HUMAN CAPITAL AND KNOWLEDGE-INTENSIVE INDUSTRIES LOCATION: EVIDENCE FROM SOVIET LEGACY IN RUSSIA

Denis Ivanov

Denis Ivanov is Research Fellow, International Center for the Study of Institutions and Development, National Research University Higher School of Economics, 20 Myasnitskaya str., Moscow 101000 Russian Federation. E-mail: dsivanov@hse.ru or d.s.ivanov@inbox.ru

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Do human capital endowments trump location for knowledge-intensive industries? This paper takes advantage of a natural experiment created by the end of the Soviet planned economy in 1991, which had geographically distributed R&D manpower according to planned needs as opposed to a distribution determined by a market economy. It examines the extent to which the planned economy created a path-dependence in the location of post-Soviet human-capital intensive production. The study finds that regions with more R&D personnel in 1991did better in the development of modern market-oriented knowledge-intensive business services, like engineering and IT. Several explanations are offered for this path-dependence, with an emphasis on human capital externalities being the most plausible.

INTRODUCTION

Knowledge-intensive business services (KIBS) such as IT, engineering, accounting, auditing, and management consulting, are of growing importance for regional economies, especially for those of large cities. Local human capital and knowledge inputs are generally discussed as the most fundamental correlates for location of such industries. (Keeble and Nachum 2002; Acs and Armington 2004; Shearmur and Doloruex 2008; Meliciani and Savona 2014). At the same time, the causal link between the location of human capital and knowledge-intensive business services remains underexplored. In this paper, I propose to overcome the endogeneity problem using a natural experiment arising from the central planning of the R&D sector in the USSR prior to the collapse of the command economy and the cuts in government spending. Under Soviet rule, due to limitations on private entrepreneurship, independent knowledge-intensive business service providers in Russia were unknown. Industrial enterprises relied on their own R&D departments or on large publicly owned research institutions, with military-related research dominating the government-sponsored agenda. When the central planning system was abolished in early 1992, people were agglomerated in places for reasons only loosely related to the market. I argue that central planners were unable to anticipate which locations would be favored when market forces were allowed to operate. With the collapse, spending cuts pushed many professionals out of Soviet-style research institutions. Pre-existing ties to industry were also unlikely to drive KIBS development because of the deteriorating financial condition of former R&D sponsors, such as the arms or aerospace industries.

Existing evidence supports the view that market agents followed different locational policies to those pursued by central planners of the socialist era. In Falck et al. (2014) it has been shown that following German reunification, new entrants tended not to locate in the same areas with incumbent firms within the same industries in East Germany. At the same time, there was strong tendency for coagglomaration of incumbents and new entrants in former West Germany. The authors interpret this as an element of post socialist transformation in the former German Democratic Republic. Of course, in some industries like manufacturing and transportation, the Soviet-era legacy included physical capital, which is extremely costly to relocate even if the market required it. For tertiary industries, this was not the case: knowledge-intensive business services are not a capital-intensive but rely on human capital, which is relatively mobile. I explore just how mobile or path dependent that labor was in the aftermath of the collapse of the Soviet regime.

If knowledge-intensive business service location is determined primarily by fundamentals like natural resources, amenities, or governance, which attract firms to a region and drive demand for business services, one should not expect to see any influence of late Soviet R&D staff on the present-day geography of these services. If, however, the spatial pattern of the Soviet R&D sector is "sticky" (i.e. path dependence in present-day KIBS location is observed), explanations for this this persistence would depend on whether this was the result of voluntary choice of former researchers. Low rates of residential mobility attributed to poverty traps and labor market rigidness are often blamed for preserving distortions in the Russian urban systems (Hill and Gaddy 2003; Shepotylo 2012, Guriev and Vakulenko 2015). Additionally, if getting a skilled job in a new location requires reputation, which can be earned only locally, former researchers might be deterred from migrating. In such cases, we should see the KIBS clusters as a negative phenomenon, and policy interventions should be aimed at helping the people employed there to move to those regions where their skills are in demand.

In contrast, former researchers might voluntarily stay in places they had been agglomerated under the central planning. A plausible reason behind this are the externalities arising from local density of high human capital workers, as well as from the presence of other KIBS firms. The idea that skilled professionals generate externalities for other workers in the same area is an established one in the literature (Lucas 1988; Rauch 1993; Acemoglu and Angrist 2001; Moretti 2004, Fu 2007). Human capital externalities are multifaceted. Workers may learn from their high-skilled peers. A high density of skilled jobs allows better specialization between workers on special types of tasks, as well as expedites job search in a case of unemployment (the latter is of enormous importance in the turbulent economy of transition-era Russia). Another advantage from spatial clustering of skilled workers is improved matching in worker groups necessary to undertake collaborative projects (Venables 2011). Spatial proximity can also facilitate diffusion of innovations. Adam B. Jaffe, Manuel Trajtenberg and Rebecca Henderson (1993) have shown that citations to US patents are more likely to come from the same metropolitan statistical area as the original patent.

If human capital externalities hold, one still cannot draw straightforward welfare implications, since the existing locational pattern may be distorted due to the central planners' decisions.[1] For example, very cold parts of Russia remain overpopulated when compared to Canada's north (Hill and Gaddy (2003), Mikhailova (2004)).

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[1] One can however conclude that locational decisions in R&D sector may cause some kind of QWERTY effect, rendering science as a potentially powerful tool for regional policy

This paper contributes to the literature on path-dependence and natural experiments in economic geography. One of the most intriguing questions of economic geography is whether an industry location pattern is uniquely determined by some fundamental factors or whether there are multiple equilibria, and that spatial catastrophes can switch them. The New Economic Geography view, dating back to such scholars as Paul Krugman, Masahisa Fujita, Jacques-Francois Thisse, Antony J. Venables (Krugman (1991), Fujita and Thisse (1996), Fujita, Krugman and Venables (2001)) emphasizes increasing returns due to spatial agglomeration of firms, even when this agglomeration is due to idiosyncratic factors. The robustness of these spatial agglomerations has been evaluated in the aftermath of exogenous shocks. How quickly does the spatial distribution of population and industry recover? Donald R. Davis and David Weinstein (2002) find that the Allied bombing of Japan left unchanged the relative size of Japanese cities. [2] Other studies came to similar conclusions with evidence for war-related shocks: Germany (Brakman et al. 2004), Vietnam (Miguel and Roland 2011) and Russia (Mikhailova 2012).

Locational patterns of population and economic activity appear in these studies as tremendously persistent and path-dependent: even nuclear bombings were unable to change spatial equilibrium in the long run. However, one can argue that war-related destruction is not a proper shock to test the hypothesis of path-dependence. Firstly, these cities could be located in correct places initially. Secondly, people in cities devastated by bombing nevertheless could be sure that hostilities eventually would cease, and dwellings they and their neighbors used to live in, and factories they used to work in would be reconstructed.

Other studies investigate the consequences of long-term exogenous constraints on spatial equilibrium, as well as shocks caused by unexpected collapses of such constraints. Stephen J.

[2] In Davis and Weinstein (2008) similar results were obtained with data on city-level employment in aggregate manufacturing as well as individual industries.

Redding and Daniel M. Sturm (2008) found that West German cities close to the East-West border grew substantially more slowly relative to other cities and even their catch-up after reunification was much more gradual. Redding et al. (2011) show that the division of Germany led to a shift of the major airline hub from Berlin to Frankfurt-am-Main, and that there is no evidence of reverse movement after the fall of the Berlin Wall.[3]

This paper takes advantage from two major events in the social and economic history of the 20th century: the Soviet state-led modernization project and the ensuing post-socialist transition. The novelty of this paper lies in showing how path-dependence of industry location may arise from exogenous agglomeration not of physical assets but of (potentially mobile) human capital, with special emphasis on upper-tail skills. The paper, therefore, bridges between literatures on multiple equilibria in economic geography and on human capital externalities. In contrast to many other studies, the nature of exogenous shock under consideration is not the physical destruction of built environment, or locational fundamental obsolescence due to technical progress, but sweeping institutional changes. I show that spatial clusters of research,

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[3] Some recent literature in economic history also considers the consequences of exogenous shocks that have influenced location of human capital. Davide Cantoni and Noam Yuchtman (2012) show that following the 1386 Papal Schism, university foundation in Germany caused an increased rate of market establishment in those areas where the distance to the nearest university shrank most. Similarly, Mara Squicciarini and Nico Voigtlaender (2014) proxy upper-tail knowledge by local density of the *Encyclopédie* subscriptions in mid-18-century France and find its positive effect on various measures of economic development in later decades. Researchers also considered recent evidence from relatively minor natural experiments conducted in developed countries, like Sweden (Andersson, Quigley and Wilhelmson 2004) or the United States (Hausman 2012).

Another sort of paper deals with events that cause locational fundamentals to lose their importance, often due to technical progress. Hoyt Bleakley and Jeffrey Lin (2012) have shown that cities at portages in Northern America have not fallen into decay after portage decline, but persisted. Moreover, this effect cannot be explained by sunk costs. Nicholas F.R. Crafts and Nikolaus Wolf (2014) found evidence of strong path-dependence in the case of the 19th century British cotton industry: cotton mills remained heavily concentrated in Lancashire even while location factors related to water power become obsolete.

development and other knowledge-intensive activities became self-sustainable and persist even under very unpleasant external conditions and poor location.

HISTORICAL BACKGROUND

In the Soviet centrally planned economy, knowledge-intensive business services were a minor sector. In fact, some service industries simply did not exist (Bradshaw 2008), such as consumer IT or management consulting. Indeed, the economy lacked a sector of small knowledge-intensive companies. Rather, the state-owned R&D sector was highly militarized. In 1983, more than 70% of the USSR's R&D expenses were incurred for purposes related to national defense and the space program. Overall the R&D expenses to GDP ratio was very high (3.6% in 1983) but much smaller when only the civil fraction was taken into account (Freeman 1995).

The Russian R&D sector is largely a creature of the Communist regime. Before the 1917 Revolutions in the classification of occupations listed in the Imperial census of 1897 science was merged with creative writing and fine arts. The Soviet government designated the Academy of Sciences, founded in 1724 in St. Petersburgh, [4] as the powerhouse of progress, endowing it with generous funding and greatly expanding the network of research institutions. Even during the civil war, the number of research staff in the Academy of Sciences quadrupled (Osipov, 1999)[5].

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[4] Like at many European courts, the Academy of Sciences in St. Petersburg has been founded in 1724. It consisted of the relatively small board of elected fellows (full, corresponding and honorary members) with the president appointed by Emperor, and the system of research and auxiliary institutions governed by the Academy (libraries, museums, laboratories, observatories). As on 1913, scholars of arts and humanities preponderated among the Academy fellows: only 18 of 40 full members represented science or mathematics, and one member was an economist. Under umbrella of the Academy 21 institutions existed, located mostly near St. Petersburg. In peripheral areas of the Empire, only several observatories and marine biology stations were established.

[5] Several other state academies has been modeled after the Academy of Sciences, namely the Academy of Agricultural Sciences, widely known as VASKhNIL (1929); the Academy of Pedagogical Sciences (1943); the

Constituent republics of the USSR replicated this system, creating research institutions in places with previously almost no science. Outside the Academies system, so-called scientific research institutes (known under Russian acronym NII) and design bureaus (in similar manner called KB) under the aegises of government ministries and even individual plants were created in large numbers in order to conduct practically-oriented research and development.

The resulting Soviet model of R&D sector was quite unique: universities, aside from a few elite schools like Moscow State University, Leningrad (now St. Petersburgh) State University, Moscow Engineering Physics Institute, were committed primarily to teaching, with research being conducted in specialized institutions working under umbrellas of various government agencies, industrial enterprises, or the Academies. Thus the system of R&D planning was highly centralized and bureaucratized (Radosevic 2003).

The geography of the Soviet-era knowledge-intensive industries was shaped without taking into account the viability of industries or market conditions. Instead, ideological, political and military considerations were given high priority (Rodgers 1974; Hill and Gaddy 2003; Mikhailova 2004; Kumo 2004). WWII-related evacuations left their imprints with academic institutions relocated to cities which believed to be invulnerable for German invasion. For example, the evacuation of the Academy of Sciences of USSR from Moscow and Leningrad to Kazan on Volga, which gave rise to the Kazan branch of the Academy.

Postwar, the government implemented a deliberate policy of spreading research activities outside Moscow and Leningrad. A notable case was Novosibirsk *Akademgorodok* – the seat of the Siberian branch of the Academy of Sciences. Initially, regional branches of the Academy were understaffed and narrowly focused, committed mostly to local problems like natural resources exploration (Vek Lavrent'eva, 2000, p. 126, 200). A groundbreaking decision was made in 1957 when many scientists, both young and renowned ones, were incentivized to move

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Academy of Medical Sciences (1944); the Academy of Artillery Sciences (1946-1953, reinstated in 1994); the Academy of Construction and Architecture (1956-1964, reinstated in 1992).

to Novosibirsk with the intention to build a world-class research center with all-encompassing range of disciplines and topics. Relative freedom from academic hierarchy and rapid promotion were touted as a motivation to move to Siberia.

Novosibirsk was not a straightforward location choice, however[6]. Many top officials, including the president of the Academy of Sciences and the Minister of Higher Education thought the project unviable (Vek Lavrent'eva, 2000, p. 123), mostly because Siberia still had a reputation as the country's place of exile and penal labor, not to mention its harsh climate. Novosibirsk, although a rapidly growing manufacturing center and ranked as seventh most populous city of the USSR in 1959, lagged when it came to science, as did Siberia and Soviet Far East as a whole, with a share in the total country's R&D workforce of only1-2%, according to Lavrentyev's own estimates (Vek Lavrent'eva, 2000, p. 122). Novosibirsk, however was already home to the peripheral West Siberian branch of the Academy, headed by Timofei Gorbachev, a mining engineer. However, similar research centers existed in several other regions of the USSR. Indeed, the city lacked graduate-level institution granting degrees in mathematics, physics or chemistry, and the Novosibirsk State University had to be created from scratch.

Soviet regional governments enjoyed enormous autonomy in pursuing their own economic policies under Khrushchev's short-lived *sovnarkhoz* reform (1957-1965), exactly the same period the *Akademgorodok* in Novosibirsk was being built. With Khrushchev ouster in 1964, the new Soviet leader Leonid Brezhnev reversed course and returned to administrative centralization. [7] In general, key economic decisions were taken in Moscow throughout the most of the Soviet era. In addition, Soviet regional leaders were appointed *de facto* from Moscow and

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[6] The project's champion, Academician Mikhial Lavrentyev stated that the decisive factor making him favor Novosibirsk over Irkutsk for the seat of the Siberian branch was the cooperative position of local government. He was offered a spacious plot on the bank of the Ob River outside Novosibirsk, while Irkutsk authorities insisted on building an urban campus, which implicated heavy contribution to urban milieu from the Academy's side (Vek Lavrent'eva, 2000, p. 123, 129).

[7] For details on the *sovnarkhoz* reform, please refer to Andrei Markevich and Ekaterina Zhuravskaya (2011).

rotated, especially during the reigns of Stalin and Khrushchev. Therefore, differences in their policies can be treated as idiosyncratic. One indicative anecdote is that Boris Kobelev, the First Secretary of Irkutsk Obkom of CPSU in 1955-1957, whose policy Lavrientyev blamed for choosing Novosibirsk over Irkutsk as a location of the *Akademgorodok* (see footnote 6), was transferred to Novosibirsk in May 1957 – the same month final decision about placing there the Siberian branch of the Academy was made.[8]

Another feature of Soviet R&D sector after WWII were closed towns, (*ZATOs*) devoted to military research and production or double-purpose research, development and manufacturing.[9] Typically closed towns were located in remote places, although some have been placed in Moscow region. While some *ZATO*s remain restricted to visits even for Russians up to this day, others have been converted to "science cities", or *naukograds*, with civilian-oriented research agenda, with no visit or migration restrictions. For example, Dubna in the Moscow region hosted an internationally renowned nuclear physics research center as early as in 1956. It is highly unlikely that considerations taken into account by the bureaucracy while picking locations for highly secretive research and production facilities during the Cold War had much to do with current market-era factors influencing location choice of KIBS providers.

With the collapse of the Soviet Union in 1991, military budgets and public spending on fundamental science were cut dramatically. Even civil research-intensive industries, like aerospace and electronics, also shrunk. As a result, Russian scientists faced decreased salaries, inflation, shortages of laboratory supplies and aging equipment. Worsening work conditions led

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[8] See biography in Russian at URL: http://www.knowbysight.info/KKK/03227.asp

[9] Closed towns should not be confused to Soviet cities with prohibited access of foreigners. Despite the restrictions, these cities were often first-level administrative centers with population sometimes exceeding one million, and diversified economies embracing both civilian and military industries. They were considered outside the system of "closed towns" and never were hidden from Soviet citizens. Many researchers outside Moscow and Leningrad worked in the cities closed to foreign visitors.

to growing human resource outflow from the R&D sector. At the same time the emerging KIBS sector offered promising opportunities.

Russia retains the legacy Soviet-style R&D sector, although significantly cut in size and capabilities (fig. 1). Even in 2011, 76.1 per cent of total R&D staff were in fully publicly-owned organizations, with 74.5 per cent in those owned by the federal government. An additional 10.7 per cent worked for institutions in mixed public-private ownership (Belousova et al. 2013, p. 39). From the point of industry classification, it was still dominated by the traditional Soviet-era subsectors: independent research institutions (OKVED industry code 73 "Scientific research and development"), university research laboratories and in-house R&D divisions of manufacturing enterprises (Belousova et al. 2013, p. 42).

Yet by 2011, a vibrant market-oriented KIBS has emerged, with the heavy involvement of skilled professionals who left academia and military-related R&D institutions. These former researchers possessed high cognitive skills along with broad fundamental knowledge. Therefore, they were able to bridge this gap even if their background was not directly related to their new career path (Yurevich 1998, p. 107-110). Unlike the R&D sector, the KIBS sector is dominated by private ownership. As of 2011, it was less than quarter of public sector employment in architecture, engineering, IT, law, auditing, accounting and management consulting combined. Public sector KIBS employment was in establishments owned by regional and local authorities rather than the federal government.[10]

The recent history of Miass, Chelyabinskaya oblast epitomizes the story. In 1955, Miass was a rather typical medium industrial town near the Ural Mountains a thousand kilometers from the seashore. Despite this, it was chosen for the location of the Makeyev design bureau in charge of submarine-launched missile development. After 1991, engineers who previously worked for

[10] Source: Edinaya Mezhvedomstvennaya Informatsionno-Statisticheskaya Sistema (Unified Interagency Information and Statistics System)

https://fedstat.ru/indicator/43007.do

the missile design bureau founded several startups in Miass, although they were able to move elsewhere. Among those startups was *Papillon Systems*, which developed fingerprint identification hardware and software – a field loosely related to missilery. The company founder Pavel Zaitsev calls his decision to venture into this field after running an imported computers dealership "pure accidental"[11]. Despite the town's backward location, Papillon Systems gained commercial success with contracts from both Russian and foreign law enforcement agencies.

Novosibirsk *Akademgorodok* also provides vivid examples of successful business founded by researchers who switched their careers. An outstanding case is the Center of Financial Technologies (CFT), also known by its Russian name *Centr Finansovykh Tekhnologiy*. This software company has about 2,000 employees on its payroll. CFT sells IT solutions to financial sector companies as well as maintains the independent payment system *Zolotaya Korona* (Golden Crown). A co-founder of the company, Igor Potashnikov, worked for the *Akademgorodok's* mining science institute after his graduation from Novosibirsk State University in 1986[12]. Another co-founder, Aleksandr Pogudin, had read geology in Novosibirsk State University[13]. Before launching their own company, both worked for a private bank. Now, CFT retains close ties to *Akademgorodok*, basing there its software development division. So, despite being able to move, entrepreneurs chose to stay.

Two factors facilitate the success of former researchers in transition economy. Firstly, KIBS ventures often relied on the adoption of Western information technology. In the Soviet

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[11] Pavel Zaitsev interview in Russian magazine "Expert-Ural" on 24.05.2010: http://www.expert-ural.com/archive/20-421/pokazhi-palcem.html

[12] See biography in Russian at URL: http://www.it-vip.ru/Person.asp?ID=211&Display=1&First_Letter=

[13] See biography in Russian at URL: http://www.tadviser.ru/index.php/%D0%9F%D0%B5%D1%80%D1%81%D0%BE%D0%BD%D0%B0:%D0%9F%D0%BE%D0%B3%D1%83%D0%B4%D0%B8%D0%BD_%D0%90%D0%BB%D0%B5%D0%BA%D1%81%D0%B0%D0%BD%D0%B4%D1%80_%D0%92%D0%B8%D0%BA%D1%82%D0%BE%D1%80%D0%BE%D0%B2%D0%B8%D1%87

Union, research institutions enjoyed privileged access to computers, including Western designs, with heavily restricted public access. Therefore, people with research background had advantages in technology adoption and transmission, while outside the R&D sector people often lacked any idea of IT.

Secondly, the R&D sector was a testing ground for the very cautious experiments in legalizing private entrepreneurship in the USSR. Since 1987, Centers for Youth Scientific and Technical Creativity were allowed under the supervision of the Komsomol, the communist youth organization. Their official purpose was to boost technology transfer from scientific labs to industry, although they quickly diversified their activity into other fields, including foreign trade. Although limited in scope, these centers were instrumental in nurturing Russian businesspersons' community (Kryshtanovskaya, 2005, p.294). Therefore, researchers also had opportunity to gain experience in private entrepreneurship somewhat earlier than most other Russians did.

EMPIRICAL STRATEGY

To establish association between location of the Soviet R&D workforce and various outcomes, I run simple OLS regressions in the following general specification form:

$$Y_i = \beta_0 + \beta_1 R\&D1991_i + \beta_j X_{ij} + \varepsilon_i \qquad (1)$$

Where:

Y_i – outcome (e.g. number of workforce in engineering and architecture or other knowedge-intensive industry)

$R\&D1991_i$ – number of R&D personnel in region *i* in 1991

X_{ij} – control variables

ε_i – random term

Given differences in the size of Russian regions, log-log transformation of both dependent and independent variables are used to reduce the possible influence of outlier observations, like Moscow and St. Petersburg. Another way to mitigate this problem is to scale 1991 R&D workforce and control variables by total employment in a relevant year (when applicable). As a robustness check, I do this with and without log-log-transformation (i.e. using both "shares in employment" and "log shares in employment").

The regressions are of two different kinds: balancing test, with circa 1991 variables appearing on both sides of the equation, and baseline specifications, with 1991 number of researchers on the right-hand side and 2011 outcomes on the left-hand side.

To yield consistent estimates, OLS requires conditional independence assumption, or exogeneity of independent variables. To obtain additional underpinnings for the assumption of exogeneity of Soviet-era R&D sector location with respect to factors potentially influencing development of knowledge-intensive business services, I perform the balancing test, regressing 1991 R&D employment on various measures of economic development in the late years of the Soviet Union, while controlling for total employment, measures of urbanization and population density. The balancing test regressions are not causal, but they are important to reduce concerns of endogeneity in the baseline specifications.

In the baseline specifications, I use the number of staff involved in R&D in 1991 across Russian regions as a measure of the Soviet-era legacy, and employment in various KIBS industries in 2011 as well as number of microenterprises in business services sector are outcome variables.

I examine salaries in engineering and IT to distinguish between the theories of poverty trap and human capital externalities as the causes of path-dependence. Poverty trap theory implies that an excess supply of (supposedly immobile) skilled labor for legacy reasons depresses local salaries. Under human capital externalities theory, factor price equalization across regions is expected in long run, while in short run it is possible that KIBS employees get a premium for working in Soviet-era R&D hotspots. Although, as shown in Enrico Moretti (2004), a positive effect of human capital externalities on skilled workers themselves can be significantly mitigated by the negative effect of excess supply of their skills. Unfortunately, there is insufficient data to disentangle different facets of human capital externalities in this particular setting.

Path-dependence in KIBS location may be the result of one-shot employment leakage in the 1990s or of persistent knowledge spillovers between state-owned research institutions and KIBS firms. Having in mind significant decrease in research activity after the demise of the Soviet Union, the former seems more plausible. I perform a placebo test substituting 1991 number of researchers with 2011 one in the regressions, assuming that people who left science for KIBS in early 1990s are not counted in 2011, and the effect is expected to attenuate if one-shot employment leakage drives the correlation.

DATA AND VARIABLES

In this paper, I use region-level data, the only spatially disaggregated data available in Russia for this question. The baseline sample includes 75 regions. Data are obtained mostly from official statistical yearbooks. Greater detail about data collection is available in the Appendix.

Descriptive statistics are shown in table 1. One can note that there is significant variation across regions in number of employees in R&D in 1991 and in knowledge-intensive business services even after taking logs. Also, there is great heterogeneity in terms of urbanization, human capital and economic development (proxied by electricity consumption in 1991). The distribution of life expectancy and infant mortality is more equal across regions, because the Soviet government did impressive work to provide essential health services and hygiene education in the whole country, including underdeveloped and remote parts of the USSR.

In the baseline specifications, the dependent variables are 2011 employment in three two -digit industries defined by statistical classification (OKVED): Engineering and architecture (74.20.1), Information technology and computer-related services (72), Law, accounting, auditing and management consulting (74.1). These industries are of comparable size, each employing about 300-400 thousand people nationwide. In several specifications, mean monthly salary is also used as a dependent variable.

In addition to employment and salaries, I use the 2011 number of microenterprises in the business service sector as another measure of entrepreneurial activity. A microenterprise is defined by the Russian statistical service as a firm with the number of employees not exceeding 15, sales per year not greater than 60 million rubles (equivalent to 2 million USD in 2011), and the stake of the government, non-profit organizations, foreign entities and persons not exceeding 25 per cent. Because data on the number of microenterprises by region is only available by one-digit industry codes, I am restricted to the "Real estate, leasing and services" industry. This statistical code includes the majority of knowledge-intensive business services, but not retail and wholesale trade, catering, transportation services and other tertiary industries employing mainly low-skilled labor.

The number of R&D staff in 1991 by region is the main independent variable. Reflecting the traditions of the Soviet scientific community, these data, published by the government statistical service, do not include university lecturers but do cover those who performed research tasks on campus, as well as employees of the state Academies, other independent research establishments and enterprise R&D departments.[14]

Prior to estimating baseline models, I conduct a balancing test with various variables from the pre-transition period (see Table 2). Lack of market prices makes any indicators of monetary nature unreliable. Instead, I use a range of physical indicators. Electricity consumption is one indicator of economic activity. Other variables used in the balancing test reflect quality of living and public goods provision in a region; namely road and railway density, life expectancy, infant mortality, car ownership and number of theater visits. Due to the lack of Soviet-era data, I use fixed assets accumulated depreciation in 1997 as a relevant measure. Change in measurement year is unlikely to create significant distortions because there was very little investment in Russia during the 1990s.

[14] Data were obtained from the statistical yearbook published in 1999, long after the fall of communism, so they are unlikely to be affected by the Soviet policy of censoring information on military-related research.

Regressions of present-day KIBS on 1991 R&D staff were run controlling for the main potential co-determinants of KIBS location. Following Joshua D. Angrist and Jörn-Steffen Pischke (2008, p. 47-51), in the baseline specification a variety of late Soviet, i.e. pre-treatment control variables, are used. The number of college-educated persons in a region from 1989 census and the number of fresh university graduates in 1990 were used as a proxy for the strength of the regional university system and regional human capital.

The relationship between the thickness of local market and demand for business services is well established. Greater market size promotes division of labor and contracting-out.[15] Electricity consumption and total employment in 1991 are used here as a proxy for economic development and market size.

There is also rich evidence that large cities are popular KIBS locations (Bennett et al. 1999; Keeble and Nachum 2002; Shearmur and Doloreux 2008; Kolko 2010). Due to ilocation factors like proximity to clients and suppliers, labor pooling, transport accessibility as well as localized knowledge spillovers and availability of tacit knowledge (Howells 2002; Keeble and Nachum 2002; Muller and Doloreux 2009).

Region-level urbanization is controlled for using a constructed urbanization index. Formally, this is as follows:

$URBINDEX_i = \sum S_{ij} P_j$

Where:

S_{ij} – share of settlement j in region i's aggregate population

P_j – population of settlement j

This index is preferred to the simple urbanization rate (share of people who reside in cities and towns) because the latter does not distinguish between the concentration of people in a few large cities and dispersed urbanization patterns. The urbanization index is calculated with

[15] The theoretical foundation has been provided by Joseph F. Francois (1990), and empirical evidence has been studied by Yukako Ono (2007) and Liza Jabbour (2013).

city- or town-level data from 1989 census. In addition, I control for regional population density in all specifications given the major population differences across Russian regions.

All the specifications include dummies for eight federal districts: groups of contiguous regions with similar geography, including one specially designated district for the North Caucasus republics.

EMPIRICAL RESULTS

Balancing test

Table 2 presents the results for the balancing test of various economic development measures in the late Soviet era on the 1991 number of R&D personnel (log-log specifications). The logarithm of total employment was controlled for to remove the region size effect and to make the specification more flexible. In even-numbered columns, I control for logarithms of urbanization index and population density. In addition, the federal districts dummies were included. As noted earlier, I do not tackle causality issues when running these regressions. Instead, I simply attempt to ascertain whether Soviet-era R&D institutions were located in more developed or favored by the government regions.

Most coefficients in table 2 are small in magnitude and insignificant, especially when controlling for the urbanization index and population density. Correlation is often negative, as for electricity consumption, road and railroad density, life expectancy. These results support the view that it is unlikely that regions with a greater size of R&D sector near the end of the Soviet era could have greater potential demand for KIBS.

This result superficially contradicts anecdotes of the high quality, by the Soviet standard, of life in the closed towns. However, privileges of the scientific enclaves were a consequence not cause of their research functions. Isolated and often relatively small, these settlements could rely on regional authorities for pubic goods provision and had little contacts with neighboring places. Therefore, their local economic impact was limited. In addition, closed towns constituted only a fraction of the Soviet R&D sector. In larger cities with diversified economies, the share of researchers in the population was typically small, and the scientific community had no major influence on governance.

It is beyond the scope of this research to explain the lack of correlation between the R&D employment and the basic socio-economic variables in the last years of the Soviet Union. However, I raise the suggestion that the scientific sector was unable to generate significant spillovers to regions' economies because of centralized decision-making and funds allocation, military dominance over the research agenda and weak incentives to innovate in civil industries. Soviet people also could not move freely to any location with better quality of living because of mobility restrictions imposed in many large cities (Gang and Stuart 1999).

Baseline regressions

Table 3 reports the results from regressions of 2011 engineering and architecture employment on 1991 R&D workforce with a number of controls described above, when natural logarithm of both left-hand and right-hand variables is taken. The variables are used in two different functional forms: as log absolute numbers or as log shares in total employment.

The 1991 R&D employment has a statistically and economically significant effect on the present-day number of employees in engineering and architecture: a 10-percent change in 1991 number of R&D staff is associated with 3-percent change in current number of workers in engineering and architecture (column 1) The result is robust to the elimination of Moscow and St. Petersburg, the two most important and privileged Russian cities in column (2). Similarly, the result holds (and becomes even stronger) when the lowest quartile of urbanization index is dropped, as in columns (3). In column (4), logs of urbanization index and population density are substituted with third-order polynomials of the transformed variables without logarithmic transformation. The result remains generally the same.[16]

[16] The coefficient is reduced to 0.24, p-value decreases to 0.087 in the log absolute numbers model, but the estimates of the effect are more stable in the log shares of total employment.

In the next four columns I run regressions with the same variables used in "log shares of total employment" form,[17] applying the same robustness checks as in the columns (1)-(4). A relative change in share of R&D employment in 1991 by 10 percent leads to 3.85-4 percent relative change in 2011 workforce share of engineering and architecture[18].

Results for information technology are given in table 4. The effect is not so strong for the full sample: a 10 percent change in number of Soviet-era researchers is associated with 1.66 percent change in IT workforce today (column 1). The size of the respective effect in the log shares in employment specification is 1.87 percent (column 5). [19] Introducing polynomials of the urbanization index and population density into the regression brings little change (columns 4 and 8).

With the exclusion of the two largest cities and the lowest quartile of the urbanization index, the 1991 number of R&D personnel becomes a significant predictor of present-day IT employment. The size of the effect per 10 percent change is 2-2.6 percent both in the log absolute numbers (column 2) and the log shares in employment (column 6) specifications. Soviet-era human capital endowments, therefore, appear able to explain differences in IT sector development within the main body of Russian regions, but not in outliers, big and small. The smaller size of effect on IT may also reflect the fact that information technology has progressed very quickly and has become ubiquitous since the early 1990s, thus facilitating a "dissipation" of the path-dependence.

Strikingly different are the results for law, accounting, auditing and management consulting (table 5). The coefficient on 1991 R&D employment is much smaller in magnitude when compared to IT and engineering, a less than 1 percent relative change of the dependent

[17] I leave unscaled by employment only population density and urbanization index.

[18] Not to be confused to percentage points, which are considered in the regressions without log-log transformation in Table 7.

[19] *p*-value of the coefficient of interest is teetering around 0.10.

variable per 10 percent change of 1991 number of R&D staff in all the specifications, and is statistically insignificant. This is an important placebo test, since law, accounting and similar industries are close to engineering and IT in many dimensions, but not in the possibility of direct transmission of Soviet-era skills and competencies. Therefore, it is unlikely that 1991 R&D personnel actually stand for some omitted variable determining regions' attractiveness for KIBS location.

In table 6, results using log number of business services microenterprises are listed. The effect of 1991 R&D personnel is sizeable, equaling about 2.5 percent per 10 percent change of the independent variable. It is statistically significant and stable across specifications.[20] These results corroborate the view that launching startups was an important mechanism by which former researchers adapted to new circumstances.

In each of these specifications, I use log-log models exclusively. To test for sensitivity of the results to specification change, shares of total employment regression without logarithmic transformation were run (table 7). The results from these specifications are qualitatively the same as from log-log models, with positive and significant effect for engineering and IT, and zero effect for auditing, accounting and management consulting. Interpreted in terms of standard deviations, one standard deviation change in the 1991 employment share of R&D activities is associated with 0.3-0.4 standard deviation change in present-day employment share of engineering or IT.

Channels of influence

The possibility exists that the observed results are driven by current, not pre-transition knowledge spillovers between research institutions and KIBS. To check for this, I run the same regressions substituting the 2011 number of R&D staff for the 1991 number. As argued above,

[20] Results of additional specifications involving number of microenterprises in business service sector, with both right-hand side and left-hand side variables standardized by total regional employment, are generally the same and available by request.

the 2011 variable measures mostly employment remaining in research institutions inherited from the Soviet era. If an employment leakage occurred, one should expect attenuation of the effect when newer data on R&D personnel are used (since many researchers left the R&D sector for KIBS, and there are presumably smaller spillovers from present-day R&D sector to the rest of economy). This is exactly what is shown in table 8: the coefficients are mostly statistically insignificant or marginally significant, and smaller in magnitude when compared to those in tables 3 and 4. This result is not surprising, given that the research capabilities of contemporary state-owned scientific institutions are reduced relative to the Soviet era.

In table 9, I give the results of regressing log mean salaries by region on log 1991 number of R&D personnel (or log 1991 share of researchers in regional employment) with the same set of control variables. I find no significant association between salaries and late Soviet R&D employment. This suggests that regional labor markets in these industries are integrated, factors prices are equalized, and poverty trap is unlikely to cause the observed persistence.

Human capital externalities in these cases are not manifested in higher wages in regions with greater R&D endowments. Nevertheless, this explanation is consistent with increased number of business services microenterprises in those regions, which signalize vigorous exchange in ideas and ability of KIBS professionals to engage in collaborative undertakings.

CONCLUSIONS

This paper examines whether Soviet-era patterns of R&D-sector location influenced the modern-day location of knowledge-intensive business services. Under the central planning, decisions on research institutions location were made in a manner exogenous to the market, thus creating a natural experiment. My paper shows that the 1991 R&D employment by region was not significantly associated with several important contemporaneous indicators of economic development and public goods provision, especially when controlling for urbanization and population density.

During the transition, there were severe spending cuts in academia and the R&D sector, which forced many people to move to industry. Ex-researchers may have bridged the shortage of skilled professionals in the service sector due to their high human and social capital. Did this, however, mean that regions where greater number of researchers were gathered under the Soviet rule do better in the development of knowledge-intensive business services during the ensuing decades? The results show the sizeable effect on employment in engineering and architecture as well as in information technology: according to most specifications, 10 percent relative change in 1991 R&D employment is associated with 2-4 percent change in contemporary employment in the respective industries. At the same time, there is no significant effect for employment in law, accounting, auditing and management consulting. The 2011 number of R&D staff (mostly in legacy state-owned institutions) is also unable to explain contemporary location of knowledge-intensive business services. Therefore, it is likely that the present-day spatial pattern of this sector has been influenced by the one-shot employment leakage from state-owned R&D sector, not by persistent knowledge spillovers between the two sectors.

Two possible explanations for this path-dependence were initially envisioned. Firstly, it might be the case that former researchers were stuck in their initial locations due to poverty traps and labor market imperfections. Alternatively, high concentration of skilled workers in a region might cause human capital externalities. Regions with greater 1991 R&D-related employment do not have lesser mean salaries in KIBS now, so it is unlikely that labor market distortions due to central planning locked former researchers in poverty traps. The number of microenterprises is also greater in those regions in which more people involved in R&D were gathered under the Soviet rule. This is suggestive that exchange in ideas and extensive social ties among former researchers helped some of them to start business in the knowledge-intensive industries in the original locations, and generated human capital externalities sufficient to impose path-dependence in KIBS location during the transition.

In a broader framework, the results do not necessarily imply that the Soviet-era policy of R&D sector placement were effective in long run. Indeed, the present-day location pattern of KIBS might still bear the imprint of earlier suboptimal decisions due to the path-dependence mechanism. Rather the findings imply that human capital relocation is able to result some kind of spatial QWERTY effect, making arbitrary policy interventions sustainable.

APPENDIX
SAMPLE CONSTRUCTION AND DATA COLLECTION

As of 2011, the Russian Federation has consisted of 80 full-fledged regions. In addition, Khanty-Mansi and Yamalo-Nenets Autonomous Okrugs have been included into Tyumen Oblast, and Nenets Autonomous Okrug has been included into Arkhangelsk Oblast (Tyumen and Arkhangelsk Oblasts are known colloquially as *matryoshka* regions).

Several observations are dropped due to data availability and reliability concerns: war-torn Chechnya and Ingushetia, which is common practice in Russian regional studies, as well as small and peripheral Chukotka Autonomous Okrug and Jewish Autonomous Oblast, which have data on the key variables missing. None of these regions has distinct specialisation in KIBS.

In addition, Leningrad Oblast is not included in the sample because it had zero fresh university graduates in 1990; therefore, it would be impossible to run log-log regressions with this important control variable if Leningrad Oblast was included. This region, comprising rural areas around St. Petersburg, had no universities on its own territory in 1990, relying instead on superior higher education institutions in St. Petersburg, thus formally outside the oblast. This is atypical among Russian regions, which usually have universities clustered in their regional centers. Therefore, dropping Leningrad Oblast makes the sample more homogenous.

Information on data sources is provided in table A1.

REFERENCES

Acemoglu, Daron, and Joshua Angrist. "How Large Are Human-Capital Externalities? Evidence from Compulsory-Schooling Laws." In NBER Macroeconomics Annual 2000, Volume 15, pp. 9-74. MIT PRess, 2001.

Acs, Zoltan J., and Catherine Armington. "The Impact of Geographic Differences in Human Capital on Service Firm Formation Rates." Journal of Urban Economics 56, no. 2 (2004): 244-278.

Andersson, Roland, John M. Quigley, and Mats Wilhelmson. "University decentralization as regional policy: The Swedish experiment." Journal of Economic Geography 4, no. 4 (2004): 371-388.

Angrist, Joshua D., and Jörn-Steffen Pischke. Mostly Harmless Econometrics: An Empiricist's Companion. Princeton University Press, 2008.

Belousova, Yu.V., N.V. Gorodnikova, L.M., Gokhberg et al. Indikatory nauki: 2013. Staisticheskiy sbornik. (Indicators of Science: 2013. Statistical Yearbook). Moscow: National Research University Higher School of Economics, 2013.

Bennett, Robert J., Daniel J. Graham, and William Bratton. "The Location and Concentration of Businesses in Britain: Business Clusters, Business Services, Market Coverage and Local Economic Development." Transactions of the Institute of British Geographers 24, no. 4 (1999): 393-420.

Bleakley, Hoyt, and Jeffrey Lin. "Portage and Path Dependence." The Quarterly Journal of Economics 127, no. 2 (2012): 587-644.

Bradshaw, Michael. "The Geography of Russia's New Political Economy." New Political Economy 13, no. 2 (2008): 193-201.

Brakman, Steven, Harry Garretsen, and Marc Schramm. "The Strategic Bombing of German Cities during World War II and Its Impact on City Growth." Journal of Economic Geography 4, no. 2 (2004): 201-218.

Cantoni, Davide, and Noam Yuchtman. "Medieval Universities, Legal Institutions, and the Commercial Revolution." The Quarterly Journal of Economics 129, no. 2 (2014): 823-887.

Crafts, N.F.R, and Nikolaus Wolf. "The Location of the British Cotton Textiles Industry in 1838: A Quantitative Analysis." The Journal of Economic History 74, no. 4 (2014): 1103-1139.

Davis, Donald R., and David Weinstein. "Bones, Bombs, and Break Points: The Geography of Economic Activity." American Economic Review 92, no. 5 (2002): 1269-1289.

Davis, Donald R., and David E. Weinstein. "A Search for Multiple Equilibria in Urban Industrial Structure." Journal of Regional Science 48, no. 1 (2008): 29-65.

Falck, Oliver, Michael Fritsch, and Stephan Heblich. "Is Industry Location Persistent over Time? Evidence from Coagglomeration Patterns between New and Incumbent Firms in Germany." Review of Regional Research 34, no. 1 (2014): 1-21.

Francois, Joseph F. "Producer Services, Scale, and the Division of Labor." Oxford Economic Papers 72, no.4 (1990): 715-729.

Freeman, Chris. "The 'National System of Innovation' in Historical Perspective." Cambridge Journal of Economics 19, no. 1 (1995): 5-24.

Fu, Shihe. "Smart café cities: Testing human capital externalities in the Boston metropolitan area." Journal of Urban Economics 61, no. 1 (2007): 86-111.

Fujita, Masahisa, and Jacques-François Thisse. "Economics of agglomeration." Journal of the Japanese and International Economies 10, no. 4 (1996): 339-378.

Fujita, Masahisa, Paul R. Krugman, and Anthony Venables. The spatial economy: Cities, regions, and international trade. MIT press, 2001.

Gaddy, Clifford G., and Barry W. Ickes. "Resource Rents and the Russian Rconomy." Eurasian Geography and Economics 46, no. 8 (2005): 559-583.

Gang, Ira N., and Robert C. Stuart. "Mobility where mobility is illegal: Internal migration and city growth in the Soviet Union." Journal of Population Economics12, no. 1 (1999): 117-134.

Guriev, Sergei, and Elena Vakulenko. "Breaking out of poverty traps: Internal migration and interregional convergence in Russia." Journal of Comparative Economics (2015).

Hausman, Naomi. "University Innovation, Local Economic Growth, and Entrepreneurship." US Census Bureau Center for Economic Studies Paper No. CES-WP-12-10 (2012).

Hill, Fiona, and Clifford G. Gaddy. The Siberian Curse: How Communist Planners Left Russia Out in the Cold. Brookings Institution Press, 2003.

Howells, Jeremy R.L. "Tacit Knowledge, Innovation and Economic Geography." Urban Studies 39, no. 5-6 (2002): 871-884.

Jabbour, Liza. "Market Thickness, Sunk Costs, Productivity, and the Outsourcing Decision: An Empirical Analysis of Manufacturing Firms in France." Canadian Journal of Economics/Revue canadienne d'économique 46, no. 1 (2013): 103-134.

Jaffe, Adam B., Manuel Trajtenberg, and Rebecca Henderson. "Geographic Localization of Knowledge Spillovers as Evidenced by Patent Citations." The Quarterly Journal of Economics 108, no. 3 (1993): 577-598.

Keeble, David, and Lilach Nachum. "Why Do Business Service Firms Cluster? Small Consultancies, Clustering and Decentralization in London and Southern England." Transactions of the Institute of British Geographers 27, no. 1 (2002): 67-90.

Kolko, Jed. "Urbanization, Agglomeration, and Coagglomeration of Service Industries." In Agglomeration Economics, pp. 151-180. University of Chicago Press, 2010.

Krugman, Paul. "Increasing Returns and Economic Geography." The Journal of Political Economy 99, no. 3 (1991): 483-499.

Kryshtanovskaya, Olga. Anatomiya rossiyskoy elity (The Anatomy of Russian Elite). Moscow: Zakharov, 2005.

Kumo, Kazuhiro. "Soviet Industrial Location: A Re-Examination." Europe-Asia Studies 56, no. 4 (2004): 595-613.

Lucas, Robert E. “On the Mechanics of Economic Development.” Journal of Monetary Economics 22, no.1 (1988): 3-42.

Markevich, Andrei, and Ekaterina Zhuravskaya. "M-Form Hierarchy with Poorly-Diversified Divisions: A Case of Khrushchev's Reform in Soviet Russia." Journal of Public Economics 95, no. 11 (2011): 1550-1560.

Meliciani, Valentina, and Maria Savona. "The Determinants of Regional Specialisation in Business Services: Agglomeration Economies, Vertical Linkages and Innovation." Journal of Economic Geography (2014): lbt038.

Mikhailova, Tatiana N. "Essays on Russian Economic Geography: Measuring Spatial Inefficiency." PhD diss., Pennsylvania State University, 2004.

_________. Gulag, WWII and the Long-run Patterns of Soviet City Growth. University Library of Munich, Germany, 2012.

Miguel, Edward, and Gerard Roland. "The Long-Run Impact of Bombing Vietnam." Journal of Development Economics 96, no. 1 (2011): 1-15.

Moretti, Enrico. "Estimating the Social Return to Higher Education: Evidence from Longitudinal and Repeated Cross-Sectional Data." Journal of Econometrics 121, no. 1 (2004): 175-212.

Muller, Emmanuel, and David Doloreux. "What We Should Know About Knowledge-Intensive Business Services." Technology in Society 31, no. 1 (2009): 64-72.

Ono, Yukako. "Market Thickness and Outsourcing Services." Regional Science and Urban Economics 37, no. 2 (2007): 220-238.

Osipov, Yuri. Akademiya nauk v istorii Rossiyskogo gosudarstva (Academy of Sciences in the History of the Russian State. Moscow: Nauka, 1999.

Radosevic, Slavo. "Patterns of Preservation, Restructuring and Survival: Science and Technology Policy in Russia in Post-Soviet Era." Research Policy 32, no. 6 (2003): 1105-1124.

Rauch, James E. "Productivity gains from geographic concentration of human capital: evidence from the cities." Journal of Urban Economics 34, no. 3 (1993): 380-400.

Redding, Stephen J., and Daniel M. Sturm. "The Costs of Remoteness: Evidence from German Division and Reunification." American Economic Review 98, no. 5 (2008): 1766-1797.

Redding, Stephen J., Daniel M. Sturm, and Nikolaus Wolf. "History and Industry Location: Evidence from German Airports." Review of Economics and Statistics 93, no. 3 (2011): 814-831.

Rodgers, Allan. "The Locational Dynamics of Soviet Industry." Annals of the Association of American Geographers 64, no. 2 (1974): 226-240.

Shearmur, Richard, and David Doloreux. "Urban Hierarchy or Local Buzz? High-Order Producer Service and (or) Knowledge-Intensive Business Service Location in Canada, 1991–2001." The Professional Geographer 60, no. 3 (2008): 333-355.

Shepotylo, Oleksandr. "Cities in Transition." Comparative Economic Studies 54, no. 3 (2012): 661-688.

Squicciarini, Mara, and Nico Voigtlaender. "Human Capital and Industrialization: Evidence from the Age of Enlightenment." NBER Working Paper w20219 (2014).

Vek Lavrent'eva (Lavrentyev's Age). Novosibirsk: Izdatel'stvo SO RAN, Filial V26 "Geo", 2000.

Venables, Anthony J. "Productivity in Cities: Self-selection and Sorting." Journal of Economic Geography 11, no 2 (2010): 241-251.

Yurevich, Andrei V. Umnye, no bednye: uchyonye v sovremennoy rossii (Smart but Poor: Scientists in Contemporary Russia). Moscow: Moskovskiy Obschestvennyy Nauchnyy Fond, 1998.

TABLE 1
DESCRIPTIVE STATISTICS

Variable	Obs.	Mean	Std. Dev.	Min	Max
ln Employment in engineering and architecture, 2011	75	7.34	1.37	3.58	11.24
ln Share of engineering and architecture in total employment, 2011	75	-6.01	0.73	-8.32	-4.40
ln Employment in information technology and computer-related services, 2011	75	7.46	1.22	4.44	11.41
ln Share of information technology and computer-related services in total employment, 2011	75	-5.90	0.57	-8.14	-4.27
ln Employment in law, accounting, auditing and management consulting, 2011	75	8.02	1.02	5.78	11.50
ln Share of law, accounting, auditing and management consulting in total employment, 2011	75	-5.34	0.41	-6.70	-4.18
ln Number of microenterprises in real estate, leasing and services, 2011	75	7.71	1.17	4.37	10.93
ln Mean salary in engineering and architecture, 2011	75	10.26	0.44	9.26	11.27
ln Mean salary in information technology and computer-related industries, 2011	75	9.96	0.38	8.59	10.91
ln R&D personnel, 1991	75	8.88	1.47	4.57	13.01
ln Share of R&D personnel in total employment, 1991	75	-4.62	0.86	-6.83	-2.26
ln Fresh university graduates, 1990	75	8.01	0.98	5.96	11.30
ln Ratio of fresh university graduates, 1990 to total emplloyment, 1991	75	-5.48	0.45	-6.74	-4.15
ln Population with tertiary degree, 1989	75	11.60	0.85	9.27	14.46
ln Share of population with tertiary degree, 1989	75	2.28	0.22	1.98	3.27
ln Electricity consumption, 1991	75	9.09	1.02	5.88	11.04
ln Electricity consumption per employee, 1991	75	-4.40	0.45	-5.53	-3.20
ln Total employment, 1991	75	13.49	0.77	11.41	15.45
ln Urbanization index, 1989	75	12.38	0.90	10.64	16.00
ln Population density, 1989	75	2.95	1.60	-1.04	9.00
ln R&D personnel, 2011	75	7.74	1.56	4.69	12.38
ln Share of R&D personnel in total employment, 2011	75	-5.62	0.99	-7.97	-3.31
ln Road density, 1991	72	3.96	1.28	0.18	5.72
ln Railroad density, 1991	68	4.73	1.09	-0.69	6.21
ln Car ownership per 1,000 inhabitants, 1991	75	4.09	0.27	3.45	4.65
ln Life expectancy, 1989/90	75	4.24	0.02	4.13	4.29
ln Infant moratlity, 1990	75	2.84	0.15	2.54	3.50
ln Theater visits per 1,000 inhabitants, 1990	75	5.71	0.44	4.77	7.10
ln Fixed assets accumulated depreciation, per cent, 1997	75	3.67	0.11	3.13	3.87

Sources: see Table A1

TABLE 2
BALANCING TEST

Dependent Variable	*ln* Electricity consumption, 1991		*ln* Road density, 1991		*ln* Railroad density, 1991		*ln* Car ownership per 1,000 inhabitants, 1991		*ln* Life expectancy, 1989/90		*ln* Infant moratlity, 1990		*ln* Theater visits per 1,000 inhabitants, 1990		*ln* Fixed assets accumulated depreciation, per cent, 1997	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
ln R&D personnel, 1991	-0.0929	-0.00808	0.0902	-0.0601	-0.00974	-0.199	0.0374	0.0289	-0.00209	-0.00566*	-0.0265	-0.0245	0.265***	0.0953	0.0230	0.0175
	(0.0924)	(0.107)	(0.142)	(0.0718)	(0.171)	(0.126)	(0.0556)	(0.0630)	(0.00253)	(0.00299)	(0.0269)	(0.0294)	(0.0864)	(0.0922)	(0.0233)	(0.0268)
ln Total employment, 1991	1.334***	1.322***	-0.0989	-0.155	0.194	0.284*	-0.0157	-0.0111	0.0111*	0.0111*	0.0126	0.0132	-0.380**	-0.378**	0.0222	0.0217
	(0.162)	(0.161)	(0.285)	(0.129)	(0.349)	(0.157)	(0.102)	(0.0993)	(0.00647)	(0.00629)	(0.0562)	(0.0564)	(0.168)	(0.143)	(0.0408)	(0.0405)
ln Urbanization index, 1989		0.00906		-0.0832		-0.0314		-0.0515		0.00642*		-0.0132		0.288***		0.0183
		(0.0727)		(0.0985)		(0.171)		(0.0544)		(0.00330)		(0.0266)		(0.108)		(0.0211)
ln Population density, 1989		-0.167***		0.970***		0.969***		0.0636**		0.000707		0.00855		0.0491		-0.00655
		(0.0511)		(0.0686)		(0.114)		(0.0275)		(0.00134)		(0.0167)		(0.0482)		(0.0140)
Federal district dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	75	75	72	72	68	68	75	75	75	75	75	75	75	75	75	75
R-squared	0.867	0.893	0.614	0.939	0.378	0.838	0.301	0.345	0.622	0.654	0.359	0.362	0.232	0.394	0.430	0.435

*= Significance at 10 percent level
**= Significance at 5 percent level
***= Significance at 1 percent level
Notes: Robust standard errors in parentheses. Due to data limitations, Moscow, Moscow oblast, St Petersburg and Leningrad oblast are dropped in columns (3)-(6).
Sources: see Table A1

TABLE 3
EMPLOYMENT IN ENGINEERING AND ARCHITECTURE

	ln Employment in engineering and architecture, 2011					*ln* Share of engineering and architecture in total employment, 2011			
	(1)	(2)	(3)	(4)		(5)	(6)	(7)	(8)
ln R&D personnel, 1991	0.306**	0.307**	0.392***	0.239*	*ln* Share of R&D personnel in total employment, 1991	0.403***	0.420***	0.411***	0.385***
	(0.122)	(0.138)	(0.120)	(0.137)		(0.115)	(0.141)	(0.120)	(0.137)
ln Fresh university graduates, 1990	0.815***	0.859***	0.824***	0.825***	*ln* Ratio of fresh university graduates, 1990 to total employment, 1991	0.742***	0.779***	0.828***	0.745***
	(0.209)	(0.210)	(0.192)	(0.245)		(0.187)	(0.187)	(0.199)	(0.213)
ln Population with tertiary degree, 1989	-0.209	0.292	-0.280	-0.155	*ln* Share of population with tertiary degree, 1989	-0.693	-0.464	-0.409	-1.007*
	(0.493)	(0.786)	(0.655)	(0.751)		(0.429)	(0.647)	(0.582)	(0.599)
ln Electricity consumption, 1991	0.326**	0.280*	0.417**	0.301	*ln* Electricity consumption per employee, 1991	0.367**	0.351**	0.410**	0.395**
	(0.145)	(0.161)	(0.176)	(0.185)		(0.140)	(0.148)	(0.171)	(0.158)
ln Total employment, 1991	-0.0433	-0.427	-0.262	-0.0193	*ln* Total employment, 1991	0.0969	0.169	0.0431	0.0725
	(0.464)	(0.608)	(0.531)	(0.616)		(0.129)	(0.159)	(0.158)	(0.152)
ln Urbanisation index, 1989	-0.182	-0.320*	-0.145		*ln* Urbanisation index, 1989	-0.150	-0.266*	-0.152	
	(0.122)	(0.186)	(0.168)			(0.112)	(0.153)	(0.162)	
ln Population density, 1989	0.150	0.194*	0.137		*ln* Population density, 1989	0.149*	0.176**	0.126	
	(0.0951)	(0.102)	(0.0940)			(0.0808)	(0.0830)	(0.0794)	
Urbannization index and population density third-order polynomial				Yes	Urbannization index and population density third-order polynomial				Yes
Federal district dummies	Yes	Yes	Yes	Yes	Federal district dummies	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Constant	Yes	Yes	Yes	Yes
Observations	75	72	57	75	Observations	75	72	57	75
R-squared	0.877	0.853	0.890	0.877	*R*-squared	0.662	0.622	0.720	0.669

*= Significance at 10 percent level
**= Significance at 5 percent level
***= Significance at 1 percent level
Notes: Robust standard errors in parentheses. In columns (2) and (6), Moscow, Saint Petersubrg and Moscow Oblast are dropped. In columns (3) and (7), the lowest quartile of urbaization index is dropped
Sources: see Table A1

TABLE 4
EMPLOYMENT IN INFORMATION TECHNOLOGY

	ln Employment in information technology and computer-related services, 2011					*ln* Share of information technology and computer-related services in total employment, 2011			
	(1)	(2)	(3)	(4)		(5)	(6)	(7)	(8)
ln R&D personnel, 1991	0.166	0.222**	0.200**	0.172	*ln* Share of R&D personnel in total employment, 1991	0.187*	0.260**	0.207**	0.214*
	(0.0996)	(0.104)	(0.0849)	(0.106)		(0.105)	(0.116)	(0.0909)	(0.119)
ln Fresh university graduates, 1990	-0.00447	-0.00261	-0.148	-0.0231	*ln* Ratio of fresh university graduates, 1990 to total emplloyment, 1991	-0.0921	-0.0871	-0.143	-0.104
	(0.155)	(0.160)	(0.165)	(0.158)		(0.149)	(0.154)	(0.174)	(0.151)
ln Population with tertiary degree, 1989	0.465*	0.258	0.380	0.208	*ln* Share of population with tertiary degree, 1989	0.526*	0.172	0.362	0.108
	(0.248)	(0.323)	(0.306)	(0.309)		(0.280)	(0.330)	(0.244)	(0.334)
ln Electricity consumption, 1991	0.289**	0.331**	0.363**	0.375***	*ln* Electricity consumption per employee, 1991	0.309**	0.354**	0.339**	0.402***
	(0.141)	(0.139)	(0.144)	(0.140)		(0.137)	(0.138)	(0.155)	(0.137)
ln Total employment, 1991	0.125	0.240	0.154	0.294	*ln* Total employment, 1991	-0.0258	-0.0199	-0.0968	-0.0402
	(0.335)	(0.387)	(0.389)	(0.369)		(0.119)	(0.140)	(0.136)	(0.136)
ln Urbanisation index, 1989	0.138	0.0446	0.332**		*ln* Urbanisation index, 1989	0.125	0.0431	0.292**	
	(0.0888)	(0.132)	(0.135)			(0.0908)	(0.130)	(0.127)	
ln Population density, 1989	0.0444	0.0156	0.0430		*ln* Population density, 1989	0.0341	0.00531	0.0361	
	(0.0540)	(0.0571)	(0.0728)			(0.0524)	(0.0557)	(0.0760)	
Urbannization index and population density third-order polynomial				Yes	Urbannization index and population density third-order polynomial				Yes
Federal district dummies	Yes	Yes	Yes	Yes	Federal district dummies	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Constant	Yes	Yes	Yes	Yes
Observations	75	72	57	75	Observations	75	72	57	75
R-squared	0.917	0.898	0.915	0.926	*R*-squared	0.646	0.587	0.709	0.683

*= Significance at 10 percent level
**= Significance at 5 percent level
***= Significance at 1 percent level
Notes: Robust standard errors in parentheses. In columns (2) and (6), Moscow, Saint Petersubrg and Moscow Oblast are dropped. In columns (3) and (7), the lowest quartile of urnaization index is dropped
Sources: see Table A1

TABLE 5
EMPLOYMENT IN LAW, ACCOUNTING, AUDITING AND MANAGEMENT CONSULTING

	ln Employment in law, accounting, auditing and management consulting, 2011					*ln* Share of law, accounting, auditing and management consulting in total employment, 2011			
	(1)	(2)	(3)	(4)		(5)	(6)	(7)	(8)
ln R&D personnel, 1991	0.00740	0.0681	-0.0125	0.0217	*ln* Share of R&D personnel in total employment, 1991	0.0318	0.117	0.00592	0.0710
	(0.0893)	(0.0893)	(0.0890)	(0.0953)		(0.0863)	(0.0941)	(0.0718)	(0.0956)
ln Fresh university graduates, 1990	0.102	0.103	0.0941	0.0530	*ln* Ratio of fresh university graduates, 1990 to total emplloyment, 1991	0.0171	0.0207	0.0976	-0.0328
	(0.150)	(0.152)	(0.171)	(0.154)		(0.126)	(0.127)	(0.141)	(0.128)
ln Population with tertiary degree, 1989	0.497	0.291	0.587	0.0393	*ln* Share of population with tertiary degree, 1989	0.522	0.0860	0.440	-0.105
	(0.311)	(0.420)	(0.375)	(0.348)		(0.315)	(0.395)	(0.286)	(0.314)
ln Electricity consumption, 1991	-0.0546	-0.00837	0.153	0.0620	*ln* Electricity consumption per employee, 1991	-0.0308	0.0244	0.135	0.0969
	(0.162)	(0.159)	(0.171)	(0.166)		(0.147)	(0.143)	(0.149)	(0.149)
ln Total employment, 1991	0.565	0.681*	0.313	0.874**	*ln* Total employment, 1991	0.0480	0.0525	0.0745	-0.0216
	(0.355)	(0.374)	(0.388)	(0.376)		(0.102)	(0.124)	(0.125)	(0.109)
ln Urbanisation index, 1989	0.0353	-0.0802	0.0888		*ln* Urbanisation index, 1989	0.0224	-0.0709	0.0651	
	(0.0948)	(0.132)	(0.189)			(0.0847)	(0.115)	(0.165)	
ln Population density, 1989	0.00879	-0.0253	0.0329		*ln* Population density, 1989	0.00153	-0.0353	0.0319	
	(0.0551)	(0.0656)	(0.0777)			(0.0490)	(0.0605)	(0.0670)	
Urbannization index and population density third-order polynomial				Yes	Urbannization index and population density third-order polynomial				Yes
Federal district dummies	Yes	Yes	Yes	Yes	Federal district dummies	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Constant	Yes	Yes	Yes	Yes
Observations	75	72	57	75	Observations	75	72	57	75
R-squared	0.883	0.855	0.879	0.898	*R*-squared	0.404	0.340	0.548	0.482

*= Significance at 10 percent level
**= Significance at 5 percent level
***= Significance at 1 percent level
Notes: Robust standard errors in parentheses. In columns (2) and (6), Moscow, Saint Petersubrg and Moscow Oblast are dropped. In columns (3) and (7), the lowest quartile of urbnaization index is dropped.
Sources: see Table A1

TABLE 6
BUSINESS SERVICES MICROENTERPRISES

	ln Number of microenterprises in real estate, rental and services, 2011			
Dependent variable	(1)	(2)	(3)	(4)
ln R&D personnel, 1991	0.253***	0.244**	0.314***	0.227**
	(0.0869)	(0.0965)	(0.0792)	(0.101)
ln Fresh university graduates, 1990	0.111	0.130	0.184	0.114
	(0.163)	(0.164)	(0.161)	(0.163)
ln Population with tertiary degree, 1989	0.223	0.484	0.209	0.191
	(0.316)	(0.472)	(0.372)	(0.388)
ln Electricity consumption, 1991	0.105	0.0783	0.127	0.104
	(0.155)	(0.157)	(0.167)	(0.164)
ln Total employment, 1991	0.433	0.243	0.213	0.477
	(0.380)	(0.431)	(0.398)	(0.417)
ln Urbanisation index, 1989	-0.0497	-0.102	-0.0688	
	(0.0850)	(0.130)	(0.128)	
ln Population density, 1989	0.0882*	0.111	0.0636	
	(0.0519)	(0.0664)	(0.0601)	
Urbannization index and population density third-order polynomial				Yes
Federal district dummies	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes
Observations	75	72	57	75
R-squared	0.918	0.897	0.910	0.920

*= Significance at 10 percent level
**= Significance at 5 percent level
***= Significance at 1 percent level
Notes: Robust standard errors in parentheses. In column (2), Moscow, Saint Petersubrg and Moscow Oblast are dropped. In column (3), lowest quartile of urnaization index is dropped
Sources: see Table A1

TABLE 7
NON LOG-TRANSFORMED SHARES IN EMPLOYMENT

	Share of engineering and architecture in total employment, 2011		Share of information technology and computer-related services in total employment, 2011		Share of law, accounting, auditing and management consulting in total employment, 2011	
	(1)	(2)	(3)	(4)	(5)	(6)
Share of R&D personnel in total employment, 1991	0.0499**	0.0503**	0.0433***	0.0449***	0.00653	0.0171
	(0.0202)	(0.0206)	(0.0159)	(0.0163)	(0.0234)	(0.0241)
Ratio of fresh university graduates, 1990 to total emplloyment, 1991	0.416***	0.416***	-0.0725	-0.0809	-0.00795	-0.0216
	(0.0755)	(0.0739)	(0.0867)	(0.0874)	(0.134)	(0.121)
Share of population with tertiary degree, 1989	-0.000228**	-0.000216*	-2.75e-05	-2.98e-05	-5.30e-05	-0.000170
	(0.000101)	(0.000124)	(8.99e-05)	(0.000115)	(0.000130)	(0.000173)
Electricity consumption per employee, 1991	0.0451*	0.0410	0.0486***	0.0388**	0.0343	0.0114
	(0.0244)	(0.0266)	(0.0174)	(0.0175)	(0.0375)	(0.0407)
Inverse total employment, 1991	-122.2	-151.4	7.149	-41.90	152.6	93.25
	(96.94)	(113.9)	(85.09)	(101.1)	(194.1)	(220.9)
Urbannization index and population density third-order polynomial	Yes	Yes	Yes	Yes	Yes	Yes
Federal district dummies	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes
Observations	75	72	75	72	75	72
R-squared	0.859	0.715	0.780	0.534	0.565	0.404

*= Significance at 10 percent level
**= Significance at 5 percent level
***= Significance at 1 percent level
Notes: Robust standard errors in parentheses. In the even-numbered columns, Moscow, Saint Petersubrg and Moscow Oblast are dropped.
Sources: see Table A1

TABLE 8

PLACEBO TEST: 2011 R&D PERSONNEL

	ln Employment in engineering and architecture, 2011	Ln Employment in information technology and computer-related services, 2011	*ln* Employment in law, accounting, auditing and management consulting, 2011	*ln* Number of microenterprises in real estate, rental and services, 2011		*ln* Share of engineering and architecture in total employment, 2011	*ln* Share of information technology and computer-related services in total employment, 2011	*ln* Share of law, accounting, auditing and management consulting in total employment, 2011
ln R&D personnel, 2011	0.0970	0.0948	0.0959*	0.111*	*ln* Share of R&D personnel in total employment, 2011	0.0941	0.0813	0.0744
	(0.0973)	(0.0574)	(0.0505)	(0.0598)		(0.0926)	(0.0582)	(0.0487)
ln Fresh university graduates, 1990	0.791***	-0.00823	0.121	0.0983	*ln* Ratio of fresh university graduates, 1990 to total emplloyment, 1991	0.715***	-0.0951	0.0319
	(0.214)	(0.157)	(0.147)	(0.169)		(0.195)	(0.150)	(0.126)
ln Population with tertiary degree, 1989	-0.0640	0.437	0.264	0.266	*ln* Share of population with tertiary degree, 1989	-0.339	0.590**	0.371
	(0.568)	(0.280)	(0.299)	(0.362)		(0.492)	(0.288)	(0.309)
ln Electricity consumption, 1991	0.374*	0.344**	0.0119	0.166	*ln* Electricity consumption per employee, 1991	0.402**	0.350**	0.0170
	(0.190)	(0.143)	(0.158)	(0.168)		(0.195)	(0.149)	(0.149)
ln Total employment, 1991	0.0320	0.169	0.574*	0.497	*ln* Total employment, 1991	0.168	-0.0114	0.0204
	(0.515)	(0.363)	(0.341)	(0.418)		(0.148)	(0.118)	(0.100)
ln Urbanisation index, 1989	-0.0850	0.182**	0.0181	0.0240	*ln* Urbanisation index, 1989	-0.0351	0.174*	0.0230
	(0.130)	(0.0814)	(0.0939)	(0.0828)		(0.122)	(0.0874)	(0.0848)
ln Population density, 1989	0.152	0.0540	0.0276	0.0961*	*ln* Population density, 1989	0.149	0.0405	0.0129
	(0.106)	(0.0567)	(0.0538)	(0.0541)		(0.0948)	(0.0556)	(0.0492)
Federal district dummies	Yes	Yes	Yes	Yes	Federal district dummies	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Constant	Yes	Yes	Yes
Observations	75	75	75	75	Observations	75	75	75
R-squared	0.868	0.916	0.887	0.912	*R*-squared	0.605	0.632	0.418

*= Significance at 10 percent level
**= Significance at 5 percent level
***= Significance at 1 percent level
Notes: Robust standard errors in parentheses. In columns (2) and (4), Moscow, Saint Petersubrg and Moscow Oblast are dropped.
Sources: see Table A1

TABLE 9
MEAN SALARY IN ENGINEERING AND IT

	ln Mean salary in engineering and architecture, 2011		*ln* Mean salary in information technology and computer-related industries, 2011	
	(1)	(2)	(3)	(4)
ln R&D personnel, 1991	0.0121	0.0198	0.0414	0.0802
	(0.0741)	(0.0832)	(0.0702)	(0.0686)
ln Fresh university graduates, 1990	-0.0952	-0.0950	-0.161	-0.178*
	(0.122)	(0.124)	(0.0964)	(0.0897)
ln Population with tertiary degree, 1989	0.528**	0.584	0.946***	0.608***
	(0.263)	(0.375)	(0.181)	(0.194)
ln Electricity consumption, 1991	0.0850	0.0907	0.0717	0.121
	(0.0925)	(0.0960)	(0.0966)	(0.0925)
ln Total employment, 1991	-0.271	-0.298	-0.762***	-0.530*
	(0.272)	(0.323)	(0.284)	(0.287)
ln Urbanisation index, 1989	-0.0213	-0.0933	0.00632	-0.0121
	(0.0668)	(0.111)	(0.0583)	(0.0811)
ln Population density, 1989	-0.0344	-0.0494	-0.0577	-0.0980**
	(0.0545)	(0.0565)	(0.0381)	(0.0381)
Federal district dummies	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes
Observations	75	72	75	72
R-squared	0.630	0.616	0.663	0.640

	ln Mean salary in engineering and architecture, 2011		*ln* Mean salary in information technology and computer-related industries, 2011	
	(5)	(6)	(7)	(8)
ln Share of R&D personnel in total employment, 1991	-0.00120	-0.00644	0.00725	0.0464
	(0.0767)	(0.0975)	(0.0677)	(0.0722)
ln Ratio of fresh university graduates, 1990 to total emplloyment, 1991	-0.0851	-0.0819	-0.148	-0.164*
	(0.125)	(0.127)	(0.0907)	(0.0884)
ln Share of population with tertiary degree, 1989	0.582**	0.675	1.128***	0.761***
	(0.277)	(0.477)	(0.174)	(0.244)
ln Electricity consumption per employee, 1991	0.0845	0.0806	0.0680	0.106
	(0.0920)	(0.0986)	(0.0916)	(0.0938)
ln Total employment, 1991	0.265***	0.303***	0.151**	0.109
	(0.0735)	(0.103)	(0.0670)	(0.0778)
ln Urbanisation index, 1989	-0.0381	-0.0868	-0.0280	-0.0101
	(0.0660)	(0.106)	(0.0519)	(0.0786)
ln Population density, 1989	-0.0251	-0.0295	-0.0447	-0.0765**
	(0.0522)	(0.0522)	(0.0356)	(0.0376)
Federal district dummies	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes
Observations	75	72	75	72
R-squared	0.633	0.614	0.694	0.642

*= Significance at 10 percent level
**= Significance at 5 percent level
***= Significance at 1 percent level
Notes: Robust standard errors in parentheses. In even-numbered columns, Moscow, Saint Petersubrg and Moscow Oblast are dropped.
Sources: see Table A1

TABLE A1
DATA SOURCES

Variable	Source
Employment in engineering and architecture, 2011	Edinaya Mezhvedomstvennaya Informatsionno-Statisticheskaya Sistema http://fedstat.ru/indicators/start.do
Employment in information technology and computer-related services, 2011	
Employment in law, accounting, auditing and management consulting, 2011	
Number of microenterprises in real estate, leasing and services, 2011	
Mean salary in engineering and architecture, 2011	Central'naya Baza Statisticheskikh Dannykh, Rosstat http://www.gks.ru/dbscripts/cbsd/
Mean salary in information technology and computer-related industries, 2011	
R&D personnel, 1991	Regiony Rossii, Vol. 2, Rosstat, 1999, pp. 718-719
Fresh university graduates, 1990	Obrazovaniye v Rossii. Rosstat, 2003, pp. 296, 298
Population with tertiary degree, 1989	Itogi Vsesoyuznoy perepisi naseleniya 1989 goda http://demoscope.ru/weekly/ssp/rus_edu_89.php
Electricity consumption, 1991	Elektrobalanc narodnogo khoziaystava (Electric balance of national economy), Rosstat, 1991
Total employment, 1991	Regiony Rossii, Vol. 2, Rosstat, 1999, pp. 76-77
Urbanization index, 1989	Itogi Vsesoyuznoy Perepisi Naseleniya 1989 Goga: Chislennost i Razmeshchenie Naseleniya SSSR. EastView Publications, 1992 (raw data on individual cities population)
Population density, 1989	Regiony Rossii. Sotsialno-Ekonomucheskie Pokazateli. Rosstat, 2012, pp. 54-55 (total population, then divided by region's area)
R&D personnel, 2011	Regiony Rossii. Sotsialno-Ekonomucheskie Pokazateli. Rosstat, 2012, pp. 780-781
Road density, 1991	Regiony Rossii, Vol. 2, Rosstat, 1999, pp. 594-595
Railroad density, 1991	Regiony Rossii, Vol. 2, Rosstat, 1999, pp. 592-593
Car ownership per 1,000 inhabitants, 1991	Regiony Rossii, Vol. 2, Rosstat, 1999, pp. 590-591
Life expectancy, 1989/90	Regiony Rossii, Vol. 2, Rosstat, 1999, pp. 58, 60
Infant moratlity, 1990	Regiony Rossii, Vol. 2, Rosstat, 1999, pp. 54-55
Theater visits per 1,000 inhabitants, 1990	Regiony Rossii, Vol. 2, Rosstat, 1999, pp. 244-245
Fixed assets accumulated depreciation, per cent, 1997	Regiony Rossii, Vol. 2, Rosstat, 1999, pp. 304-305

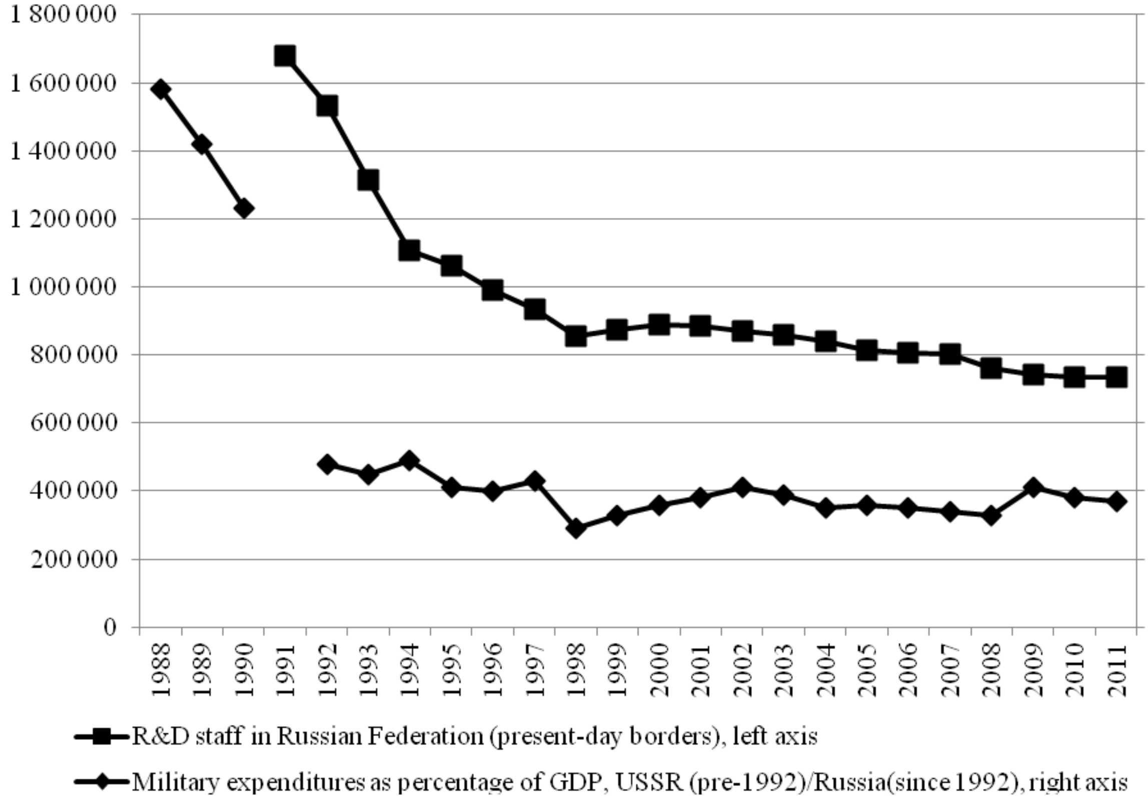

Fig. 1. Military expenditures and R&D staff dynamics in Russia.

Sources: SIPRI military expenditure database; Regiony Rossii, Vol. 2, Rosstat, 1999, pp. 718-719; Regiony Rossii. Sotsialno-Ekonomucheskie Pokazateli. Rosstat, 2012, pp. 780-781.