated by the authors using data provided by the UNCTAD

[5] See **Table 7** in Iwasaki and Suganuma (2005, p. 168).

resources or to real estate trading or commercial activities for which the investments can be recovered in a relatively short period of time. In contrast, investors have been more wary than ever of investing in manufacturing industries. Lack of interest by foreign investors in manufacturing activities in Russia due to the high risks associated with long-term investments implies that technology transfer may not be fully achieved through FDI in this country.

Fourth, there remains a stark difference in terms of investments received among Russian regions even after 2003 when FDI increased sharply. In fact, as Panel (a) of **Table 3** shows, Moscow, which was ranked first in cumulative FDI among the 71 constituent entities of the Russian Federation between 2003 and 2011, received 21,151 times more than did the Altai Republic, which ranked last. Similarly, Panel (b) of the same table illustrates that the Sakhalin Region, which ranked first in terms of cumulative investment per capita, enjoyed a rate 4,823 times higher than that of the Republic of Mari El at the bottom of the ranking.[6] The mean and the standard deviation of cumulative FDI are 2,049.3 million USD and 6,559.0 million USD, respectively, while the mean and the standard deviation of the cumulative investment per capita is 1,300.7 USD and 5,761.7 USD, respectively. Accordingly, the coefficient of variation becomes 3.20 for the former and 4.43 for the latter, suggesting that the difference in the total amount of FDI received by the 71 regions is much wider when the population size of each region is taken into account. Moreover, there were only 20 regions that received FDI of more than 1 billion USD, and only 15 regions reported amounts invested per capita of greater than 1,000 USD during the same period. Therefore, we presume that there was a very limited number of Russian regions in which FDI could have had a significant impact on economic development.

Meanwhile, we found a total of 11 articles that examined the effect of FDI on the Russian economy using a quantitative method. **Table 4** outlines these studies. In general, most macroeconomic studies failed to detect any statistically robust and significant effect of FDI. Moreover, most studies focusing on the Russia regions, including Ahrend (2005, 2008), Brock (2005), and Ledyaeva and Linden (2008), found a significant effect of FDI only after imposing certain restrictions on the estimation period or the regions to be analyzed. On the other hand, many microeconomic studies, represented by Brown and Earle (2000) and Yudaeva et al. (2003), could verify the effects of foreign ownership and productivity spillovers from foreign companies to domestic firms. In recent years, however, as the Rosstat has sharply restricted access by outsiders (even for academic purposes) to individual sets of data that form the basis of the official statistics, the possibility of firm-level empirical analyses using the official data has become

[6] The Russian Federation is comprised of 83 constituent entities. However, 12 remaining regions, including those politically unstable in the North Caucasus Federal District, do not appear in **Table 3**, mainly due to data availability.

extremely limited.

Based on the FDI trends in Russia during the period from 1995–2011 and an overview of the studies described above, it may be helpful to consider the following points for empirically reexamining the impact of FDI on the Russian regions:

First, the previous literature listed in **Table 4** hardly examines the effect on the Russian economy of the big wave of FDI in and after 2003, mainly due to the studies' timing, with the exception of Dolgopyatova (2009). As we pointed out, it is highly likely that the presence of foreign capital significantly increased in the Russian economy during this period. Hence, an empirical analysis with an estimation period extending beyond 2003 may have a greater likelihood of identifying a statistically significant FDI effect than would studies focusing on a period prior to 2003. On the other hand, given the lower amount of direct investment in Russia than in the CEE countries in terms of per capita FDI and the strong investment bias toward certain industries, it is possible that it is still difficult to empirically verify the macroeconomic effect of FDI, even during the investment boom of 2003 and beyond.

The persistent FDI gap between the Russian regions is the second important point to be considered. As shown in **Table 3**, Russia has many regions that have attracted only small amounts of foreign capital. It is unreasonable to expect these regions, such as the small autonomous republics in remote areas, to have enjoyed a sufficient macroeconomic effect from FDI to be captured by quantitative analysis. Ledyaeva and Linden (2008) successfully estimated a statistically significant FDI effect by dividing the regions into high-income and low-income groups. It may be an effective empirical strategy to examine the influence of the regional investment gap on the marginal effect of FDI by classifying the regions to be analyzed in terms of the total amount of actual investment or by another method.

In the following sections, we conduct an empirical analysis of FDI's effect on regional TFP, taking into account the two points described above.

3. Empirical Methodology

In accordance with the first issue discussed in the previous section, we estimated a regional-level production function using long-term panel data that cover the period of the investment boom in and after 2003. In response to the second issue, we also performed an estimation of an extended model designed to examine the possible influence of the regional investment gap on the effect of FDI, in addition to the baseline estimation.

More specifically, we conducted a panel data estimation of a Cobb-Douglas production function, taking the real gross regional product (GRP) of the i-th Russian region in the year t as a dependent variable:

$$GRP_{i,t} = \mathrm{F}(A_{i,t}, K_{i,t}, L_{i,t}) = A_{i,t}K_{i,t}^{\alpha}L_{i,t}^{\beta}, \quad (1)$$

where A represents TFP, K and L denote inputs of capital and labor, while α and β are their output elasticities. By taking the logarithms of both sides and adding a disturbance term into the right-hand side, we transform Equation (1) into the following linear model:

$$lnGRP_{i,t} = a_{i,t} + \alpha lnK_{i,t} + \beta lnL_{i,t} + \varepsilon_{i,t}, \quad (2)$$

where $a = lnA$, and ε is a disturbance term. We assume that the first term on the right-hand side of Equation (2) is a function of FDI and other various factors that affect TFP of the Russian regions.

While the primary focus of our empirical analysis is the effect of FDI on regional TFP, the direction and extent to which foreign capital affects the productivity of the recipient regions are not theoretically clear. In fact, according to the endogenous growth theory, FDI directly and indirectly affects TFP in a recipient region as long as it brings improvements in technology systems and/or human capital to the region through the contributions of foreign participation in management, the establishment of local subsidiaries by multinational enterprises, the outsourcing of contracts between local and foreign firms, and so forth (Grossman and Helpman, 1991; Markusen and Venables, 1999; Iwasaki et al., 2012). Meanwhile, market-seeking FDI may hamper the growth of productivity in a host region due to its crowding-out effects through fierce competition between foreign and domestic firms (Ponomareva, 2000; Moran, 2005). Taking into account the weak management base and backward production technology of former socialist enterprises as compared with multinational corporations based in developed economies, it is highly likely that such negative external effects have taken place in Russia (Iwasaki and Tokunaga, 2014). In summary, as Castellani and Pieri (2011) argue, the effect of FDI and the entry of foreign multinationals on aggregate productivity in the host economy largely depend on the balance between the positive pecuniary and technological externalities and the sterling's negative effect on business. The impact of FDI is also affected by the type of activities that foreign companies transfer into the host economy. Therefore, it is possible that FDI works as a detrimental factor against aggregate productivity dynamics. In addition, theoretical consideration regarding the time-lag effect and the accumulation effect of direct investments is also insufficient.

For this reason, researchers have attempted to examine the effect of FDI on the recipient economies using a variety of FDI variables (Iwasaki and Tokunaga, 2014). Following the empirical strategy adopted in the previous literature, we also estimate a total of five types of FDI variables. They consist of (1) the natural logarithm of annual direct investments (*lnFDIANN*), (2) the natural logarithm of the three-year moving average of annual direct investments (*lnFDI3AVE*), (3) the natural logarithm of annual direct investments per capita (*lnFDIPC*), (4) the natural logarithm of cumulative direct investments (*lnCUMFDI*), and (5) the natural logarithm of cumulative direct investment per capita (*lnCUMFDIPC*). The estimation of these five different kinds of FDI variables may allow us to verify the time-lag and accumulation effects of FDI on regional TFP in Russia from multi-angle perspectives. Further, following Ledyaeva (2009) and Castellani and Pieri (2011), we have adopted predetermined variables reported for the previous year for all of the FDI variables, taking into consideration the possibility that foreign investment activities affect the production activities of the recipient regions with at least a one-year lag. Needless to say, the use of predetermined variables is effective for avoiding or mitigating the endogeneity bias between GRP and FDI.

We employed the following 10 variables as control variables to be simultaneously estimated with the FDI variables above: (1) the ratio of former state-owned (ex-municipal) privatized companies to the total number of companies (*PRICOM*), (2) the natural logarithm of the number of fixed telephones per thousand people (*lnTELEPHONE*), (3) a dummy for large cities and areas adjacent to a large city (*BIGCITY*), (4) a dummy for regions with a large-scale port (*BIGPORT*), (5) a dummy for regions bordering Europe (*EUROPE*), (6) a dummy for the Pacific coastal regions (*PACIFIC*), (7) a dummy for resource-rich regions (*RESOURCE*), (8) the natural logarithm of the latest production technologies utilized (*lnNEWTECH*), (9) the natural logarithm of total fixed capital (*lnFIXCAP*), and (10) the natural logarithm of the annual average number of workers (*lnLABOR*).

PRICOM is used as a proxy for the progress in economic liberalization, while *lnTELEPHONE* is utilized to express the prevalence of the communication infrastructure. *BIGCITY* is designed to capture the concentration effects of a large city and its spillover effects on the surrounding areas. *BIGPORT* is introduced to estimate the effects of trading activities with foreign countries on a region with large-scale port facilities. *EUROPE* and *PACIFIC* represent the geographical proximity to foreign markets. *RESOURCE* is employed to examine the effects of abundant natural resources on the development of a regional economy. *lnNEWTECH* is adopted to capture the effects of local R&D activity on promoting regional productivity.[7] Along with the FDI variables, these eight variables are assumed to determine

[7] According to the Rosstat, the latest production technologies denote planning, production, and processing systems based on computer, microelectronic, and information sciences, comprising machines and equipment utilized for their realization. The typical case includes: an assembly robot and a flexible production center, as well as an automatic designing and controlling system operated

regional-level TFP. The remaining, $lnFIXCAP$ and $lnLABOR$, are proxy variables for capital and labor inputs, respectively. We predict that these controlling factors are positively correlated with the dependent variable together with the FDI variables.[8]

Table 5 provides more detailed definitions, described statistics, and a correlation matrix of the variables used for the panel data estimation. The dependent variable of $lnGRP$ and other continuing variables are derived from the official statistics released by the Rosstat, while we set dummy variables based on materials available on the Internet. As this table shows, all of the correlation coefficients of the independent variables that were simultaneously estimated are below 0.70, the threshold of possible multicollinearity (Lind et al., 2004).

The panel regression equation, in which the individual effects of the *i*-th region and the time fixed effect of year *t* are also controlled together with the independent variables listed in **Table 5**, is formulated as follows:

$$\begin{aligned} lnGRP_{i,t} = \mu &+ \beta_1 FDI_{i,t-1} + \beta_2 PRICOM_{i,t} + \beta_3 lnTELEPHONE_{i,t} + \beta_4 BIGCITY_i \\ &+ \beta_5 BIGPORT_i + \beta_6 EUROPE_i + \beta_7 PACIFIC_i + \beta_8 RESOURCE_i \\ &+ \beta_9 lnNEWTECH_{i,t} + \beta_{10} lnFIXCAP_{i,t} + \beta_{11} lnLABOR_{i,t} + \varphi_i + \vartheta_t \\ &+ \varepsilon_{i,t}, \quad (3) \end{aligned}$$

where μ is the constant term, β is a parameter to be estimated, φ denotes the individual effect on the Russian regions, and ϑ represents the time fixed effect.

To estimate Equation (3), we used panel data of the 71 Russian regions for the period from 1996–2011. The breakdown of these 71 regions is consistent with **Table 3**. Since some independent variables are constant during the observation period, we utilized a pooled OLS estimator or a random-effects estimator to obtain estimates for these time-invariant variables. We selected one of these two estimators for our estimation in accordance with the Breusch-Pagan test of the null hypothesis that the variance of the individual effects is zero. We set the critical value for this specification test at a 5% significance level.

Although our basic empirical strategy is described above, following Castellani and Pieri

by a computer. The raw data are collected for all but small business enterprises through an enterprise questionnaire survey. The variate does not mean the total sum of employed machines and equipment but the number of realized technological systems as a whole. This variable comes much closer to the real circumstances of the production sites in Russian firms than do alternative R&D-related variables, thus, suiting well the purpose of our research.

[8] In selecting our independent variables, we referred to Popov (2001), Piliasov (2003), Solanko (2003), Benini and Czyzewski (2007), Brock (2009), Bajo-Rubio et al. (2010), Kirillova and Kantor (2011), Ledyaeva et al. (2012), and Kuzmina et al. (2014), in addition to the previous studies listed in **Table 4**.

(2011), Gries and Redlin (2011), and Jiang (2012), we also estimated a system generalized method-of-moments (GMM) dynamic model that adopts a non-lagged FDI variable and explicitly deal with its endogeneity with the dependent variable *lnGRP* in order to check the statistical robustness of the FDI variables.[9]

4. Estimation Results

Table 6 presents the baseline estimation of Equation (3). Models [1] to [5] are estimation results in accordance with the basic empirical strategy, and Models [6] to [10] report those of the system GMM dynamic models. The Breusch-Pagan test rejects the null hypothesis for all of the first five models at the 1% significance level. Therefore, we have reported the results of the random-effects estimation. The coefficient of determination (R^2), which represents the explanatory power of an entire model, is above 0.90 in all five random-effects models (0.91 on average), suggesting that they sufficiently explain the variance of the real GRP in the Russian regions. With regard to the system GMM dynamic models, we cannot conduct the Sargan test of overidentifying restrictions with robust standard errors. However, according to the test results that use estimates with normal standard errors, the null hypothesis that overidentifying restrictions are valid is accepted for all models [6] to [10]. In addition, the Arellano-Bond test for AR(2) also accepts the null hypothesis of no autocorrelation for all five models.[10]

Consistent with our prediction described in Section 2, it is likely that the role of foreign capital in the Russian economy increased greatly throughout the period in and after 2003 when FDI grew sharply. In fact, as the random-effects models in **Table 6** show, unlike most of the earlier studies, which do not cover this investment boom in their observation periods, the three-year moving average of annual direct investments (*lnFDI3AVE*), the cumulative direct investments (*lnCUMFDI*), and the cumulative direct investments per capita (*lnCUMFDIPC*) are estimated to be positive and statistically significant; furthermore, the significance level of the latter two variables reached 1%, implying an extremely strong correlation with the dependent variable. These results underline the considerable importance of FDI as a determining factor for the economic development of the Russian regions.

On the other hand, although the regression coefficient of annual direct investments (*lnFDIANN*) and annual direct investments per capita (*lnFDIPC*) also show positive signs, along

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[9] To estimate the system GMM dynamic model, we assumed a two-year lag structure of the FDI variable.

[10] Although we do not mention it hereafter due to space limitations, the same model specification test results apply for all of the regression analyses reported in **Table 7** and Section 5.

with the above three variables, their statistical significance is below the 10% level. This implies that the input of direct capital from various foreign countries contributes to the Russian regions, not as much in short-term as through long-term and cumulative improvements in TFP. The system GMM dynamic models, however, show significant and positive coefficients of *lnFDIANN* and *lnFDIPC* together with *lnCUMFDI* and *lnCUMFDIPC*. Although these results strongly suggest the presence of the accumulation effect of foreign capital inflow on TFP in Russian regions, they do not enable us to evaluate the time-lag effect of FDI.

Among the control variables, *RESOURCE*, which represents the natural resource abundance, shows a robust and positive effect on regional TFP, along with *lnFIXCAP* and *lnLABOR*, in line with our predictions. Both *EUROPE* and *PACFIC*, the dummy variables for regions bordering Europe and for Pacific coastal regions, respectively, show significant and positive estimates in Models [1] to [3]. However, given that the coefficient and the statistical significance of the latter greatly exceed those of the former, the economic significance of the proximity to foreign markets is likely to differ sharply between Russian regions bordering Europe and Asia. The fact that the federal government has increased interest in forging economic ties with high-growth Asian economies to shore up the Far East region in recent years is not without reason, from this perspective.

PRICOM, the ratio of former state-owned (ex-municipal) privatized companies to all of the companies, and *lnTELEPHONE*, the number of fixed telephones per thousand people, are estimated with a positive sign in all of the models; however, their statistical significances are below the 10% level, except for the latter variable in Model [6]. Moreover, the estimates of *BIGCITY* and *BIGPORT* are also insignificant, indicating that the geographical factors of being a large city or a port region are actually not important factors for the productivity increase in the Russian regions. *lnNEWTECH* also shows insignificant estimates, implying that local R&D activity itself is not bringing remarkable improvements to TFP in the regional economy. These results strongly suggest that a series of policy issues, including overcoming regional fragmentation through deepening economic ties between large cities and their surrounding regions, revitalizing port regions by promoting foreign trade, and improving the efficiency of domestic R&D activities, are far from complete.

In **Table 7**, we examine the relationship between the investment gaps among Russian regions and the effect of FDI. Panel (a) of the table shows the estimation results, in which the observations are limited to the top 35 regions in terms of the cumulative FDI per capita from 2003–2011. As seen in this panel, the sign and the effect size of the statistically significant FDI variables do not differ remarkably from those of the baseline estimation reported in **Table 6**, and, although the coefficient of *lnFDI3AVE* in the random-effects model and *lnCUMFDIPC* in the system GMM dynamic model remained positive, their statistical significance levels fall to more than 10%. These results suggest that the effects of FDI on regional TFP are not necessarily limited to the regions that have attracted relatively large amounts of foreign capital. As indicated in Panels (b) and (c) of **Table 7**, however, the interaction terms of an FDI variable and the dummy variable for the top 35 regions as well as the squared terms of an FDI variable are estimated to be significant and positive in 14 of the 20 models.[11] This finding entails the possibility of a mild non-linear correlation between the size of FDI and its TFP enhancing effect in the Russian regions.

5. Examination of the Absorptive Capacity Hypothesis

In order to enable FDI to enhance productivity in the host economy, advanced knowledge and technology that will be introduced from abroad in the wake of a capital investment must be actually applied to management practices as well as production activities on site. In this case, refinements and changes are often required in response to local-specific circumstances and/or conditions; hence, these requirements demand at least a certain level of comprehension and applied skill on the part of economic entities in the recipient country. The case is much more relevant to domestic firms that strive to improve their productivity by observing and following foreign companies (Iwasaki et al., 2012). In sum, the feasibility of technology transfer from FDI is positively correlated with the absorptive capability of the host economy (Girma, 2005).

The above paragraph describes the basic idea of the absorptive capacity hypothesis that we mentioned in the Introduction. There seems to be little room for any counterargument. Nevertheless, not all preceding studies have presented evidence that supports this hypothesis (Crespo and Fontoura, 2007). In addition, several studies of the CEE economies have examined the relationship between the productivity-enhancing effect of FDI and the absorptive capability of the recipient country, and their empirical results are far from consistent (Campos and Kinoshita, 2002; Altomonte and Pennings, 2009; Bijsterbosch and Kolasa, 2010; Nicolini and Resmini, 2010; Damijan et al., 2013; Neycheva, 2013). Moreover, with regard to Russia, as mentioned in **Table 4**, Brock (2005) has estimated the interaction term of the percentage of change in the cumulative amount of FDI to GRP relative to the prior year and the number of secondary school students per 10,000 residents in order to test a possible synergistic effect between FDI and human capital. However, his empirical results have failed to support the absorptive capacity hypothesis, as the regression coefficients are insignificant in the baseline

[11] Although the estimates of the control variables are not reported in **Table 7**, they are not so different from those in the baseline estimation.

estimation, and they are rather significant and negative in the subsample estimation, using the observations of corrupted regions.

As shown above, with regard to the validity of the absorptive capacity hypothesis, the conclusions obtained from earlier studies are mixed. One reason is that these empirical results largely depend on the method of measuring the absorptive capability of the host economy (Liu and Nishijima, 2013). From this viewpoint, Todo and Miyamoto (2006), Fu (2008), Lööf (2009), and Huang et al. (2012), all of which have stressed the role of R&D activities as an intermediate factor of technology transfer, are noteworthy. Therefore, in this paper, we will use R&D potential as a proxy for the absorptive capability of Russia instead of the average education level in the recipient country, which has been adopted by many preceding studies on developing economies, in order to reexamine the absorption capacity hypothesis in the case of the Russian regions. As is well known, Russia experienced considerable downsizing of R&D activities due to economic stagnation and other difficulties during its transition period. Nevertheless, this country still maintains one of the world's largest groups of R&D experts as well as enormous R&D facilities inherited from the Soviet Union. The problem is that such a large scale of R&D capital has not necessarily been utilized by the private business sector in an effective manner (Algieri, 2006; Yegorov, 2009; Gutierrez and Correa, 2012). This notion is also consistent with the empirical results we reported in the previous section, which show insignificant estimates of the natural logarithm of the latest production technologies utilized (*lnNEWTECH*).

If these domestically excessive R&D facilities and related human resources are effectively combined with the advanced knowledge and technology introduced by foreign capital, FDI might be capable of enhancing productivity in the relevant recipient regions without causing fierce competition with local firms. Moreover, as mentioned below, Russia's R&D potential is far from being geographically homogeneous; rather, there is uneven distribution among the regions. This fact infers that the feasibility of linking FDI and R&D potential may differ substantially between the regions; thus, this factor is likely to have a certain effect on regional TFP. This is why we have focused on local R&D potential to examine the absorptive capacity hypothesis in the context of the Russian economy.

As is the case with domestic firms, it is obviously true that foreign companies have insufficient connections with the local R&D sector (Dyker, 2004). However, this does not mean that FDI has no tendency to move to local regions with high R&D potential. As seen from Panel (a) of **Figure 1**, in which the natural logarithm of annual direct investments (*lnFDIANN*) is plotted on the vertical axis and the natural logarithm of the latest production technologies utilized (*lnNEWTECH*) is plotted on the horizontal axis, a moderate positive correlation between the two can be observed. A similar tendency can also be confirmed in the other panels of the same figure, in which the natural logarithm of technological innovation costs per R&D staff member (*lnINNOVCOST*), the natural logarithm of the total number of research and higher education institutions (*lnINSTITUTE*), and the natural logarithm of the number of higher education school students per 10,000 residents (*lnSTUDENT*) have been adopted as alternative variables to *lnNEWTECH*. Moreover, **Figure 1** also shows that the variance of these four R&D variables is quite large and, consequently, suggests significant regional disparity in R&D potential as the cause of the regional distribution of FDI.

The absorptive capacity hypothesis can be tested by estimating the interaction term of an FDI variable and a proxy variable for the absorptive capability. Therefore, we have introduced the interaction term of the FDI variable and the *lnNEWTECH* variable into the right-hand side of the regression equation and re-estimated it with the other conditions in the baseline estimation being the same. **Table 8** shows the results. As shown in this table, the interaction term is positive and significant at a level of 5% or less in all ten models, irrespective of the difference in the definition of the FDI variable and the estimator. These results strongly suggest that a very remarkable TFP-promoting synergistic effect between FDI and local R&D potential prevails in the Russian regions. Meanwhile, as is the case with the estimation results of Borensztein et al. (1998), **Table 8** reveals that all of the statistically significant estimates of FDI variables have a negative sign, indicating that FDI may cause a net negative effect on the aggregate productivity in a region where the linkage between foreign companies and the local R&D sector is very weak.[12]

How many regions are actually faced with a net negative effect of FDI in Russia? According to the random-effects model [5] in **Table 8**, the negative direct effect of FDI and the positive synergistic effect between FDI and local R&D potential offset each other, and, hence, the total effect of FDI becomes zero in a region where the number of the latest production technologies utilized is only 56.5. **Table 9** shows that, in 2011, the Republic of Tuva is the sole region under this threshold and, accordingly, the rest of the 70 regions enjoy a positive FDI effect on TFP in the net term. Based upon this result, we surmise that direct investment from foreign economies positively influences productivity in almost all of the Russian regions.

In order to check the statistical robustness of the synergistic effect between FDI and local R&D potential, we also performed another set of estimations, using alternatives to the *lnNEWTECH* variable as presented in **Figure 1**. The results, shown in **Table 10**, show that each

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[12] In addition to the FDI variable, the *lnNEWTECH* variable is estimated to be negative and significant in six out of ten models. We conjecture that, in Russia, R&D facilities and the related human resources are more likely to become burdens on the regional economies unless they are effectively connected to the business activities of foreign companies.

interaction term of the FDI variable and each of the three kinds of R&D variables show positive and significant coefficients in 24 of the 30 models, suggesting that the combination of FDI and R&D capital has a very powerful synergistic effect on regional TFP. To summarize, the empirical results in this section strongly support the validity of the absorption capacity hypothesis in the Russian regions.

6. Additional Robustness Check

In the previous two sections, we have consistently exhibited the estimation results of the random-effects model according to the basic empirical strategy described in Section 3. In this regard, we report that the Hausman test accepts the null hypothesis of the random-effects assumption in most cases; additionally, in a few cases when the Hausman test rejected the null hypothesis, we performed a fixed-effects estimation and compared its result with the random-effects estimation and did not find any significant differences between the two. As another robustness check, we also conducted estimation of a first-difference model, a population-average model, and a between-effects model and found no noteworthy differences from the random-effects models and/or the system GMM dynamic models reported in **Tables 6**, **7**, **8**, and **10**. These findings lead us to the conclusion that the empirical results in this paper are robust across the various specifications.

7. Conclusions

As illustrated by Russia's accession to the WTO in August of 2012 after more than 18 years of long negotiations and a series of other policy events in recent years, the country has been steadily bolstering its economic ties with the international community. As reported in **Table 1**, direct investments from abroad into Russia increased remarkably in and after 2003, fully demonstrating its power as an emerging market.

Now that Russia is becoming dynamically integrated into the global economy, the role foreign capital plays in developing the Russian economy is certainly attracting interest among policymakers and economists. This is because, as pointed out in Section 2, there is still ample room for Russia to attract more FDI and for multinational enterprises to establish their bases in this country, given the size of its national economy, although Russia is already the largest recipient of FDI among the CEE and FSU countries. The number of empirical studies regarding Russia's economic development in relation to FDI is currently very limited, and most macroeconomic and regional-level studies have failed to find the positive relation between these two elements. In this paper, we have attempted to re-examine the TFP-enhancing effect of FDI in the Russian regions by conducting a unique panel data analysis.

More specifically, we estimated the Cobb-Douglas production function that takes real GRP as a dependent variable, using panel data covering a total of 71 regions for the period of 1996–2011. As a result, we found a close relationship between FDI and regional TFP in Russia. In fact, according to our baseline estimation, three out of the five FDI variables in the random-effects estimation and four in the system GMM estimation show statistically significant and positive coefficients (**Table 6**). In particular, the cumulative direct investment (*lnCUMFDI*) variable is repeatedly estimated to be significant and positive, even when the observations are limited to the top 35 regions in terms of cumulative FDI per capita from 2003–2011 (Panel (a) of **Table 7**). These results strongly suggest the long-term and cumulative impact of FDI on TFP in the recipient regions. Considering that the previous regional-level studies, including Ahrend (2005, 2008), Brock (2005), and Ledyaeva and Linden (2008), were not successful in detecting a statistically significant effect of FDI in their baseline estimations, we think that it is a useful empirical strategy to extend the observation period more broadly to include the years after 2003 from the viewpoint of increasing the amount of information and our arguments as described in Section 2.

In this paper, we also examined the absorption capacity hypothesis. As shown in **Tables 8** and **10**, with regard to the interaction term of the FDI variable and a proxy variable for local R&D potential, as many as 34 cases out of 40 different combinations have repeatedly shown positive and significant coefficients. These surprisingly robust estimates strongly demonstrate the validity of the absorption capacity hypothesis in the Russian regions. Based on these findings, we maintain that the enhancement of collaboration between foreign companies and the domestic R&D sector is an extremely important policy issue for Russia.

Moreover, our estimation results suggest that a series of geographical factors, such as the size of cities and the existence of a port region, did not provide sufficient productivity-promoting effects in the Russian regions, while geographical proximity to foreign markets and the abundance of natural resources contributed significantly to the improvement of regional productivity, in line with our predictions. In order to achieve balanced and dynamic economic development in the Russian regions, we hope that policymakers will attract FDI more proactively through further market liberalization and deregulation and promote ties between the R&D sector and foreign multinationals, while formulating and executing policy measures that will address the various economic problems implied in our empirical evidence without delay.[13]

[13] From the viewpoint of attracting more FDI and promoting mutual cooperation between the domestic R&D sector and foreign companies, tighter state control over so-called strategic industries and diplomatic tensions with Western developed countries over political rights and

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human rights issues send negative signals to foreign investors and multinational enterprises (Iwasaki and Suganuma, 2015). It is hoped that the Putin administration will modify its policies as soon as possible. In the same context, the political conflict with Ukraine from the spring of 2014 should be settled immediately.

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Table 1. Selected macroeconomic indicators of Russia, 1995–2011

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Gross domestic product (GDP) (%) [a]	-4.1	-3.6	1.4	-5.3	6.4	10.0	5.1	4.7	7.3	7.2	6.4	8.2	8.5	5.2	-7.8	4.5	4.3
Industrial production (%) [a]	-4.6	-4.5	2.0	-5.2	11.0	8.7	2.9	3.1	8.9	8.0	5.1	6.3	6.8	0.6	-9.3	8.2	4.7
Consumer price index (%) [b]	131.3	21.8	11.0	84.4	36.5	20.2	18.6	15.1	12.0	11.7	10.9	9.0	11.9	13.3	8.8	8.8	6.1
Unemployment rate (%) [c]	9.6	9.8	12.0	13.4	12.9	10.0	9.0	8.7	8.0	8.1	7.3	7.0	5.9	7.1	8.7	7.6	6.7
Trade balance (billion USD)	31.5	38.7	32.0	27.7	42.6	69.2	58.1	60.5	76.4	106.0	142.8	163.4	152.1	200.5	134.4	168.2	211.0
Foreign direct investments (FDI) inflow (million USD)	2,020	2,440	5,333	3,361	4,260	4,429	3,980	4,002	6,781	9,420	13,072	13,678	27,797	27,027	15,906	13,810	18,415
Cumulative FDI (million USD) [d]	2,020	4,460	9,793	13,154	17,414	21,843	25,823	29,825	36,606	46,026	59,098	72,776	100,573	127,600	143,506	157,316	175,731
Annual FDI inflow per capita (USD) [e]	13.6	16.5	36.0	22.7	28.9	30.2	27.2	27.5	46.8	65.3	91.1	95.8	195.4	190.3	112.1	96.6	128.9
Cumulative FDI per capita (USD) [d, e]	13.6	30.1	66.2	89.0	118.0	148.7	176.5	204.8	252.5	319.3	411.9	509.8	707.2	898.5	1,011.3	1,100.8	1,230.0

Notes: [a] Year-on-year real growth rate

[b] Year-on-year change as of December

[c] Average unemployment rate of the working population (men aged 16–59 and women aged 15–54)

[d] Total amount of inward FDI after 1995

[e] Calculated based on the population as of January 1 of each year

Source: Russian Federal State Statistics Service (http://www.gks.ru/)

Table 2. Sectoral breakdown of FDI in Russia, 2004–2008

	2004		2005		2006		2007		2008		2004–2008 total	
	Invested amount (million USD)	Share (%)	Invested amount (million USD)	Share (%)	Invested amount (million USD)	Share (%)	Invested amount (million USD)	Share (%)	Invested amount (million USD)	Share (%)	Total investment (million USD)	Share (%)
Total	9,420	100.0	13,072	100.0	13,678	100.0	27,797	100.0	27,027	100.0	90,994	100.0
Agriculture, hunting, and forestry	89	0.9	118	0.9	190	1.4	224	0.8	503	1.9	1,124	1.2
Fishing	1	0.0	1	0.0	4	0.0	26	0.1	2	0.0	34	0.0
Mining and quarrying	4,080	43.3	4,012	30.7	4,521	33.1	13,933	50.1	4,979	18.4	31,525	34.6
Fuel and energy resources	3,984	42.3	3,913	29.9	4,313	31.5	13,670	49.2	4,645	17.2	30,525	33.5
Other mineral resources	96	1.0	99	0.8	208	1.5	263	0.9	334	1.2	1,000	1.1
Manufacturing	2,911	30.9	6,028	46.1	2,602	19.0	4,101	14.8	5,918	21.9	21,560	23.7
Food, beverages, and tobacco	336	3.6	550	4.2	629	4.6	1,147	4.1	1,060	3.9	3,722	4.1
Textiles and clothing	35	0.4	19	0.1	8	0.1	49	0.2	40	0.1	151	0.2
Leather, leather products, and shoes	5	0.1	10	0.1	2	0.0	0	0.0	0	0.0	17	0.0
Wood processing and wood products	326	3.5	329	2.5	296	2.2	234	0.8	566	2.1	1,751	1.9
Paper and pulp, printing, and publishing	44	0.5	95	0.7	81	0.6	178	0.6	559	2.1	957	1.1
Coking coal and oil products	5	0.1	3,555	27.2	7	0.1	21	0.1	15	0.1	3,603	4.0
Chemicals	238	2.5	229	1.8	282	2.1	371	1.3	324	1.2	1,444	1.6
Rubber and plastic products	75	0.8	154	1.2	208	1.5	273	1.0	296	1.1	1,006	1.1
Other non-ferrous metal and mineral products	449	4.8	397	3.0	481	3.5	550	2.0	814	3.0	2,691	3.0
Metallurgy and metal processing	1,142	12.1	173	1.3	221	1.6	565	2.0	782	2.9	2,883	3.2
Machinery and equipment	60	0.6	166	1.3	127	0.9	77	0.3	197	0.7	627	0.7
Electrical, electronic, and optical products	29	0.3	71	0.5	34	0.2	118	0.4	258	1.0	510	0.6
Transportation and transport equipment	114	1.2	217	1.7	172	1.3	353	1.3	893	3.3	1,749	1.9
Electricity, gas, and water supply	0	0.0	149	1.1	50	0.4	152	0.5	2,332	8.6	2,683	2.9
Construction	87	0.9	117	0.9	271	2.0	891	3.2	958	3.5	2,324	2.6
Wholesale and retail trade [a]	958	10.2	767	5.9	840	6.1	3,256	11.7	3,994	14.8	9,815	10.8
Hotels and restaurants	20	0.2	21	0.2	21	0.2	49	0.2	72	0.3	183	0.2
Transport and communications	196	2.1	245	1.9	379	2.8	591	2.1	1,282	4.7	2,693	3.0
Communications	41	0.4	54	0.4	159	1.2	327	1.2	126	0.5	707	0.8
Financial intermediation	356	3.8	589	4.5	1,502	11.0	1,123	4.0	1,713	6.3	5,283	5.8
Real estate, rental, and business activities	650	6.9	930	7.1	3,210	23.5	3,273	11.8	5,043	18.7	13,106	14.4
Others	72	0.8	95	0.7	88	0.6	178	0.6	231	0.9	664	0.7

Note: [a] Including repair of motor vehicles, motorcycles, and personal and household goods

Source: Russian Federal State Statistics Service (http://www.gks.ru/)

Table 3. Regional breakdown of FDI in Russia, 2003–2011

(a) Cumulative FDI

Rank	Entity	FDI (million USD)
1	Moscow	48,648.2
2	Sakhalin Region	24,113.5
3	Moscow Region	15,211.3
4	St. Petersburg	6,036.0
5	Omsk Region	3,904.8
6	Tyumen Region	3,459.2
7	Kaluga Region	3,246.9
8	Leningrad Region	2,979.3
9	Chelyabinsk Region	2,567.3
10	Arkhangelsk Region	2,335.2
11	Krasnodar Territory	1,970.8
12	Nizhny Novgorod Region	1,942.6
13	Tomsk Region	1,854.5
14	Republic of Tatarstan	1,845.1
15	Lipetsk Region	1,582.8
16	Republic of Komi	1,439.9
17	Vladimir Region	1,407.4
18	Amur Region	1,348.0
19	Novgorod Region	1,214.2
20	Sverdlovsk Region	1,000.7
21	Tula Region	977.5
22	Rostov Region	971.4
23	Orenburg Region	949.8
24	Samara Region	906.7
25	Primorsky Territory	897.1
26	Irkutsk Region	837.5
27	Kaliningrad Region	687.9
28	Republic of Bashkortostan	627.3
29	Kemerovo Region	612.0
30	Republic of Khakasia	603.9
31	Perm Territory	498.4
32	Zabaikalsk Territory	485.9
33	Kostroma Region	481.0
34	Krasnoyarsk Territory	425.7
35	Novosibirsk Region	422.6
36	Tver Region	420.1
37	Yaroslavl Region	400.9
38	Saratov Region	378.0
39	Khabarovsk Territory	377.5
40	Ryazan Region	377.2
41	Republic of Karelia	349.7
42	Stavropol Territory	327.2
43	Belgorod Region	318.9
44	Magadan Region	294.5
45	Voronezh Region	279.7
46	Republic of Chuvashia	265.6
47	Kirov Region	261.4
48	Pskov Region	233.0
49	Volgograd Region	224.0
50	Kamchatka Territory	203.8
51	Republic of Udmurtia	190.7
52	Orel Region	190.3
53	Republic of Sakha (Yakutia)	185.6
54	Kursk Region	165.1
55	Ivanovo Region	162.5
56	Kurgan Region	146.8
57	Altai Territory	145.5
58	Ulyanovsk Region	141.8
59	Astrakhan Region	134.6
60	Vologda Region	124.2
61	Murmansk Region	123.2
62	Bryansk Region	106.7
63	Republic of Mordovia	106.1
64	Penza Region	100.9
65	Smolensk Region	84.3
66	Tambov Region	75.6
67	Jewish Autonomous Area	56.1
68	Republic of Tuva	31.7
69	Republic of Buryatia	15.8
70	Republic of Mari El	7.0
71	Republic of Altai	2.3

(b) Cumulative FDI per capita

Rank	Entity	FDI (USD)
1	Sakhalin Region	48,714.2
2	Moscow	4,189.1
3	Kaluga Region	3,221.2
4	Moscow Region	2,113.0
5	Omsk Region	1,977.1
6	Novgorod Region	1,927.3
7	Arkhangelsk Region	1,925.1
8	Magadan Region	1,900.1
9	Tomsk Region	1,752.9
10	Leningrad Region	1,718.1
11	Amur Region	1,641.9
12	Republic of Komi	1,617.8
13	Lipetsk Region	1,357.5
14	St. Petersburg	1,218.7
15	Republic of Khakasia	1,135.2
16	Tyumen Region	999.8
17	Vladimir Region	982.8
18	Chelyabinsk Region	737.7
19	Kostroma Region	726.5
20	Kaliningrad Region	726.4
21	Kamchatka Territory	636.9
22	Tula Region	632.7
23	Nizhny Novgorod Region	589.2
24	Republic of Karelia	546.5
25	Republic of Tatarstan	485.2
26	Orenburg Region	469.3
27	Primorsky Territory	459.8
28	Zabaikalsk Territory	441.7
29	Krasnodar Territory	373.0
30	Pskov Region	349.4
31	Irkutsk Region	345.5
32	Ryazan Region	328.6
33	Jewish Autonomous Area	320.8
34	Yaroslavl Region	315.4
35	Tver Region	313.1
36	Samara Region	282.1
37	Khabarovsk Territory	281.3
38	Orel Region	243.7
39	Sverdlovsk Region	232.3
40	Rostov Region	228.0
41	Kemerovo Region	222.5
42	Republic of Chuvashia	213.0
43	Belgorod Region	207.6
44	Kirov Region	196.9
45	Republic of Sakha (Yakutia)	194.2
46	Perm Territory	189.4
47	Kurgan Region	163.9
48	Novosibirsk Region	157.3
49	Murmansk Region	156.3
50	Republic of Bashkortostan	154.3
51	Ivanovo Region	154.2
52	Saratov Region	150.7
53	Krasnoyarsk Territory	150.0
54	Kursk Region	147.1
55	Astrakhan Region	132.6
56	Republic of Mordovia	128.6
57	Republic of Udmurtia	125.7
58	Voronezh Region	120.0
59	Stavropol Territory	117.4
60	Ulyanovsk Region	110.6
61	Vologda Region	103.7
62	Republic of Tuva	102.6
63	Volgograd Region	86.3
64	Smolensk Region	85.9
65	Bryansk Region	84.4
66	Penza Region	73.3
67	Tambov Region	69.9
68	Altai Territory	60.4
69	Republic of Buryatia	16.3
70	Republic of Altai	10.9
71	Republic of Mari El	10.1

Source: Russian Federal State Statistics Service (http://www.gks.ru/)

Table 4. List of studies that examine the impact of FDI on the Russian economy

Author(s)	Estimation period	Objects of analysis	Estimation method [a]	Dependent variable	Estimation results regarding effects of FDI [b]
Brown and Earle (2000)	1992–1998	14,961 companies in Russia	OLS, RE	Value of output the enterprise produced in December 1992 prices	<In survival regression> Dummy for the foreign-owned or foreign-domestic joint venture in 1993 (-); <In basic regressions> Dummy for the foreign-owned or foreign-domestic joint venture (+); <In ownership effects> Dummy for the foreign-owned or foreign-domestic joint venture (+)
Ponomareva (2000)	1993–1997	Companies in Russia, with 5–1,000 full-time employees (four-digit classification companies)	OLS, FE	Total output	<In cross-section estimation> Dummy for foreign ownership (+), Sector-level spillovers from foreign investment (-); <In fixed-effects regression> In-year dummies not included: Sector-level spillovers from foreign investment (-); In-year dummies included: Sector-level spillovers for foreign investment (+), Spillovers from foreign investment at the regional level (+), Interaction term of the export dummy and the sector-level spillovers from foreign investment (-), Interaction term of the level of secondary education and the sector-level spillovers from foreign investment (+), Interaction term of the economic reform progress index and the sector-level spillovers from foreign investment (no)
Bessonova et al. (2003)	1994–2000 (early period: 1994–1998, late period: 1999–2000)	Russian companies in 83 sectors	OLS, FE, RE	Total factor productivity (TFP) growth rate	<In all industries and import competing industries> In all periods: Share of FDI (+), Share of FDI among suppliers (+), Share of FDI among consumers (+); In the early period: Share of FDI among suppliers (+), Share of FDI among consumers (+); In the late period: Share of FDI among suppliers (-); <In Export-oriented industries> In all and in the early period: Share of FDI (-), Share of FDI among consumers (+); In the late period: Share of FDI (+), Share of FDI among suppliers (-), Share of FDI among consumers (-); <In non-traded industries> In the entire period: Share of FDI (+), Share of FDI among consumers (+); In the early period: Share of FDI among suppliers (+), Share of FDI among consumers (+); In the late period: Share of FDI (+), Share of FDI among suppliers (-), Share of FDI among consumers (-); <In industries with high intra-industry trade> In the entire period: Share of FDI (+), Share of FDI among suppliers (+); In the early period: Share of FDI among consumers (+); In the late period: Share of FDI (+), Share of FDI among suppliers (-
Yudaeva et al. (2003)	(1) 1996 or 1997 (comparison between foreign and domestic companies); (2) 1993–1997 (spillover effects from foreign companies)	Russia	FE	Value added	Industry spillovers (+), Upstream spillovers (-), Downstream spillovers (-)
Peter et al. (2004)	1993–2000	Russia and the Czech Republic	OLS, RE, FE, 2SLS-RE	Productivity gap to foreign frontier	<In Russia> Spillover to domestic companies (early period (-) and thereafter (-)), Spillover to foreign companies (early period (-) and thereafter (+))
Ahrend (2005)	1990–1998	77 regions in Russia and the European part of Russia	OLS, RE, 2SLS	(1) Growth rate of per capita GRP; (2) Growth rate of real income per capita; (3) Growth rate of industrial production	<In all dependent variables> All FDI variables (no), FDI per capita in the European part of Russia (+)
Brock (2005)	1995–2000 (early period: 1995–1997, late period: 1998/1999–2000)	Russian regions (plus 40 subgroups)	OLS	Growth rate of GRP	<In all samples> In all periods: ratio of FDI in GRP (no), Change in cumulative FDI to GRP (no); In the early period: Ratio of FDI in GRP (+); In the late period: Change in cumulative FDI to GRP (-); <In subgroups by corruption> In all and the late period: Ratio of FDI in GRP (no), Change in cumulative FDI to GRP (+), Interaction term of the number of secondary school students per 10,000 residents and the change in the cumulative FDI to GRP (-)
Tytell and Yudaeva (2006)	N/A	Data of companies in Russia, Ukraine, Poland, and Romania	OLS, GMM	(1) Value added; (2) Total factor productivity (TFP); (3) Capital-labor ratio of domestic firms	<In value added > FDI means the direct effect of foreign participation (+), Interaction term of the fixed capital and FDI (+), Interaction term of the employment and FDI (-), Weighted labor employed in firms with foreign capital (FDI DENSITY) means spillover effect of foreign participation (+ and no), Export-oriented FDI density (+), FDI by share of people with secondary education (+), Direct effects of FDI in low corruption regions (+), Spillover effects of FDI in low corrupution regions (-); <In TFP> TFP of firms with foreign ownership (FDI TFP) (+), FDI DENSITY (no); <In capital-labor ratio> FDI TFP (no), FDI DENSITY (no)
Ahrend (2008)	1993–2004	77 regions in Russia	EBA	(1) Pre-crisis growth: real GRP growth 1995–1998; (2) Post-crisis growth: real GRP growth 1999–2004	<In pre- and post-crisis growth> FDI per capita (1995) (no)
Ledyaeva and Linden (2008)	1996–2005 (early period:1996–1999, late period: 2000–2005)	74 regions in Russia	OLS, LAD, FE, GMM	GRP growth rate	<In all regions> In all periods: FDI (basically, no); In the early period: FDI (+) in OLS, FDI (no) in GMM; <In region groups by income> In high-income regions: FDI (-) in OLS; In low-income regions: FDI (+) in GMM
Dolgopyatova (2009)	2009	64 regions (882 companies)	Logit, Probit	Rate of decrease in concentration of ownership	<In strategic development> Emergence of strategic foreign partners (+); <In methods and techniques of management> Standardization with foreign competitors (+)

Notes: [a] OLS, RE, FE, 2SLS, GMM, EBA, LAD, Logit, and Probit denote ordinary least squares, random-effects estimator, fixed-effects estimator, two-stage least squares estimator, generalized method of moments, extreme bounds analysis, least absolute deviation method, logit estimator, and probit estimator, respectively.

[b] The sign "+" denotes a statistically significant and positive correlation with the dependent variable; "-" denotes a statistically significant and negative correlation with the dependent variable; and "no" denotes an insignificant estimate.

Source: Compiled by the authors

Table 5. Definition, descriptive statistics, and a correlation matrix of the variables used in the empirical analysis

Variable name	Definition	Descriptive statistics			Correlation matrix																			
		Mean	S.D.	Median	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]
[1] *lnGRP*	Real gross regional product (GRP) (natural logarithm) [a, b]	8.77	1.06	8.69	1.00																			
[2] *lnFDIANN*	Annual direct investments (natural logarithm) [a, c]	9.55	2.53	9.78	0.59	1.00																		
[3] *lnFDI3AVE*	Three-year moving average of annual direct investments (natural logarithm) [a, c]	9.70	2.32	9.88	0.67	0.89	1.00																	
[4] *lnFDIPC*	Annual direct investments per capita (natural logarithm) [a, d]	2.20	2.36	2.48	0.38	0.95	0.82	1.00																
[5] *lnCUMFDI*	Cumulative direct investments (natural logarithm) [a, c]	11.43	2.38	11.65	0.74	0.58	0.66	0.44	1.00															
[6] *lnCUMFDIPC*	Cumulative direct investments per capita (natural logarithm) [a, d]	4.19	2.52	4.34	0.64	0.77	0.85	0.72	0.74	1.00														
[7] *PRICOM*	Ratio of former state-owned (ex-municipal) privatized companies after 1995 to the total number of companies [a]	0.01	0.01	0.01	0.01	-0.04	-0.03	-0.02	0.04	0.07	1.00													
[8] *lnTELEPHONE*	Number of fixed telephones per 1,000 residents (natural logarithm) [a]	9.81	0.31	9.88	0.37	0.40	0.44	0.43	0.42	0.61	0.14	1.00												
[9] *BIGCITY*	Dummy for large cities and areas adjacent to a large city [e]	0.70	0.91	0	0.48	0.26	0.32	0.10	0.41	0.28	-0.18	0.10	1.00											
[10] *BIGPORT*	Dummy for regions with a large-scale port [f]	0.34	0.82	0	0.14	0.12	0.15	0.11	0.18	0.20	-0.01	0.16	-0.05	1.00										
[11] *EUROPE*	Dummy for regions bordering Europe [g]	0.08	0.28	0	-0.03	0.08	0.08	0.12	0.07	0.07	-0.04	0.11	-0.12	0.31	1.00									
[12] *PACIFIC*	Dummy for Pacific coastal regions [g]	0.07	0.26	0	-0.07	0.04	0.06	0.13	0.17	0.21	0.10	0.15	-0.21	0.42	-0.08	1.00								
[13] *RESOURCE*	Dummy for resource-rich regions [a, h]	0.29	0.64	0	0.45	0.21	0.25	0.16	0.26	0.21	0.08	0.07	0.13	-0.10	-0.14	0.05	1.00							
[14] *lnNEWTECH*	Latest production technologies utilized (natural logarithm) [a, i]	6.59	1.65	6.86	0.57	0.37	0.40	0.21	0.42	0.39	-0.02	0.40	0.38	-0.12	-0.09	-0.29	0.02	1.00						
[15] *lnFIXCAP*	Total fixed capital (natural logarithm) [a, b]	10.04	1.46	10.07	0.85	0.63	0.67	0.50	0.57	0.61	0.04	0.53	0.33	0.14	0.00	-0.04	0.34	0.58	1.00					
[16] *lnLABOR*	Annual average number of workers (natural logarithm) [a, j]	6.49	0.80	6.42	0.87	0.43	0.52	0.16	0.66	0.45	-0.10	0.14	0.58	0.10	-0.06	-0.24	0.25	0.61	0.63	1.00				
[17] *UPPER_REGION*	Dummy for the top 35 regions in terms of cumulative direct investments per capita [g]	0.49	0.50	0	0.13	0.29	0.33	0.35	0.29	0.38	0.05	0.19	0.01	0.18	0.21	0.17	0.10	-0.03	0.12	-0.02	1.00			
[18] *lnINNOVCOST*	Technological innovation costs per R&D staff member (natural logarithm) [a, k]	12.07	1.96	12.24	0.22	0.20	0.21	0.22	-0.01	0.27	0.13	0.48	-0.03	-0.17	-0.03	-0.13	0.17	0.37	0.48	0.03	-0.09	1.00		
[19] *lnINSTITUTE*	Number of research and higher education institutions (natural logarithm) [a]	3.59	0.97	3.47	0.80	0.43	0.52	0.19	0.66	0.46	-0.10	0.18	0.58	0.20	-0.09	-0.11	0.16	0.55	0.57	0.54	-0.01	-0.12	1.00	
[20] *lnSTUDENT*	Number of higher education school students per 10,000 residents (natural logarithm) [a]	5.75	0.56	5.85	0.33	0.22	0.24	0.19	0.25	0.35	0.03	0.57	0.23	0.06	-0.25	0.04	0.03	0.44	0.54	0.23	-0.10	0.39	0.31	1.00

Note: [a] Calculated by the author, using official data from the Russian Federal State Statistical Service

[b] Unit is one billion rubles until 1998 and one million rubles thereafter.

[c] Unit is 1,000 US dollars.

[d] Unit is US dollars.

[e] A value of 2 is given to regions with the 10 largest cities, and 1 is given to regions adjacent to a region having one of the 10 largest cities.

[f] A value of 3 is given to regions with the largest port in the country, 2 is given to regions with a large-scale port, and 1 is given to regions with a medium-scale port. The total score for each region is calculated by adding them up.

[g] A value of 1 is given to applicable regions.

[h] Based on a cluster analysis of the outputs of mineral resources (four classifications), a value of 3 is given to the Tyumen Region; 2 is given to the Republic of Tatarstan, the Kemerovo Region, the Sakhalin Region, and the Orenburg Region; and 1 is given to the Republic of Sakha (Yakutia), the Republic of Komi, the Arkhangelsk Region, the Republic of Bashkortostan, the Perm Territory, the Samara Region, the Tomsk Region, the Krasnoyarsk Territory, and the Republic of Udmurtia.

[i] For definition and other details of the variable, see footnote 8 of this paper and Rosstat website (http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/science_and_innovations/science/#).

[j] Unit is 1,000 people.

[k] Unit is 1,000 rubles until 1998 and rubles thereafter.

Source: Compiled by the author, using data from the Russian Federal State Statistics Service (Rosstat) (http://www.gks.ru/) and other geographical materials available on the Internet.

Table 6. Panel data estimation of the Russian regional production function: Baseline estimation [a]

Estimation period	1996–2011									
Target regions	All 71 regions									
Estimator [b]	RE					system GMM				
Model	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
Lagged endogenous variable										
lnGRP						0.1536 ***	0.2227 ***	0.1511 ***	0.2067 ***	0.1703 ***
						(0.033)	(0.078)	(0.034)	(0.071)	(0.045)
FDI variables [c]										
lnFDIANN	0.0037					0.0119 ***				
	(0.002)					(0.004)				
lnFDI3AVE		0.0094 *					0.0083			
		(0.005)					(0.007)			
lnFDIPC			0.0027					0.0111 ***		
			(0.002)					(0.004)		
lnCUMFDI				0.0809 ***					0.1401 *	
				(0.024)					(0.074)	
lnCUMFDIPC					0.0369 ***					0.0591 **
					(0.010)					(0.025)
Control variables										
PRICOM	3.0711	3.1517	3.1795	1.8816	3.1719	2.2107	1.6606	1.5021	2.4509	3.4102
	(2.965)	(2.933)	(2.973)	(2.845)	(2.854)	(4.496)	(4.066)	(4.502)	(3.943)	(4.049)
lnTELEPHONE	0.1282	0.1251	0.1287	0.0845	0.0921	0.1954 *	0.0404	0.1800	0.0632	0.0696
	(0.091)	(0.091)	(0.091)	(0.087)	(0.088)	(0.119)	(0.104)	(0.117)	(0.110)	(0.102)
BIGCITY	-0.0153	-0.0166	-0.0149	-0.0410	-0.0260					
	(0.045)	(0.045)	(0.045)	(0.040)	(0.044)					
BIGPORT	0.0012	0.0027	0.0011	0.0240	0.0045					
	(0.050)	(0.050)	(0.050)	(0.043)	(0.049)					
EUROPE	0.1364 *	0.1275 *	0.1374 *	0.0060	0.1011					
	(0.077)	(0.077)	(0.077)	(0.082)	(0.086)					
PACIFIC	0.3272 **	0.3122 **	0.3283 **	0.0302	0.2222					
	(0.151)	(0.152)	(0.152)	(0.150)	(0.165)					
RESOURCE	0.2780 ***	0.2771 ***	0.2780 ***	0.2533 ***	0.2762 ***					
	(0.065)	(0.065)	(0.065)	(0.055)	(0.067)					
lnNEWTECH	0.0091	0.0097	0.0093	0.0047	0.0042	0.0228	0.0310	0.0245	0.0164	0.0263
	(0.020)	(0.020)	(0.020)	(0.019)	(0.018)	(0.020)	(0.024)	(0.019)	(0.020)	(0.020)
lnFIXCAP	0.2665 ***	0.2636 ***	0.2672 ***	0.2746 ***	0.2432 ***	0.2088 ***	0.2080 ***	0.2143 ***	0.2055 ***	0.1837 ***
	(0.020)	(0.020)	(0.020)	(0.018)	(0.022)	(0.019)	(0.026)	(0.020)	(0.024)	(0.022)
lnLABOR	0.7770 ***	0.7674 ***	0.7794 ***	0.6260 ***	0.7672 ***	1.0401 ***	0.7279 **	0.9506 **	1.1175 ***	1.5701 ***
	(0.060)	(0.058)	(0.060)	(0.067)	(0.056)	(0.356)	(0.370)	(0.378)	(0.291)	(0.329)
Constant term	-0.4421	-0.3760	-0.4427	0.0843	0.1402	-3.6520 *	-0.6253	-2.8614	-4.0859 **	-5.8431 ***
	(0.866)	(0.855)	(0.862)	(0.846)	(0.829)	(2.115)	(2.306)	(2.295)	(1.873)	(2.098)
Individual effects of regions	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Time fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
N	920	937	921	944	944	817	792	817	872	872
R^2	0.91	0.91	0.91	0.92	0.91	na	na	na	na	na
Breush-Pagan test (χ^2) [d]	2123.62 ***	2210.80 ***	2131.3 ***	1998.94 ***	2277.74 ***	na	na	na	na	na
Sargan test (χ^2) [e]	na	na	na	na	na	32.37	23.47	33.25	28.80	31.67
Arellano-Bond test (z) [f]	na	na	na	na	na	-0.21	1.48	-0.32	0.43	-0.005
Wald test (χ^2) [g]	1836.88 ***	1847.51 ***	1827.18 ***	1985.63 ***	1899.67 ***	1940.98 ***	2288.36 ***	1912.69 ***	2186.42 ***	1845.97 ***

Note: [a] The dependent variables of all models are the natural logarithm of the real gross regional product (*lnGRP*). Figures in parentheses beneath regression coefficients are robust standard errors. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

[b] RE and system GMM denote random-effects estimator and system generalized method-of-moments (GMM) estimator, respectively.

[c] The random-effects models adopt one-year lagged FDI variables, while the system GMM dynamic models endogenize non-lagged FDI variables assuming a two-year lag structure.

[d] Specification test of the pooled OLS estimator and the random-effects estimator. Null hypothesis: Variance of individual effects is zero.

[e] Test of overidentifying restrictions using estimates with normal standard errors. Null hypothesis: Overidentifying restrictions are valid.

[f] Autocorrelation test for AR(2). Null hypothesis: No autocorrelation.

[g] Null hypothesis: All coefficients are zero.

Source: Authors' estimation. See Table 5 for the definitions and descriptive statistics of the variables used in the estimation.

Table 7. Panel data estimation of the relationship between the size of FDI and regional total factor productivity [a]

(a) Subsample estimation using observations of the higher regions in terms of cumulative FDI per capita

Estimation period	1996–2011									
Target regions	The top 35 regions in cumulative FDI per capita from 2003–2011									
Estimator [b]	RE					system GMM				
Model	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
FDI variables [c]										
lnFDIANN	0.0047					0.0155 **				
	(0.004)					(0.007)				
lnFDI3AVE		0.0087					0.0144			
		(0.006)					(0.011)			
lnFDIPC			0.0035					0.0125 *		
			(0.004)					(0.008)		
lnCUMFDI				0.1069 ***					0.2502 ***	
				(0.035)					(0.059)	
lnCUMFDIPC					0.0265 **					0.0439
					(0.014)					(0.039)
N	460	461	460	461	461	419	392	419	425	425
Wald test (χ^2) [d]	1430.71 ***	1447.67 ***	1449.97 ***	2084.45 ***	1350.63 ***	968.45 ***	1714.93 ***	922.57 ***	1515.21 ***	1067.52 ***

(b) Estimation with the dummy for the top 35 regions in terms of cumulative FDI per capita from 1996–2011 and its interaction term with an FDI variable

Estimation period	1996–2011									
Target regions	All 71 regions									
Estimator [b]	RE					system GMM				
Model	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]
FDI variables [c]										
lnFDIANN	-0.0033					0.0065				
	(0.003)					(0.005)				
lnFDI3AVE		0.0009					-0.0015			
		(0.008)					(0.005)			
lnFDIPC			-0.0038					0.0068		
			(0.003)					(0.005)		
lnCUMFDI				0.0528 **					0.0687	
				(0.024)					(0.057)	
lnCUMFDIPC					0.0253 **					0.0550 **
					(0.013)					(0.027)
Dummy for the top 35 regions in terms of cumulative FDI per capita										
UPPER_REGION	-0.0007	-0.0220	0.0953	-0.6972 *	0.0170					
	(0.084)	(0.115)	(0.065)	(0.381)	(0.088)					
Interaction term of FDI variable and dummy for the top 35 regions in terms of cumulative FDI per capita [c]										
FDI × UPPER_REGION	0.0127 **	0.0139	0.0118 **	0.0649 **	0.0145	0.0132	0.0201 *	0.0094	0.2612 ***	0.0023
	(0.005)	(0.009)	(0.005)	(0.032)	(0.013)	(0.009)	(0.012)	(0.007)	(0.088)	(0.037)
N	920	937	921	944	944	817	792	817	872	872
Wald test (χ^2) [d]	2020.94 ***	2040.02 ***	2004.76 ***	2367.15 ***	2103.75 ***	1905.37 ***	2274.63 ***	1975.66 ***	2903.37 ***	1939.23 ***

(Continued)

(c) Estimation with the squared term of FDI variable

(Continued in Table 7)

Estimation period	1996–2011									
Target regions	All 71 regions									
Estimator [b]	RE					system GMM				
Model	[21]	[22]	[23]	[24]	[25]	[26]	[27]	[28]	[29]	[30]
FDI variables [c]										
lnFDIANN	-0.0395 ***					-0.0219 *				
	(0.012)					(0.012)				
lnFDI3AVE		-0.0691 ***					-0.0186			
		(0.020)					(0.011)			
lnFDIPC			-0.0010					0.0058		
			(0.003)					(0.004)		
lnCUMFDI				-0.1934 ***					-0.1648	
				(0.073)					(0.119)	
lnCUMFDIPC					-0.0249 *					0.0329
					(0.014)					(0.042)
Squared term of FDI variable [c]										
FDI^2	0.0028 ***	0.0048 ****	0.0029 ***	0.0140 ***	0.0088 ***	0.0020 ***	0.0016 *	0.0024 **	0.0225 **	0.0053
	(0.001)	(0.001)	(0.001)	(0.003)	(0.001)	(0.001)	(0.001)	(0.001)	(0.009)	(0.003)
N	920	937	921	944	944	817	792	817	872	872
Wald test (χ^2) [d]	1997.19 ***	2107.34 ***	1925.93 ***	2994.72 ***	2271.87 ***	2196.06 ***	2792.51 ***	2011.40 ***	3276.12 ***	2170.30 ***

Note: [a] The dependent variables of all models are the natural logarithm of the real gross regional product (*lnGRP*). The estimation results of control variables are not reported. Their composition is the same as that of the baseline estimation; the individual effects of regions and the time fixed effects are also controlled. Figures in parentheses beneath regression coefficients are robust standard errors. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

[b] RE and system GMM denote random-effects estimator and system generalized method-of-moments (GMM) estimator, respectively.

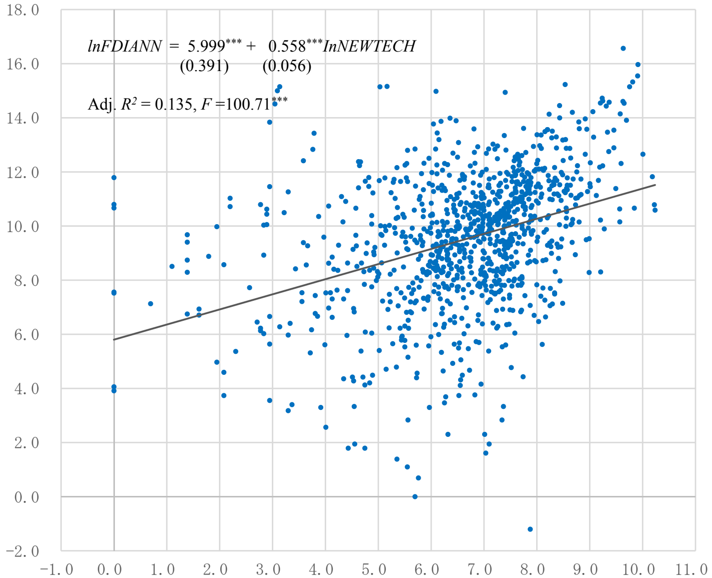
[c] The random-effects models adopt one-year lagged FDI variables and their interaction and squared terms, while the system GMM dynamic models endogenize non-lagged FDI variables and their interaction and squared terms, assuming their two-year lag structure.

[d] Null hypothesis: All coefficients are zero.

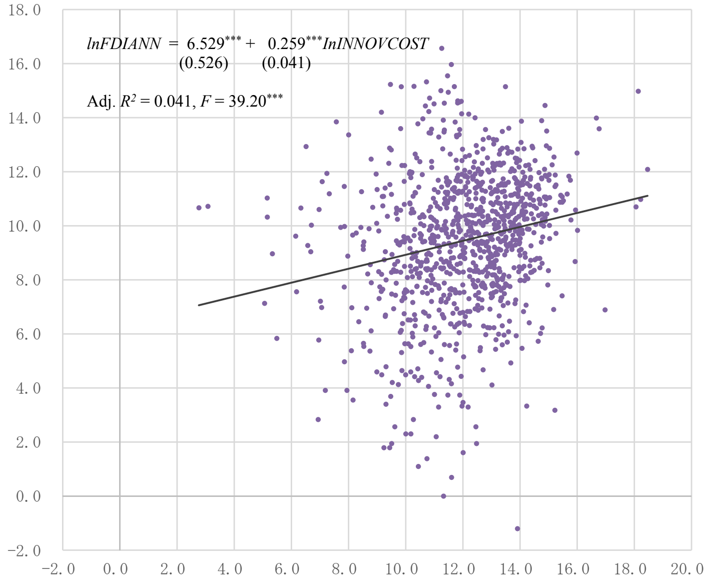
Source: Authors' estimation. See Table 5 for the definitions and descriptive statistics of the variables used in the estimation.

Figure 1. Relationship between regional R&D potential and FDI in Russia, 1996–2011

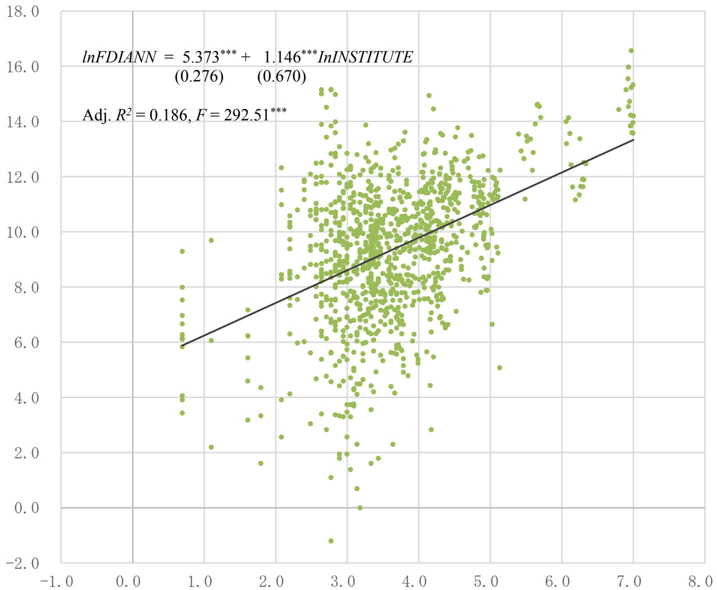
(a) Horizontal axis: the natural logarithm of the number of the latest production technologies utilized (*lnNEWTECH*)



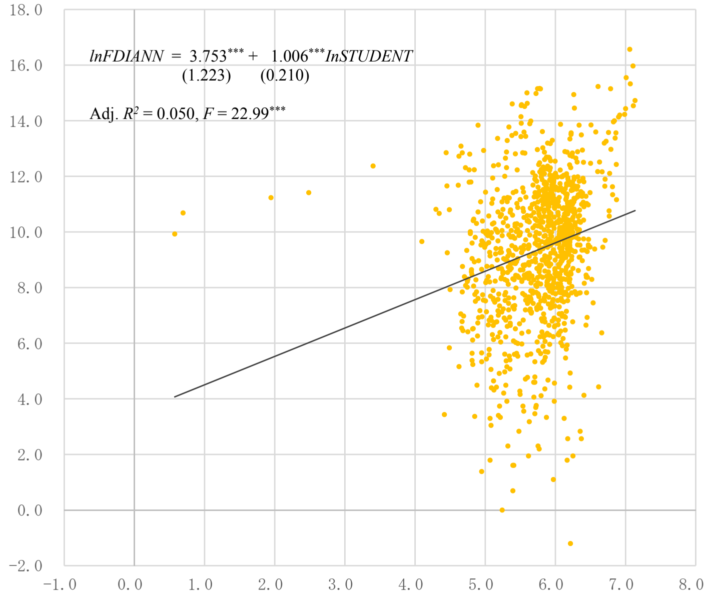
(b) Horizontal axis: the natural logarithm of technological innovation costs per R&D staff member (*lnINNOVCOST*)



(c) Horizontal axis: the natural logarithm of the total number of research and higher education institutions (*lnINSTITUTE*)



(d) Horizontal axis: the natural logarithm of the number of higher education school students per 10,000 residents (*lnSTUDENT*)



Note: The vertical axis is the natural logarithm of the annual FDI (*lnFDIANN*). Robust standard erros are reported in parentheses beneath the approximation formula in figures. Null hypothesis of *F* test: All coefficients are zero. *** denotes statistical significance at the 1% level.

Source: Authors' illustration. See Table 5 for the definitions and descriptive statistics of the variables.

Table 8. Panel data estimation of the synergy effect of FDI and regional R&D potential [a]

Estimation period	1996–2011									
Target regions	All 71 regions									
Estimator [b]	RE					system GMM				
Model	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
Lagged endogenous variable										
lnGRP						0.1596 **	0.1856 **	0.1796 **	0.1617 **	0.1428 **
						(0.073)	(0.076)	(0.080)	(0.077)	(0.064)
FDI variables [c]										
lnFDIANN	-0.0544 ***					-0.0328 *				
	(0.020)					(0.017)				
lnFDI3AVE		-0.0704 ***					-0.0465 *			
		(0.022)					(0.024)			
lnFDIPC			-0.0547 **					-0.0266		
			(0.024)					(0.017)		
lnCUMFDI				0.0120					0.1178	
				(0.034)					(0.108)	
lnCUMFDIPC					-0.0710 ***					-0.0064
					(0.022)					(0.045)
R&D variable										
lnNEWTECH	-0.0651 ***	-0.0971 ***	-0.0027	-0.1572 ***	-0.0500 ***	-0.0408	-0.0724 **	0.0312	-0.1934 ***	-0.0296
	(0.017)	(0.024)	(0.013)	(0.049)	(0.014)	(0.029)	(0.031)	(0.027)	(0.052)	(0.025)
Interaction term of FDI and R&D variables [c]										
FDI × lnNEWTECH	0.0091 ***	0.0128 ***	0.0090 **	0.0147 ***	0.0176 ***	0.0068 ***	0.0087 **	0.0057 **	0.0182 ***	0.0124 **
	(0.003)	(0.004)	(0.004)	(0.005)	(0.003)	(0.003)	(0.004)	(0.002)	(0.005)	(0.005)
Control variables										
PRICOM	3.0519	3.0623	2.6502	1.5231	3.1790	3.5376	3.5348	2.3094	0.9420	3.2525
	(3.080)	(3.097)	(3.230)	(3.072)	(3.075)	(3.685)	(3.722)	(3.872)	(3.978)	(3.687)
lnTELEPHONE	0.1354	0.1332	0.1412	0.0952	0.1014	0.2171 *	0.1506 *	0.1834	0.1919 **	0.1782 **
	(0.086)	(0.086)	(0.086)	(0.085)	(0.084)	(0.112)	(0.091)	(0.126)	(0.092)	(0.090)
BIGCITY	-0.0216	-0.0282	-0.0173	-0.0673 *	-0.0424					
	(0.045)	(0.046)	(0.045)	(0.039)	(0.045)					
BIGPORT	-0.0061	-0.0050	-0.0061	0.0137	-0.0137					
	(0.047)	(0.046)	(0.047)	(0.038)	(0.043)					
EUROPE	0.1631 **	0.1597 **	0.1559 **	0.0186	0.1532 *					
	(0.076)	(0.078)	(0.076)	(0.084)	(0.084)					
PACIFIC	0.3660 ***	0.3629 ***	0.3710 ***	0.0280	0.3257 **					
	(0.137)	(0.135)	(0.140)	(0.150)	(0.135)					
RESOURCE	0.2898 ***	0.2919 ***	0.2890 ***	0.2518 ***	0.3032 ***					
	(0.062)	(0.060)	(0.063)	(0.049)	(0.062)					
lnFIXCAP	0.2583 ***	0.2513 ***	0.2604 ***	0.2680 ***	0.2252 ***	0.1838 ***	0.1862 ***	0.1922 ***	0.1942 ***	0.1564 ***
	(0.019)	(0.020)	(0.019)	(0.017)	(0.022)	(0.024)	(0.027)	(0.025)	(0.028)	(0.022)
lnLABOR	0.7772 ***	0.7702 ***	0.7777 ***	0.6152 ***	0.7751 ***	0.2877	0.4189	0.4414	0.8030 **	0.7667 **
	(0.056)	(0.052)	(0.059)	(0.065)	(0.048)	(0.432)	(0.409)	(0.443)	(0.378)	(0.372)
Constant term	0.0239	0.2921	-0.4165	0.8625	0.4749	1.7150	1.4847	0.3832	-2.8733	-0.8473
	(0.879)	(0.849)	(0.853)	(0.855)	(0.797)	(2.752)	(2.776)	(2.649)	(2.583)	(2.271)
Individual effects of regions	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Time fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
N	920	937	921	944	944	749	783	749	796	796
Wald test (χ^2) [d]	2864.94 ***	2093.63 ***	2499.43 ***	2788.44 ***	2295.20 ***	2221.07 ***	2230.40 ***	2397.54 ***	2040.24 ***	2357.59 ***

Note: [a] The dependent variables of all models are the natural logarithm of the real gross regional product (*lnGRP*). Figures in parentheses beneath regression coefficients are robust standard errors. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

[b] RE and system GMM denote random-effects estimator and system generalized method-of-moments (GMM) estimator, respectively.

[c] The random-effects models adopt one-year lagged FDI variables and their interaction terms, while the system GMM dynamic models endogenize non-lagged FDI variables and their interaction terms, assuming their two-year lag structure.

[d] Null hypothesis: All coefficients are zero.

Source: Authors' estimation. See Table 5 for the definitions and descriptive statistics of the variables used in the estimation.

Table 9. The effect of FDI on regional total factor productivity in 2011: Predicted

Ranking of total FDI effect	Entity [a]	Cumulative direct investments per capita in 2011 (US dollars)	The number of latest production technologies utilized in 2011	The effect of FDI on regional total factor productivity [b]		
				Direct effect of FDI (a)	Synergistic effect between FDI and R&D potential (b)	Total FDI effect (a+b)
1	Moscow	47,639	17,205	-0.764	1.851	1.086
2	Moscow Region	15,469	15,159	-0.685	1.636	0.951
3	St. Petersburg	10,976	5,122	-0.660	1.400	0.740
4	Nizhny Novgorod Region	1,738	12,781	-0.529	1.243	0.713
5	Sverdlovsk Region	1,746	10,337	-0.530	1.216	0.686
6	Republic of Tatarstan	2,451	4,847	-0.554	1.167	0.613
7	Samara Region	1,170	6,870	-0.501	1.100	0.598
8	Sakhalin Region	172,322	906	-0.856	1.446	0.591
9	Tyumen Region	1,015	6,675	-0.491	1.074	0.583
10	Krasnodar Territory	5,592	2,128	-0.612	1.165	0.553
11	Chelyabinsk Region	817	5,801	-0.476	1.024	0.548
12	Kaluga Region	3,366	2,316	-0.576	1.109	0.532
13	Tula Region	834	4,898	-0.477	1.007	0.530
14	Vladimir Region	1,225	3,239	-0.505	1.013	0.508
15	Omsk Region	1,599	2,632	-0.524	1.024	0.500
16	Perm Territory	576	4,510	-0.451	0.942	0.491
17	Lipetsk Region	1,449	2,265	-0.517	0.991	0.474
18	Novgorod Region	1,709	1,944	-0.528	0.993	0.465
19	Arkhangelsk Region	2,772	1,414	-0.563	1.013	0.451
20	Leningrad Region	4,229	1,195	-0.593	1.042	0.450
21	Tomsk Region	1,043	1,902	-0.493	0.925	0.431
22	Republic of Bashkortostan	163	6,207	-0.361	0.784	0.422
23	Primorsky Territory	1,506	1,404	-0.519	0.934	0.415
24	Rostov Region	439	2,670	-0.432	0.846	0.414
25	Tver Region	420	2,394	-0.429	0.828	0.399
26	Novosibirsk Region	389	2,457	-0.423	0.820	0.397
27	Volgograd Region	528	1,989	-0.445	0.839	0.394
28	Yaroslavl Region	285	2,642	-0.401	0.785	0.383
29	Khabarovsk Territory	292	2,559	-0.403	0.785	0.382
30	Saratov Region	143	4,359	-0.352	0.732	0.380
31	Krasnoyarsk Territory	349	1,979	-0.415	0.783	0.367
32	Altai Territory	494	1,511	-0.440	0.800	0.360
33	Republic of Mordovia	192	2,626	-0.373	0.729	0.356
34	Pskov Region	403	1,594	-0.426	0.779	0.354
35	Republic of Chuvashia	195	2,497	-0.374	0.726	0.352
36	Kemerovo Region	264	1,926	-0.396	0.743	0.347
37	Kursk Region	314	1,588	-0.408	0.747	0.339
38	Voronezh Region	246	1,755	-0.391	0.725	0.334
39	Kaliningrad Region	636	1,040	-0.458	0.790	0.332
40	Republic of Komi	2,495	609	-0.555	0.884	0.329
41	Ryazan Region	513	1,076	-0.443	0.768	0.325
42	Kostroma Region	499	1,069	-0.441	0.763	0.323
43	Vologda Region	140	2,228	-0.351	0.671	0.320
44	Zabaikalsk Territory	461	1,039	-0.435	0.751	0.315
45	Republic of Udmurtia	56	4,565	-0.285	0.597	0.311
46	Tambov Region	111	2,248	-0.334	0.640	0.306
47	Kirov Region	104	2,249	-0.329	0.631	0.302
48	Irkutsk Region	367	988	-0.419	0.718	0.298
49	Murmansk Region	101	1,557	-0.328	0.598	0.270
50	Orenburg Region	359	734	-0.417	0.684	0.266
51	Belgorod Region	174	1,030	-0.366	0.631	0.264
52	Amur Region	1,016	449	-0.491	0.745	0.254
53	Magadan Region	1,563	387	-0.522	0.772	0.250
54	Ulyanovsk Region	59	1,685	-0.289	0.533	0.244
55	Smolensk Region	81	1,171	-0.312	0.546	0.235
56	Republic of Khakasia	1,960	322	-0.538	0.771	0.233
57	Orel Region	54	1,471	-0.283	0.512	0.229
58	Bryansk Region	83	1,066	-0.313	0.542	0.229
59	Kurgan Region	116	835	-0.337	0.563	0.226
60	Stavropol Territory	94	920	-0.323	0.546	0.224
61	Republic of Sakha (Yakutia)	208	597	-0.379	0.601	0.222
62	Penza Region	54	1,134	-0.283	0.495	0.211
63	Republic of Karelia	37	1,191	-0.256	0.450	0.194
64	Astrakhan Region	67	591	-0.299	0.474	0.175
65	Ivanovo Region	74	486	-0.306	0.469	0.164
66	Republic of Buryatia	93	233	-0.322	0.435	0.114
67	Kamchatka Territory	264	137	-0.396	0.483	0.088
68	Jewish Autonomous Area	116	156	-0.337	0.423	0.086
69	Republic of Mari El	2	758	-0.058	0.095	0.037
70	Republic of Altai	1	82	-0.027	0.029	0.003
71	Republic of Tuva	35	8	-0.252	0.130	-0.122

Note: [a] The name of the region (Entity) is as of 2013.

[b] Predictions based on the result of the random-effects model [5] in Table 8

Source: Authors' computation

Table 10. Robustness check of the synergy effect of FDI and regional R&D potential [a]

(a) Estimation using the natural logarithm of the technological innovation costs per R&D staff member (*lnINNOVCOST*) as the R&D variable

Estimation period	1996–2011									
Target regions	All 71 regions									
Estimator [b]	RE					system GMM				
Model	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
FDI variables [c]										
lnFDIANN	-0.0689 ***					-0.0269 **				
	(0.021)					(0.014)				
lnFDI3AVE		-0.0959 ***					-0.0387 **			
		(0.025)					(0.017)			
lnFDIPC			-0.0619 ***					-0.0282 *		
			(0.024)					(0.015)		
lnCUMFDI				0.0335					0.2143 **	
				(0.034)					(0.092)	
lnCUMFDIPC					-0.0411					0.0058
					(0.032)					(0.026)
R&D variable										
lnINNOVCOST	-0.0432 **	-0.0699 ***	-0.0008	-0.0471	-0.0169	-0.0194	-0.0275 *	0.0028	-0.0515	-0.0185
	(0.018)	(0.023)	(0.007)	(0.034)	(0.015)	(0.013)	(0.016)	(0.008)	(0.039)	(0.013)
Interaction term of FDI and R&D variables [c]										
FDI × lnINNOVCOST	0.0059 ***	0.0086 ***	0.0052 ***	0.0054 *	0.0064 **	0.0031 ***	0.0037 ***	0.0032 **	0.0050	0.0047 ***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.001)	(0.001)	(0.001)	(0.003)	(0.002)
N	931	951	932	960	960	761	797	761	809	809
Wald test (χ^2) [d]	2154.96 ***	2267.64 ***	2078.92 ***	2582.39 ***	2330.20 ***	1786.34 ***	2340.87 ***	1915.90 ***	2530.52 ***	2679.56 ***

(b) Estimation using the natural logarithm of the number of research and higher education institutions (*lnINSTITUTE*) as the R&D variable

Estimation period	1996–2011									
Target regions	All 71 regions									
Estimator [b]	RE					system GMM				
Model	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]
FDI variables [c]										
lnFDIANN	-0.0295 **					-0.0273				
	(0.015)					(0.021)				
lnFDI3AVE		-0.0340 *					-0.0651 **			
		(0.019)					(0.026)			
lnFDIPC			-0.0288 *					-0.0199		
			(0.015)					(0.018)		
lnCUMFDI				-0.0020					0.0131	
				(0.036)					(0.058)	
lnCUMFDIPC					-0.0255					-0.1642 ***
					(0.021)					(0.035)
R&D variable										
lnINSTITUTE	-0.0884 *	-0.1249 **	-0.0181	-0.3190 ***	-0.0775 *	0.0231	-0.1088	0.0788	-0.3387 **	-0.1752 **
	(0.053)	(0.056)	(0.044)	(0.090)	(0.041)	(0.086)	(0.109)	(0.080)	(0.156)	(0.078)
Interaction term of FDI and R&D variables [c]										
FDI × lnINSTITUTE	0.0097 **	0.0136 **	0.0094 **	0.0262 ***	0.0207 ***	0.0110 *	0.0208 ***	0.0087 *	0.0432 ***	0.0678 ***
	(0.004)	(0.006)	(0.004)	(0.008)	(0.005)	(0.006)	(0.008)	(0.005)	(0.016)	(0.011)
N	933	958	934	977	977	828	803	828	906	906
Wald test (χ^2) [d]	2493.04 ***	2626.94 ***	2280.28 ***	3059.16 ***	3354.84 ***	1779.03 ***	2054.32 ***	1810.16 ***	2891.04 ***	2369.22 ***

(Continued)

(c) Estimation using the natural logarithm of the number of higher education school students per 10,000 residents (*lnSTUDENT*) as the R&D variable (Continued in Table 10)

Estimation period	1996–2011									
Target regions	All 71 regions									
Estimator [b]	RE					system GMM				
Model	[21]	[22]	[23]	[24]	[25]	[26]	[27]	[28]	[29]	[30]
FDI variables [c]										
lnFDIANN	-0.1487 ***					0.0642				
	(0.041)					(0.062)				
lnFDI3AVE		-0.1597 ***					0.0673			
		(0.059)					(0.078)			
lnFDIPC			-0.1454 ***					0.0671		
			(0.050)					(0.057)		
lnCUMFDI				-0.0632					0.2133 **	
				(0.076)					(0.102)	
lnCUMFDIPC					-0.2030 ***					0.0744
					(0.062)					(0.111)
R&D variable										
lnSTUDENT	-0.2957 ***	-0.3013 ***	-0.1128 ***	-0.3410 *	-0.1822 ***	-0.0127	-0.0775	-0.0602	0.0536	-0.0536
	(0.073)	(0.099)	(0.042)	(0.175)	(0.054)	(0.129)	(0.123)	(0.075)	(0.216)	(0.085)
Interaction term of FDI and R&D variables [c]										
FDI × *lnSTUDENT*	0.0257 ***	0.0285 ***	0.0250 ***	0.0259 **	0.0423 ***	-0.0093	-0.0103	-0.0096	-0.0189	-0.0063
	(0.007)	(0.010)	(0.009)	(0.013)	(0.011)	(0.010)	(0.013)	(0.009)	(0.019)	(0.018)
N	933	958	934	977	977	828	803	828	906	906
Wald test (χ^2) [d]	2361.48 ***	2341.28 ***	2336.39 ***	2327.58 ***	2264.36 ***	1369.20 ***	2054.27 ***	1508.61 ***	2164.46 ***	2415.37 ***

Note: [a] The dependent variables of all models are the natural logarithm of the real gross regional product (*lnGRP*). The estimation results of control variables are not reported. Their composition is the same as that of the baseline estimation; the individual effects of regions and the time fixed effects are also controlled. Figures in parentheses beneath regression coefficients are robust standard errors. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

[b] RE and system GMM denote random-effects estimator and system generalized method-of-moments (GMM) estimator, respectively.

[c] The random-effects models adopt one-year lagged FDI variables and their interaction terms, while the system GMM dynamic models endogenize non-lagged FDI variables and their interaction terms, assuming their two-year lag structure.

[d] Null hypothesis: All coefficients are zero.

Source: Authors' estimation. See Table 5 for the definitions and descriptive statistics of the variables used in the estimation.