TRANSITION AND PATH-DEPENDENCE IN KNOWLEDGE-INTENSIVE INDUSTRY LOCATION: CASE OF RUSSIAN PROFESSIONAL SERVICES

Denis Ivanov[1]
Higher School of Economics

Abstract

I search for Soviet-era roots in the modern-day location pattern of professional services in Russia. Abolition of central planning provide us with the unique natural experiment: development of the market economy started while production factors were located under non-market reasons. Pre-existing spatial patterns of factors' location could be destructed or preserved depending on how market forces operated. I argue that R&D sector might be a pool of high-skilled workforce for professional services in the first years of the transition. I find that regions with more employment in academia at the end of the Soviet regime do better in the development of professional services two decades after. I emphasize human capital externalities as the explanation of path-dependence in knowledge-intensive industry location.

JEL codes: N74, R12.

[1] For correspondence: Denis Ivanov, Institute for Industrial and Market Studies, Higher School of Economics, 20 Myasnitskaya str., Moscow, 101000 Russian Federation. E-mail: d.s.ivanov@inbox.ru , dsivanov@hse.ru.

1. Introduction

One of the most intriguing questions of economic geography is whether industry location pattern is uniquely determined by some fundamental factors or there are numerous equilibria and spatial catastrophes can switch between them. Conventional view dates back to Krugman (1991) and emphasizes increasing returns due to spatial agglomeration of firms even when agglomeration is due to idiosyncratic reasons. To find such a reasons, economists turned to the study of exogenous shocks of non-economic nature.

A number of studies concluded that spatial distribution of population and of individual industries quickly recovers after short-term shocks like war-related destruction. Davis and Weinstein (2002) pioneered the field showing that Allied bombing of Japan proved impossible to change relative size of Japanese cities. In (Davis, Weinstein, 2008) similar results were obtained with data on city-level employment in aggregate manufacturing as well as individual industries. Other students came to similar conclusions with evidence from other countries which experienced war-related shocks: Germany (Brakman et al., 2004), Vietnam (Miguel and Roland, 2011) and Russia (Mikhailova, 2012).

These papers gave reasons to see locational patterns of industries and population as tremendously persistent and path-dependent: even nuclear bombings was unable to change spatial equilibrium in long-run. However, one can argue that war destruction was not a proper shock to test the hypothesis of path-dependence: people in cities devastated by bombing nevertheless could be sure that hostilities eventually would cease, dwellings they and their neighbors used to live in and factories they used to work at will be reconstructed in a relatively short time.

Another kind of empirical studies investigates consequences of long-term exogenous impacts and constraints imposed on spatial equilibria as well as shocks caused by unexpected collapse of such institutions. Some papers treat division of Germany as such a shock. Redding and Sturm (2008) found that West German cities close to the East-West border grew substantially slower relatively to other cities and that their catch-up caused by German reunification was much more gradual. In another paper (Redding et al., 2011) it was shown that the division of Germany led to a shift of major country's airline hub from Berlin to Frankfurt-am-Main and that there is no evidence of reverse movement after the fall of Berlin Wall. Crafts and Wolf (2013) found evidence strong path-dependence in the case of British cotton industry in XIX century: the industry remained heavily concentrated in Lancashire even when location factors related to water power become obsolete. They emphasize sunk costs and agglomeration economies as the explanation.

Papers mentioned dealt with “hard” shocks like bombing cities or physical separation of a country with a heavily guarded border. Location factors employed in theory are also tend to be “hard” like disadvantage in accessibility in Redding and Sturm (2008) or sunk investment in physical capital in Redding et al. (2011), Crafts and Wolf (2013).

In this paper I address the issue of path-dependence in industry location with the case of formation of professional service industry in Russia during the post-socialist transition. Spatial pattern of this industry could be shaped by both modern-day economy and by the Soviet-era background which is by assumption not relevant to the market. I use number of staff involved in R&D across 76 Russian regions in 1991 as a measure of Soviet-era legacy and employment in professional services averaged for 2009-2011 as an outcome variables. Control variables are provided to capture for modern-day determinants of industry location like level of economic development and urbanization. The simple cross-section model is tested with and without instrumenting contemporary variables with their past (i.e. late Soviet) values.

In some industries like manufacturing and transportation, Soviet-era background legacy included physical capital which is extremely costly to relocate even if market conditions require this. For tertiary industries this was not the case: professional services are not capital intensive but rely on human capital which is relatively mobile. I argue that the emerging service sector relied on the Soviet R&D sector as the pool of skilled labor which became underutilized after market reforms had been implemented. In the case of professional services there is no obvious mechanism which could impose path-dependence.

I believe that human capital externalities could become a cohesion force which has precluded spatial dispersion of professional services employment and has enhanced advantages of regions which were previously favored by the Soviet location policy. Taking into consideration tradability of some professional services, it is plausible that companies based in regions which scanty endowments of skilled labor outsourced services to firms located in established scientific centers.

There is vast amount of papers which intent to found evidence of positive human capital externalities and to develop theoretical underpinnings for them (for contemporary theories see, e.g., Lucas (1988), Acemoglu & Angrist (2001), Venables (2011)). As argued in these papers, skilled workers may benefit from spatial co-location with skilled mates due to number of reasons. Spatial clustering may improve matching workers when undertaking mutual projects and also may act as reputation device. Endogeneity, self-selection and omitted variables are major challenges to the study of spatial dimension of human capital externalities. In my empirical setting, Russia’s transition from central planning to market is considered as an exogenous shock. Using data from transition-era Russia allows us to tackle the chicken-and-egg

problem “people move to jobs or jobs move to people” which arises when studying market economies. When the central planning system was abolished in 1992, people were agglomerated in some places due to reasons loosely related to the market, and central planners evidently were unable to anticipate which places would be favorable under the market. The collapse of socialism in Russia also led to dramatic reduction of government spending on research and on the military which was the main sponsor of R&D in the centrally planned economy. So it is unlikely that the emerging service sector could rely on preexisting ties to industry.

However, human capital externalities are not the only plausible cohesion force. It might be the case that surplus of skilled labor led to poverty traps which precluded migration of ex-researchers to regions with better employment conditions. Sheptylo (2012) points out great distortions in Russian urban system caused by the central planning, specifically by subsidizing urban development in insulated areas and imposing restrictions on growth of Moscow and other old large cities. He emphasizes imperfect housing markets and underinvestment in urban infrastructure as explanations for low internal migration within post-socialist countries which impede convergence of the urban system to a new equilibrium. Alternatively, one may recall insights from Florida (2002), arguing that high-skilled (creative) professionals may value urban society and environment in places with pre-existing concentration of their peers.

In may baseline specification, I test for influence of the Soviet-era employment in R&D on present-day employment in three major subsectors of professional services: architecture and engineering; information technology and computer-related services; accounting, auditing and management consulting. Soviet-era researchers used to excel in mathematics, science and technology, but not in economics, management and social science. So, if Soviet-era R&D employment is found to impact technological but not for economic services, it is unlikely that Florida’s style explanation is apt to the case, since clustering of highly-educated people with background in technology failed to attract another segments of “creative class” like management consultants or auditors. I also add present-day number of researchers and educational attainment in my regressions thus controlling for present-day human capital to assure that the number of researchers in 1991 is not simply a proxy for human capital endowment but it captures some effect specific to the period of the collapse of the Soviet Union.

Results I find seem to confirm hypothesis that spatial agglomeration of R&D staff under the centrally planned economy gave push to development of professional services during the transition. Regions with greater R&D-related employment in 1991 now have greater employment in architecture, engineering and IT but not in accounting, auditing and management consulting. Furthermore, I fail to find higher overall employment growth in regions with greater number of R&D staff in 1991. It seems that Soviet-era knowledge endowments constitute a

minor factor of regional economic development during the transition. Regions with greater Soviet-era R&D-related employment also do not seem to have lesser labor productivity in professional services (measured as sales per worker), so it is unlikely that places where researchers were clustered turned into poverty traps under the market. Entrepreneurship is a plausible transmission mechanism to impose path-dependence. I find that regions where more people were engaged in R&D still have greater number of small and medium enterprises both in service sector and in the rest of the economy.

The paper is organized as follows. In Section 2 I consider historical roots of the impact development of academia under the Soviet rule might cause for modern-day professional services. In Section 3 I motivate the selection controls and describe data. Section 4 discusses results. Chapter 5 concludes.

2. Historical background: Russian professional services and Soviet academia

In the Soviet centrally planned economy, professional services were a minor sector and were not relevant for the market; some service industries simply did not exist (Bradshaw, 2008). State-owned R&D sector was highly militarized: in 1983, more than 70% USSR R&D expenses were incurred for purposes related to national defense and the space program. Overall R&D expenses to GDP ratio was very high (3.6% in 1983) but it looked much smaller when only civil fraction was taken into account (Freeman, 1995).

Another key feature of the Soviet R&D sector was its unique institutional structure. Universities, except several elite schools, were committed primarily to teaching while research was carried out in specialized institution working under umbrellas of various government agencies or Academies of Sciences[2]. The system of R&D planning was highly centralized and bureaucratized, and individual industrial enterprises as well as academic community lacked direct influence on it (Radosevich, 2003).

Geography of the Soviet-era knowledge-intensive industries was also shaped without taking into account viability of industries and even cities under market conditions. Instead, ideological, political and military reasons were given high priority (Rodgers, 1974; Hill and Gaddy, 2003; Mikhailova, 2004; Kumo, 2004). Specifically academia was crucial for empowerment of ethnic minorities and enlightenment of obscure regions (the spectacular example is the Siberian branch of the Academy of Sciences of USSR). WWII-related

[2] In addition to the most prominent Academy of Sciences of the USSR, there have been established other Academies committed to research in health, pedagogy, agriculture, architecture as well as Academies of Sciences of constituent republics.

evacuations also left imprints when academic institutions were relocated to the cities which were believed to be invulnerable for German invasion (noticeable case was evacuation of the Academy of Sciences of USSR to Kazan on Volga which has given rise to Kazan branch of the Academy). So, location of academic institutions near the end of the Soviet regime I consider exogenous with respect to the era of market economy.

Obviously, location of R&D establishments under the Soviet rule was not a random process in a strict sense. One can easily see that regions with the highest number of researchers were also most urbanized ones. But it seems that Soviet location policy favored some big cities more than others. Considering pairs of "rival" cities yields some evidence. Thus, Yekaterinburg (Sverdlovsk in 1924-1991) and Chelyabinsk are located near Ural mountains and separated by a distance of 200 kilometers. Both were major cities with comparable population size (in 1989, 1.3 million in Sverdlovsk and 1.1 million in Chelyabinsk); economies of both were dominated by heavy industries, including arms production. However, in 1991 number of R&D staff in Sverdlovskaya oblast was more than twice as much as in Chelyabinskaya oblast (52 vs. 21 thousand). Another comparison are Novosibirskaya and Omskaya oblats in the south of Siberia. Both regions had similar economic profile with specialization in agriculture and machinery manufacturing. Omsk (1.1 million inhabitants in 1989) and Novosibirsk (1.4 million) were the sole major cities in each oblast. However, the number of R&D staff in Novosibirskaya oblast was three times more than in Omskaya oblast (53 vs. 18 thousand) due to locational decision of the Soviet government: choosing Novosibirsk and not Omsk or Tomsk as the seat of Siberian branch of Academy of Sciences of USSR.

After 1991, dramatic decrease in public spending on basic research, space exploration and military after 1991 was a tremendous shock for the Soviet R&D sector. According to SIPRI database, military budget of USSR/Russia decreased from 371 billion constant 2011 USD in 1988 to 23 billion in 1998. Number of researchers in Russia decreased more than twofold during two postsocialist decades and the sharpest decline occurred during the first several years after the abolition of central planning (fig. 1). At the same time there was significant lack of workforce in market-oriented knowledge-intensive industries which were undeveloped under the Soviet rule – as professional services. Ex-researchers possessed high cognitive and social skills, broad fundamental knowledge as well as dim view of communist ideology and values. So, they used to bridge this gap even if their background was not directly related to their new career path (Yurevich, 1998, p. 107-110).

Recent history of town Miass, Chelyabinskaya oblast, is a symptomatic anecdote reinforcing my story. In 1955, this town near Ural mountains has been chosen for location of the design bureau in charge of developing submarine-launched ballistic missiles. Although it was a

rather typical industrial center without outstanding human capital endowments and it is situated in thousand kilometers from naval bases. In contrast, the mate design bureau devoted to land-based missiles is located in Moscow, so even policy of placing defense-related establishments in remote areas left enough space for arbitrariness. After 1991, several startups were launched in Miass by engineers who previously worked for the missile design bureau. Including those startups was Papillon Systems which developed fingerprints identification hardware and software. Despite the town's backward location, Papillon Systems acquired prominence due to contracts with Russian and foreign law enforcement agencies.

I argue that knowledge created by the Soviet-era academia was unlikely to directly influence present-day economy of Russian regions but could do it through human capital endowments. Firstly, Soviet military-industrial complex was the main sponsor of R&D. During transition to the market, its economic importance felt drastically. Instead, industries producing raw materials came out on top (Bradshaw, 2008; Gaddy and Ickes, 2005; Zubarevich and Safronov, 2011). Secondly, as noted in Yurevich (1998, p.103), researchers who opted to leave academia typically were relatively young and without high merit: 70% of them had never authored paper cited by anyone else. So, I believe not knowledge *per se* but human and social capital of former researchers to be the major channel of academia's influence on regional development during the transition. To check for this, I also regress employment growth from 1991 to 2011 on number of academic researchers in 1991 and find no significant association between them.

3. Data and variables

In this paper I use region-level data. Russian Federation consists of 83 regions also known as *oblasts.* 3 of them are autonomous districts included into other regions for statistical purposes, so I do not consider them to avoid duplicating observations. I exclude from the sample Chechnya which experienced a war shock since 1991 and also lacks reliable statistics, as well as Ingushetiya and Evreyskaya autonomous oblast which in 1991 were integrated in larger regions and thus lack data on some of the variables. I exclude Chukotskiy autonomous district which was not an incorporated region in 1991, too, and which had zero number of academic scholars in 1991 thus making impossible taking logarithm of this variable. So, I am left with 76 regions.

Data on the number of researchers by region in 1991 are obtained from 1999 Rosstat yearbook "Regiony Rossii". These data typically do not include university lecturers but do cover employees of various kinds of research establishments, including R&D departments of industrial enterprises. Number of R&D staff reported by the federal statistical services in years after 1991 captures primarily remaining Soviet-style research institutions but not modern professional

services. Russian R&D sector as defined by the statistical services is still dominated by public sector (in 2011, 76% of total R&D staff were in fully publicly-owned organizations, including 75% in those owned by the federal government, and 11% worked for institutions in mixed public-private ownership). Professional services is strikingly different industry. As of 2011, only 23% employees in engineering, architecture, IT, auditing, accounting and management consulting were hired by establishments in full or partial public ownership, including 6% in ownership by the federal government, 5% by regional governments, 9% by local governments and 3% in mixed public-private ownership.

In 1991, R&D sector was a spatially agglomerated industry: almost third of total employment was in Moscow City and Moscow Oblast and more than quarter was in St. Petersburg (then Leningrad). Outside the two metropolises, the highest degree of researchers' clustering was found in regions like Nizhegorodskaya, Novosibirskaya, Sverdlovskaya, Rostovskaya oblasts. The specific feature of Soviet-era science were closed towns (*ZATOs*) devoted to military-oriented research and manufacturing. *ZATO* were typically located in remote areas however relatively close to the major cities[3]. Some regions had disproportionately high employment share of researchers: e.g. 5% employees in Kaluzhskaya oblast were R&D-involved staff working mainly at nuclear research institutions in Obninsk.

Secrecy is the matter of caution when dealing with Soviet-era government statistics. It is expected to conceal data on number of scholars in physics, mathematics or technology to a greater extent than in social sciences, humanities or life sciences thus raising concerns of measurement error. However I rely on data released long after the fall of the Soviet regime when much information on defense-related research was declassified (precisely, Rosstat yearbook I borrowed the data from was published in 1999). Region-level pairwise correlation between official estimates of number of researchers in 2011, when secrecy is apparently not an issue, and in 1991 is also pretty high (0.96 when Moscow and St. Petersburg are included and 0.91 when these two cities are excluded). So I believe the data I use are not contaminated due to secrecy.

In a baseline specifications, I use as a dependent variables employment in three industries defined by statistical classification (OKVED):

- Engineering and architecture (OKVED 74.20.1);
- Accounting, auditing and management consulting (OKVED 74.1 minus OKVED 74.11 "Legal services")
- Information technology and computer-related services (OKVED 72).

[3] ZATOs not be confused with some major cities of USSR foreigners were prohibited to visit. ZATOs typically were relatively small settlements kept secret even for Soviet citizens. Some visit and settlement restrictions in ZATOs have not been lifted until now although the mere fact of ZATOs' existence and its' location is not classified any more.

Employment data are obtained from official Russian website of EMISS (Edinaya Mezhvedomstvennaya Informatsionno-Statisiticheckaya Sistema). I average data for 2009-2011 to minimize possible fluctuations which can be substantial in low-populated regions with small number of employees in professional services. These three years are strikingly different in macroeconomic situation: it was recession in 2009 and recovery in 2010-2011. However, region-level correlation of number of employees in three industries in 2009-2011 is about 99%, so it is unlikely that the global economic recession have brought significant distortions.

Employment in professional services in Russia in 2011 equals about one million. 376 thousand were employed in auditing, accounting and management consulting, 312 thousand in IT and 300 thousand in architecture and engineering. Even naïve comparison reveals similarity of spatial patterns of employment in R&D sector in 1991 and in professional services today. Regions leading in employment in professional services, apart from Moscow and St. Petersburg metropolitan areas, include Republic of Tatarstan, Sverdlovskaya, Nizhegorodakaya, Novosibirskaya, Rostovskaya oblasts which were also leading by number of R&D-involved staff in 1991.

Finding control variables requires examining key factors which are likely to influence location pattern of professional services. I scrutinize these factors below.

Relationship between size and thickness of market and demand for business services is well-established. Theoretical foundation is provided in Francois (1990) and empirical evidence can be found e.g. in (Ono, 2007; Jabbour, 2013). Greater market size promotes division of labor and contracting-out. I lack data on actual size of individual product markets, so I control for this with cost-of-living adjusted gross regional product (GRP). Adjustment for cost of living is essential to get rid of prices appreciation in northern regions of Russia due to high transportation, construction and heating costs. As a robustness check, I substitute this variable with overall employment in a region in 2011.

There is also rich evidence that professional services are attracted to big cities (Bennett et al., 1999; Keeble and Nachum, 2002; Shearmur and Doloreux, 2008). In Kolko (2010) it was pointed out that the services are urbanized rather spatially agglomerated industries. Explanations for this fact often feature intangible location factors like creative environment, tacit knowledge or localized knowledge spillovers as well as more traditional ones like proximity to clients and suppliers, labor pooling and transport accessibility (Howells, 2002; Keeble and Nachum, 2002; Muller and Doloreux, 2009).

I control for region-level urbanization with specially constructed urbanization index. This index for region *i* is indeed the expected population of settlement region's inhabitant resides. Formally, this is as follows:

$URBAN_i = \sum s_{ij} P_j$

where

s_{ij} – share of settlement j in region i's aggregate population[4]

P_j – population of settlement j

I prefer this index to simple urbanization rate (share of people who reside in cities and towns) because the latter does not allow to distinguish between a concentration of people in a few large cities and a dispersed urbanization pattern. Also, it has some advantages over population density, since many Russian regions, especially in Siberia and in the North, have economic activity clustered in relatively small territory around a regional capital which is often a large city, while the vast territory with less comfortable conditions is sparsely populated. The drawbacks of this index may arise when the same metropolitan area is divided between a number of municipalities. However, such a situation is not common in Russia, since the country still lacks consistent local self-government, and a city may be amalgamated with its suburbs without many lengthy legal formalities if backed by regional or federal government (this is especially true for the Soviet era).

The next factor to be accounted for is present-day human capital. This control is necessary to be sure that Soviet-era employment in academia is not merely a proxy for current human capital. Professional services are knowledge-intensive industries, so firms specialized in professional services sought for well-educated specialists and managers. Numerous studies have shown higher region-level educational attainment to be associated with higher new firm formation and survival, especially in knowledge-intensive industries (Acs et al., 2007; Lee et al., 2004; Qian et al., 2013). I control for current human capital endowment with number of employees with university degree in 2009-2011 and number of researchers in 2011.

The latter variable is of special interest because of lack of regional fixed effects in the regression. Russia has inherited organization of its R&D sector from the Soviet era, and pair-wise correlation between number of researchers in 1991 and 2011 is very high. Thus any time-invariant region-specific factors which are not captured by the controls are likely to affect both variables. If the number of R&D-involved staff has no direct effect on present-day employment in professional services but omitted variables have, I expect to observe very similar coefficients at the number of researches both in 1991 and in 2011. Otherwise, if great divergence in

[4] I lack data on number of inhabitants in individual rural settlements, so I assign them equal weights obtained from number of rural settlements and their aggregate population. Russia is a highly urbanized country (73% population are in cities and towns), so it is unlikely to cause much bias.

coefficients' sign and magnitude is found, this does not conforms with third-variable theory and thus affords ground to believe that the genuine effect of the variables is found.

Number of university graduates also allows to control for regions specializing in high-tech and middle-tech industries which can also be connected to demand for advanced producer services.

Reverse causality is also an issue of caution when designing the model. Services is very propulsive sector and a source of externalities for the rest of economy. Several studies found positive effect of increased services inputs on manufacturing firms productivity in different countries of the World, including postsocialist economies (Arnold et al., 2007, 2011, 2012; Fernandes and Paunov 2012; Shepotylo and Vakhitov, 2012), so I cannot rule out reverse causality between the development of professional services and economic development, urbanization, peoples' incentives to enroll universities. While I believe the number of academics in 1991 to be exogenous variable, reverse causality of other variables may bias estimates of all the coefficients.

I instrument number of employees with university degree and urbanization index with the respective variables obtained from 1989 census. GRP in instrumented with electricity consumption in 1991 due to lack of credible national accounts statistics for the Soviet era. Instrument for number of academics in 2011 is a problematic because Soviet-era data cannot be used directly. I argue that academia's loses in human capital due to braindrain after 1991 was slowed down in those regions where more funds was directed to R&D. So, I instrument number of academics in 2011 by region with spending for fundamental research in the respective year. Although number of scholars in *past* years could be used as an argument while bargaining for government research funding, academic staff in *current* year is likely to adjust to size of budget allotted.

The full set of variables is listed in table 1. All the variables are in logs.

4. Results

4.1. Baseline model

I start with estimating effects for current employment in three subsectors of professional services. Results for engineering and architecture are presented in table 2 and those for IT are in table 3. Both OLS and IV results confirm that there is significant positive relationship between employment in R&D in 1991 and today employment in knowledge-intensive services. Taking into account the paramount status of Moscow and St. Petersburg within the Russian urban system, I am concerned with possibility that the relationship found in overall dataset is actually

driven by effects specific to these two cities, so I run additional regressions excluding Moscow and St. Petersburg. Results are robust to exclusion and inclusion of the two largest Russian cities.

Moreover, in the IV setting current number of R&D staff is shown to negatively affect employment in engineering and architecture and in IT. This result is consistent with the view that greater funding for research during the transition caused lesser talent outflow from R&D sector. Thus it seems to downsize pool of potential labor force for the emerging sector of professional services and disincentivize researches to left academia.

As it was noted earlier, pair-wise correlation between log numbers of researchers in 1991 and 2011 by region is about 0.9, so omitted variable bias should act in a uniform way for both variables. Strikingly different coefficients for past and contemporary employment in R&D sector cast doubt on possibility for some confounding time-invariant variables to drive observed effects.

Coefficients at other variables generally support my anticipations. Overall economic development of a region is crucial location factor for professional services. However, two-decades-ago number of R&D staff is comparable in effect to GRP and overshadows urbanization effect. Present-day number of university graduates in workforce is insignificant.

As opposed to engineering and IT, there is no significant effect of past R&D-related employment on current employment in auditing, accounting and management consulting (table 4). Overall economic development and urbanization are still crucial factors. It should be mentioned that social science in the Soviet Russia was largely reduced to apology of Marxism, so Soviet-era competence in this field was unlikely to be applied under the market. This result allows me to believe that the number of R&D staff is not merely a guise for some omitted factors determining location of professional services in general since factors of such kind are expected to affect "economic" services as well as "technological".

4.2. Baseline model

Results I report are extremely sensitive to the measure of regions' size which is crucial to be properly controlled for. Number of researchers in a region is apparently correlated with various measure of its size. If GRP is not a perfect measure, regressions may reveal a trivial "fact" that larger regions remain to be large and smaller – to be small. As a robustness check, I replace GRP with current overall employment and obtain similar results (tables 5-7). Number of researchers in 1991 remains a significant predictor of current number of employees in architecture, engineering and IT, but not in accounting, auditing and consulting. However, current number of researchers, while keeping it's positive sign, is not significant at conventional confidence levels.

More encompassing robustness check focuses on structure of regional employment instead of absolute numbers of employees. An industry's share in overall employment has no direct relationship to the size of economy (although larger regions may enjoy deeper division of labor and have greater share of business services in employment, so variations in regions' size should also be controlled for). This approach has drawbacks, so it is supposed as a robustness check, not as a baseline model. Greater share of R&D sector or business services in employment does not necessarily implies greater absolute number of employees and so greater scale and scope of human capital externalities. Shares of R&D sector and business services in employment also depends on absolute number of employees in other industries, so they are hard to be isolated from various unobservable factors specific to individual.

I use share of architecture and engineering and of IT in overall employment, averaged for 2009-2011, as dependent variables. Independent variables include share on R&D-related staff in 1991 and 2011 as well as share of employees who hold an university degree. To control for possible scale effects, urbanization index and GRP of overall employment are added into equation. Regressions are estimated with OLS and IV both; instrumentation strategy is identical with these used when dealing with absolute regional scores.

Results are reported in tables 8-11. Share of R&D-related staff in employment in 1991 is shown to significantly increase present-day share of professional services. As well as in the case of absolute scores, 2011 share of researchers affects contemporary professional services negatively. Surprisingly, influence of other factors like size of regional economy and urbanization is less pronounced and its significance fluctuates heavily between various specifications.

4.3. Possible explanations

I carry out several additional statistical tests to investigate possible explanations for the facts I have discovered. Firstly, it is possible that knowledge endowments created under the Soviet rule directly transmitted into economic growth, thus pushing employment in overall economy and specifically in professional services. Sadly, in Russia there is lack of adequate measure of economic development covering the final years of the Soviet era since gross regional product was published firstly in 1998. As a remedy, I consider logarithm of employment growth. I regress log of employment growth in 1991-2011 on number of R&D-involved staff in 1991, initial employment and a set of controls (table 12). Results imply it is quite unlikely that Soviet scientific heritage was making difference anywhere outside some knowledge-intensive industries like professional services.

Low rates of residential mobility due to market rigidness and poverty traps are often blamed in preserving distortions in the urban systems of Russia (Hill & Gaddy, 2003; Shepotylo, 2012) and may explain path dependence in the location of professional services as well as human capital externalities. I cannot assess this directly, but it is possible to test some implications of different hypothesis. Human capital externalities emphasize productivity gains due to greater labor pool while poverty traps implies possibility of lesser productivity in places with heavier Soviet heritage.

I regress log cost-of-living adjusted sales per worker in professional services on number of researchers in 1991 as well as in 2011. I control for cost-of-living adjusted GRP per capita and also for urbanization index. Results for IT are shown in table 13 and for engineering and architecture in table 14. Estimation is carried out with both OLS and IV. For auditing, accounting and management consulting regressions are not estimated since no evidence of path-dependence have been found.

I find no evidence supporting lesser labor productivity in places where R&D clusters were established under centrally planned economy*;* moreover, in selected specifications significant positive relationship is found. So, human capital externalities theory seems plausible.

Entrepreneurship is likely to be a powerful transmission mechanism for human capital externalities. There is some evidence demonstrating great significance of social ties for entrepreneurship when legal restrictions for private initiative have been lifted (Burchardi and Hassan, 2013). Enhanced exchange in ideas may result in greater number of startups in knowledge-intensive services. Data on the overall number of firms provided by the official statistics is not disaggregated by industry, so I employ number of SMEs with 16 to 100 employees both in the business services sector and in the rest of the economy. Emphasis on firms with a substantial number of workers also allows to get rid of fly-by-night firms and enterprises which have ceased operation but remain to be counted by the statistics and tax authorities.

I estimate effect of Soviet-era R&D sector on number of SMEs both in the business services sector (table 15) and in the rest of the economy (table 16). The results confirm evidence obtained from employment data. Number of researchers in 1991 has substantial positive effect on number of small and medium enterprises in business services as well as in overall economy. Another variable significant in all basic specifications is GRP. Modern-day number of researchers is significant under IV-based approach. Number of employees holding university degree and, even more surprisingly, urbanization index appears generally insignificant in this setting.

5. Conclusions

In this paper I examine whether Soviet-era pattern of R&D-sector location could influence modern-day location of professional services. During transition there was severe spending cuts in academia and R&D sector which forced many people to move to industry. Ex-researchers might bridge 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 are ahead in development of professional services now?

OLS and IV approaches are implemented with controls intended to capture present-day human capital, economic development and urbanization. I find this effect for employment in engineering and architecture and in information technology and computer-related services. No significant effect is found for employment in accounting, auditing and management consulting. Number of small and medium enterprises is also greater in those regions in which more people involved in R&D were gathered under the Soviet rule.

Various explanations for this fact can be proposed. I show that regions with greater 1991 R&D-related employment do not have lesser per-worker productivity in professional services now, so it is unlikely that labor market distortions due to central planning locked ex-reseachers in poverty traps. Moreover, 1991 number of researchers is associated with higher labor productivity in engineering and architecture and in IT in selected specifications thus confirming human capital externalities theory.

References

Acemoglu, D., & Angrist, J. (2001). How large are human-capital externalities? Evidence from compulsory-schooling laws. In *NBER Macroeconomics Annual 2000, Volume 15* (pp. 9-74). MIT Press.

Acs, Z. J., Armington, C., & Zhang, T. (2007). The determinants of new-firm survival across regional economies: The role of human capital stock and knowledge spillover. *Papers in Regional Science*, *86*(3), 367-391.

Arnold, J. M., Javorcik, B. S., & Mattoo, A. (2007). Does services liberalization benefit manufacturing firms? Evidence from the Czech Republic. *World Bank Policy Research Working Paper 4109.*

Arnold, J. M., Mattoo, A., & Narciso, G. (2008). Services inputs and firm productivity in Sub-Saharan Africa: Evidence from firm-level data. *Journal of African Economies*, *17*(4), 578-599.

Arnold, J. M., Javorcik, B., Lipscomb, M., & Mattoo, A. (2012). Services reform and manufacturing performance: Evidence from India. *World Bank Policy Research Working Paper Series 5948.*

Bennett, R. J., Graham, D. J., & Bratton, W. (1999). 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*(4), 393-420.

Bradshaw, M. (2008). The geography of Russia's new political economy. *New Political Economy*, *13*(2), 193-201.

Brakman, S., Garretsen, H., & Schramm, M. (2004). The strategic bombing of German cities during World War II and its impact on city growth. *Journal of Economic Geography*, *4*(2), 201-218.

Burchardi, K. B., & Hassan, T. A. (2013). The Economic Impact of Social Ties: Evidence form German Reunification. *The Quarterly Journal of Economics*, *128*(3), 1219-1271.

Crafts, N., & Wolf, N. (2013). The location of the British cotton textiles industry in 1838: a quantitative analysis. *EHES Working Paper in Economic History, No. 45*

Davis, D. R., & Weinstein, D. E. (2002). Bones, bombs, and break points: The geography of economic activity. *The American Economic Review*, *92*(5), 1269-1289.

Davis, D. R., & Weinstein, D. E. (2008). A search for multiple equilibria in urban industrial structure. *Journal of Regional Science*, *48*(1), 29-65.

Gaddy, C. G., & Ickes, B. W. (2005). Resource rents and the Russian economy. *Eurasian Geography and Economics*, *46*(8), 559-583.

Hill, F., & Gaddy, C. G. (2003). *The Siberian curse: How communist planners left Russia out in the cold*. Brookings Institution Press.

Howells, J. R. (2002). Tacit knowledge, innovation and economic geography. *Urban Studies*, *39*(5-6), 871-884.

Fernandes, A. M., & Paunov, C. (2012). Foreign direct investment in services and manufacturing productivity: Evidence for chile. *Journal of Development Economics*, *97*(2), 305-321.

Florida, R. L. (2002). *The Rise of the Creative Class and How It's Transforming Work, Leisure Community and Everyday Life.* Basic Books.

Francois, J. F. (1990). Producer services, scale, and the division of labor. *Oxford Economic Papers*, *42*(4), 715-729.

Freeman, C. (1995). The 'National System of Innovation' in historical perspective. *Cambridge Journal of economics*, *19*(1), 5-24.

Jabbour, L. (2013). 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*(1), 103-134.

Keeble, D., & Nachum, L. (2002). Why do business service firms cluster? Small consultancies, clustering and decentralization in London and southern England. *Transactions of the Institute of British Geographers*, *27*(1), 67-90.

Kolko, J. (2010). Urbanization, agglomeration, and coagglomeration of service industries. In *Agglomeration Economics* (pp. 151-180). University of Chicago Press.

Krugman, P. (1991). Increasing Returns and Economic Geography. *The Journal of Political Economy*, *99*(3), 483-499.

Kumo, K. (2004). Soviet industrial location: a re-examination. *Europe-Asia Studies*, *56*(4), 595-613.

Lee, S. Y., Florida, R., & Acs, Z. (2004). Creativity and entrepreneurship: a regional analysis of new firm formation. *Regional Studies*, *38*(8), 879-891.

Lucas, R. E. (1988). On the mechanics of economic development. *Journal of Monetary Economics*, *22*(1), 3-42.

Mikhailova, T. N. (2004). *Essays on Russian economic geography: Measuring spatial inefficiency* (Doctoral dissertation, The Pennsylvania State University).

Mikhailova, T. (2012). Gulag, WWII and the long-run patterns of Soviet city growth. In *Presented at the XVIthWorld Economic History Congress* (Vol. 9, p. 13).

Miguel, E., & Roland, G. (2011). The long-run impact of bombing Vietnam. *Journal of Development Economics*, *96*(1), 1-15.

Muller, E., & Doloreux, D. (2009). What we should know about knowledge-intensive business services. *Technology in Society*, *31*(1), 64-72.

Ono, Y. (2007). Market thickness and outsourcing services. *Regional Science and Urban Economics*, *37*(2), 220-238.

Qian, H., Acs, Z. J., & Stough, R. R. (2013). Regional systems of entrepreneurship: the nexus of human capital, knowledge and new firm formation. *Journal of Economic Geography*, *13*(4), 559-587.

Radosevic, S. (2003). Patterns of preservation, restructuring and survival: science and technology policy in Russia in post-Soviet era. *Research Policy*, *32*(6), 1105-1124.

Redding, S. J., & Sturm, D. M. (2008). The costs of remoteness: Evidence from German division and reunification. *The American Economic Review*, *98*(5), 1766-1797.

Redding, S. J., Sturm, D. M., & Wolf, N. (2011). History and industry location: Evidence from German airports. *Review of Economics and Statistics*, *93*(3), 814-831.

Rodgers, A. (1974). The locational dynamics of Soviet industry. *Annals of the Association of American Geographers*, *64*(2), 226-240.

Shearmur, R., & Doloreux, D. (2008). Urban hierarchy or local buzz? High-order producer service and (or) knowledge-intensive business service location in Canada, 1991–2001. *The Professional Geographer*, *60*(3), 333-355.

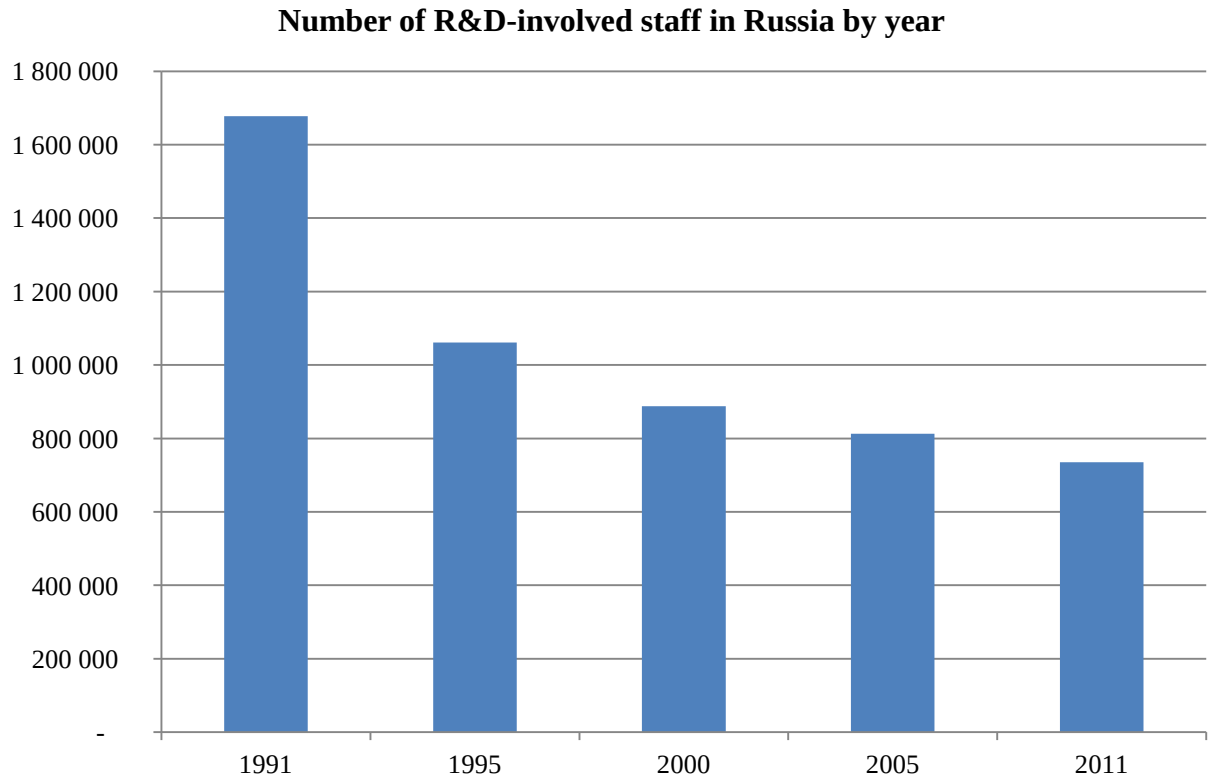
Shepotylo, O. (2012). Cities in transition. *Comparative Economic Studies, 54*(3), 661-688.

Shepotylo, O., & Vakhitov, V. (2012). Services liberalization and productivity of manufacturing firms: evidence from Ukraine. *World Bank Policy Research Working Paper Series 5944.*

Venables, A. J. (2011). Productivity in cities: self-selection and sorting. *Journal of Economic Geography*, *11*(2), 241-251.

Zubarevich, N. V., & Safronov, S. G. (2011). Regional inequality in large post-Soviet countries. *Regional Research of Russia, 1*(1), 15-26.

Yurevich, A.V. (1998). *Umnye, no bednye: Uchyonye v sovremennoy Rossii.* Moskovskiy Obschestvennyy Nauchnyy Fond.



Source: Yearbooks *Regions of Russia* by Rosstat

Fig.1

Table 1

Label	Description	Type
Log Engineering	Log number of employees in engineering and architecture, average 2009-2011	Dependent
Log IT	Log number of employees in computer-related services and information technology, average 2009-2011	Dependent
Log Consulting	Log number of employees in accounting, auduting and management consulting, average 2009-2011	Dependent
Log_Share_Engineering	Log share of engineering and architecture in overall employment, average 2009-2011	Dependent
Log_Share_IT	Log share of computer-related services and information technology in overall employment, average 2009-2011	Dependent
Log Emplchange	Log change in aggregate employment from 1991 to 2011	Dependent
Log Productivity_IT	Log cost-of-living adjusted sales per employee in computer-related services and information technology in 2011	Dependent
Log Productivity_Eng	Log cost-of-living adjusted sales per employee in engineering and architecture in 2011	Dependent
Log Firms_Services	Log number of SME's minus microenterprises in industry "Real estate, renting, leasing and business services" (16-100 employees) in 2012	Dependent
Log Firms_Others	Log number of SME's minus microenterprises in all other industries (16-100 employees) in 2012	Dependent
Log R&D_1991	Log number of academic scholars in 1991	Independent
Log R&D _2011	Log number of academic scholars in 2011	Independent
Log Share_R&D_1991	Log share of academic scholars in overall employment in 1991	Independent
Log Share_R&D _2011	Log share of academic scholars in overall employment in 2011	Independent
Log Grad	Log number of employees with university degree in 2009-2011	Independent
Log_Share_Grad	Log share of employees with university degree in 2009-2011	Independent
Log GRP	Log cost-of-loving adjusted GRP in 2009-2011	Independent
Log GRP_percap	Log cost-of-loving adjusted GRP per capita in 2011	Independent
Log Urban	Log urbanization index from data of 2010 census	Independent
Log Empl_1991	Log aggregate employment in 1991	Independent
Log R&D_Spending	Log fundamental research funding in 2011	Instrument for Log R&D_2011, Log_Share_R&D_2011
Log Grad_1989	Log number of university graduates by 1989 census	Instrument for Log Grad
Log EC_1991	Log electricity consumption in 1991	Instrument for Log GRP_percap
Log EC_percap_1991	Log per capita electricity consumption in 1991	Instrument for Log GRP
Log Urban_1989	Log urbanization index from data of 1989 census	Instrument for Log Urban

Table 2

Dependent variable is Log Engineering	**(1) OLS**	**(2) OLS**	**(3) IV**	**(4) IV**	**(5) IV**	**(6) IV**
Log R&D_1991	0.428***	0.412***	0.564***	0.629***	0.534**	0.618***
	(0.146)	(0.152)	(0.201)	(0.177)	(0.231)	(0.186)
Log R&D_2011	-0.148	-0.140	-0.396**	-0.328**	-0.380**	-0.316*
	(0.092)	(0.092)	(0.181)	(0.162)	(0.182)	(0.168)
Log Graduates	0.076**	0.077**	0.217		0.243	
	(0.033)	(0.033)	(0.282)		(0.304)	
Log GRP	0.687***	0.692***	0.756***	0.673***	0.758***	0.669***
	(0.116)	(0.118)	(0.157)	(0.142)	(0.164)	(0.139)
Log Urbanization	0.154**	0.182*	0.123	0.193**	0.134	0.203*
	(0.067)	(0.094)	(0.096)	(0.092)	(0.109)	(0.122)
Observations	76	74 Moscow and St.Petersburg dropped	76	76	74 Moscow and St.Petersburg dropped	74 Moscow and St.Petersburg dropped
R^2 (Centered R^2)	0.8861	0.8606	0.8527	0.8706	0.8111	0.8421

Heteroscedasticity-robust standard errors are in parentheses. Asterisks indicate p-value:

***	<1%
**	<5%
*	<10%

Table 3

Dependent variable is Log IT	**(1) OLS**	**(2) OLS**	**(3) OLS**	**(4) OLS**	**(5) IV**	**(6) IV**	**(7) IV**	**(8) IV**
Log R&D_1991	0.361**	0.298***	0.389**	0.311***	0.503***	0.476***	0.599***	0.534***
	(0.153)	(0.095)	(0.154)	(0.095)	(0.192)	(0.159)	(0.208)	(0.164)
Log R&D_2011	-0.084		-0.097		-0.243*	-0.272*	-0.291*	-0.340**
	(0.077)		(0.077)		(0.142)	(0.144)	(0.153)	(0.152)
Log Graduates	0.013		0.011		-0.093		-0.188	
	(0.020)		(0.020)		(0.251)		(0.280)	
Log GRP	0.595***	0.566***	0.587***	0.555***	0.684***	0.719***	0.684***	0.753***
	(0.089)	(0.091)	(0.090)	(0.092)	(0.126)	(0.109)	(0.154)	(0.109)
Log Urbanization	0.200***	0.214***	0.154**	0.181**	0.230**	0.201***	0.191	0.139
	(0.063)	(0.060)	(0.074)	(0.068)	(0.099)	(0.074)	(0.120)	(0.087)
Observations	76	76	74 Moscow and St.Petersburg dropped	74 Moscow and St.Petersburg dropped	76	76	74 Moscow and St.Petersburg dropped	74 Moscow and St.Petersburg dropped
R^2	0.9079	0.9057	0.8818	0.8783	0.8821	0.8955	0.7909	0.8554

Heteroscedasticity-robust standard errors are in parentheses. Asterisks indicate p-value:

***	<1%
**	<5%
*	<10%

Table 4

Dependent variable is Log Consulting	**(1) OLS**	**(2) OLS**	**(3) OLS**	**(4) OLS**	**(5) OLS**	**(6) IV**	**(7) IV**	**(8) IV**	**(9) IV**
Log R&D_1991	0.065 (0.178)	0.010 (0.113)	0.127 (0.097)	0.081 (0.180)	0.137 (0.097)	0.188 (0.243)	0.075 (0.075)	0.265 (0.289)	0.065 (0.076)
Log R&D_2011	0.041 (0.097)			0.033 (0.096)		0.024 (0.180)		-0.014 (0.190)	
Log Graduates	0.042* (0.024)	0.044* (0.025)		0.041 (0.025)		-0.223 (0.306)		-0.305 (0.371)	
Log GRP	0.703*** (0.107)	0.715*** (0.113)	0.696*** (0.103)	0.701*** (0.108)	0.692*** (0.104)	0.707*** (0.184)	0.796*** (0.134)	0.710*** (0.216)	0.821*** (0.124)
Log Urbanization	0.155** (0.061)	0.150*** (0.056)	0.163*** (0.060)	0.122 (0.087)	0.123 (0.082)	0.223** (0.098)	0.154** (0.061)	0.191 (0.123)	0.122* (0.073)
Observations	76	76	76	74 Moscow and St.Petersburg dropped	74 Moscow and St.Petersburg dropped	76	76	74 Moscow and St.Petersburg dropped	74 Moscow and St.Petersburg dropped
R^2	0.8368	0.8362	0.8333	0.7934	0.7895	0.7245	0.8306	0.5491	0.7838

Heteroscedasticity-robust standard errors are in parentheses. Asterisks indicate p-value:

***	<1%
**	<5%
*	<10%

Table 5

Dependent variable is Log Engineering	**(1) OLS**	**(2) OLS**	**(3) OLS**	**(4) OLS**	**(5) IV**	**(6) IV**	**(7) IV**	**(8) IV**
Log R&D_1991	0.275* (0.145)	0.199* (0.101)	0.280* (0.147)	0.199* (0.102)	0.368** (0.186)	0.263*** (0.097)	0.418* (0.224)	0.260*** (0.098)
Log R&D_2011	-0.112 (0.083)		-0.119 (0.083)		-0.160 (0.150)		-0.171 (0.157)	
Log Graduates	0.042 (0.042)		0.042 (0.042)		0.094 (0.326)		-0.010 (0.385)	
Log Employment_2011	1.038*** (0.159)	0.997*** (0.158)	1.050*** (0.161)	1.004*** (0.159)	0.905*** (0.162)	0.870*** (0.157)	0.917*** (0.158)	0.878*** (0.160)
Log Urbanization	0.150** (0.067)	0.173*** (0.062)	0.121 (0.095)	0.160* (0.085)	0.138 (0.125)	0.178** (0.070)	0.135 (0.128)	0.168* (0.092)
Observations	76	76	74 Moscow and St.Petersburg dropped	74 Moscow and St.Petersburg dropped	76	76	74 Moscow and St.Petersburg dropped	74 Moscow and St.Petersburg dropped
R^2	0.9028	0.8981	0.8810	0.8749	0.8987	0.8966	0.8744	0.8731

Heteroscedasticity-robust standard errors are in parentheses. Asterisks indicate p-value:

***	<1%
**	<5%
*	<10%

Table 6

Dependent variable is Log IT	**(1) OLS**	**(2) OLS**	**(3) OLS**	**(4) OLS**	**(5) IV**	**(6) IV**	**(7) IV**	**(8) IV**
Log R&D_1991	0.241	0.190*	0.282*	0.203**	0.273	0.236**	0.449**	0.237**
	(0.156)	(0.101)	(0.151)	(0.099)	(0.183)	(0.103)	(0.181)	(0.103)
Log R&D_2011	-0.050		-0.078		-0.067		-0.120	
	(0.073)		(0.070)		(0.147)		(0.150)	
Log Graduates	-0.016		-0.020		0.054		-0.240	
	(0.017)		(0.017)		(0.280)		(0.313)	
Log Employment_2011	0.865***	0.854***	0.881***	0.860***	0.792***	0.777***	0.810***	0.798***
	(0.116)	(0.125)	(0.113)	(0.125)	(0.145)	(0.148)	(0.175)	(0.150)
Log Urbanization	0.202***	0.203***	0.105*	0.121	0.183*	0.192***	0.149	0.117**
	(0.074)	(0.068)	(0.063)	(0.058)	(0.092)	(0.063)	(0.127)	(0.052)
Observations	76	76	74 Moscow and St.Petersburg dropped	74 Moscow and St.Petersburg dropped	76	76	74 Moscow and St.Petersburg dropped	74 Moscow and St.Petersburg dropped
R^2	0.9167	0.9156	0.8987	0.8956	0.9092	0.9148	0.8132	0.8950

Heteroscedasticity-robust standard errors are in parentheses. Asterisks indicate p-value:

***	<1%
**	<5%
*	<10%

Table 7

Dependent variable is Log Consulting	**(1) OLS**	**(2) OLS**	**(3) OLS**	**(4) OLS**	**(5) IV**	**(6) IV**	**(7) IV**	**(8) IV**
Log R&D_1991	-0.063	0.013	-0.032	0.041	-0.014	0.089	0.158	0.090
	(0.180)	(0.108)	(0.178)	(0.099)	(0.232)	(0.106)	(0.321)	(0.103)
Log R&D_2011	0.086		0.061		0.232		0.183	
	(0.092)		(0.089)		(0.187)		(0.212)	
Log Graduates	0.006		0.003		-0.250		-0.552	
	(0.032)		(0.032)		(0.350)		(0.477)	
Log Employment_2011	0.985***	1.009***	1.006***	1.038***	0.838***	0.897***	0.860**	0.944***
	(0.147)	(0.150)	(0.145)	(0.150)	(0.209)	(0.164)	(0.352)	(0.167)
Log Urbanization	0.161**	0.154**	0.071		0.212	0.121	0.193	
	(0.076)	(0.077)	(0.091)		(0.133)	(0.080)	(0.214)	
Observations	76	76	74 Moscow and St.Petersburg dropped	74 Moscow and St.Petersburg dropped	76	76	74 Moscow and St.Petersburg dropped	74 Moscow and St.Petersburg dropped
R^2	0.8424	0.8396	0.8060	0.8036	0.7328	0.8374	0.1835	0.8020

Heteroscedasticity-robust standard errors are in parentheses. Asterisks indicate p-value:

***	<1%
**	<5%
*	<10%

Table 8

Dependent variable is Log Share Engineering	**(1) OLS**	**(2) OLS**	**(3) OLS**	**(4) OLS**	**(5) IV**	**(6) IV**	**(7) IV**	**(8) IV**
Log Share R&D_1991	0.416*** (0.132)	0.407*** (0.134)	0.412*** (0.135)	0.405*** (0.135)	0.459** (0.180)	0.297*** (0.0944)	0.465** (0.189)	0.304*** (0.101)
Log Share R&D_2011	-0.178** (0.0741)	-0.158** (0.0787)	-0.178** (0.0754)	-0.158** (0.0776)	-0.213 (0.150)		-0.223 (0.159)	
Log Share Graduates	0.201 (0.295)		0.243 (0.373)			-0.614 (0.536)		-0.933 (0.855)
Log GRP	0.117* (0.0649)	0.109 (0.0678)	0.119* (0.0662)	0.112 (0.0681)	0.0960 (0.0852)	0.0622 (0.0964)	0.102 (0.0863)	0.0673 (0.0960)
Log Urbanization	0.136* (0.0686)	0.148** (0.0675)	0.145 (0.0910)	0.143 (0.0884)	0.152* (0.0813)	0.207** (0.0917)	0.140 (0.106)	0.165* (0.0955)
Observations	76	76	74 Moscow and St.Petersburg dropped	74 Moscow and St.Petersburg dropped	76	76	74 Moscow and St.Petersburg dropped	74 Moscow and St.Petersburg dropped
R^2 (Centered R^2)	0.556	0.554	0.474	0.472	0.550	0.511	0.465	0.403

Heteroscedasticity-robust standard errors are in parentheses. Asterisks indicate p-value:

***	<1%
**	<5%
*	<10%

Table 9

Dependent variable is Log Share Engineering	**(1) OLS**	**(2) OLS**	**(3) OLS**	**(4) OLS**	**(5) IV**	**(6) IV**	**(7) IV**	**(8) IV**
Log Share R&D_1991	0.397*** (0.134)	0.387*** (0.134)	0.394*** (0.136)	0.387*** (0.135)	0.428** (0.174)	0.295*** (0.0991)	0.437** (0.183)	0.305*** (0.105)
Log Share R&D_2011	-0.178** (0.0728)	-0.151* (0.0766)	-0.177** (0.0740)	-0.154** (0.0756)	-0.182 (0.149)		-0.196 (0.161)	
Log Share Graduates	0.271 (0.299)		0.283 (0.381)			-0.572 (0.538)		-0.905 (0.858)
Log Employment_2011	0.177** (0.0880)	0.160* (0.0899)	0.179* (0.0898)	0.167* (0.0915)	0.115 (0.0978)	0.0663 (0.0974)	0.123 (0.102)	0.0662 (0.101)
Log Urbanization	0.114 (0.0699)	0.133** (0.0666)	0.118 (0.0937)	0.116 (0.0909)	0.150** (0.0766)	0.207** (0.0806)	0.132 (0.106)	0.167* (0.0943)
Observations	76	76	74 Moscow and St.Petersburg dropped	74 Moscow and St.Petersburg dropped	76	76	74 Moscow and St.Petersburg dropped	74 Moscow and St.Petersburg dropped
R^2 (Centered R^2)	0.562	0.559	0.482	0.478	0.556	0.514	0.474	0.407

Heteroscedasticity-robust standard errors are in parentheses. Asterisks indicate p-value:

***	<1%
**	<5%
*	<10%

Table 10

Dependent variable is Log Share IT	**(1) OLS**	**(2) OLS**	**(3) OLS**	**(4) OLS**	**(5) OLS**	**(6) OLS**	**(7) IV**	**(8) IV**	**(9) IV**	**(10) IV**
Log Share R&D_1991	0.296* (0.153)	0.300* (0.152)	0.225** (0.102)	0.315** (0.146)	0.329** (0.148)	0.235** (0.101)	0.595** (0.288)	0.616*** (0.204)	0.600** (0.298)	0.479*** (0.153)
Log Share R&D_2011	-0.0815 (0.0679)	-0.0808 (0.0723)		-0.0731 (0.0662)	-0.101 (0.0707)		-0.483 (0.309)	-0.500** (0.246)	-0.471 (0.331)	-0.282** (0.133)
Log Share Graduates	-0.00948 (0.282)			-0.354 (0.321)			1.179 (0.816)	1.233** (0.610)	0.960 (1.118)	
Log GRP	0.0253 (0.0498)			0.0188 (0.0506)			0.146 (0.0973)	0.156** (0.0655)	0.139 (0.0942)	0.111** (0.0563)
Log Urbanization	0.168*** (0.0593)	0.184** (0.0747)	0.192*** (0.0698)	0.0938 (0.0607)	0.118 (0.0748)	0.138* (0.0695)	0.0220 (0.124)		0.00198 (0.103)	
Observations	76	76	76	74 Moscow and St.Petersburg dropped	74 Moscow and St.Petersburg dropped	74 Moscow and St.Petersburg dropped	76	76	74 Moscow and St.Petersburg dropped	74 Moscow and St.Petersburg dropped
R^2 (Centered R^2)	0.526	0.524	0.513	0.407	0.394	0.371	0.265	0.241	0.064	0.307

Heteroscedasticity-robust standard errors are in parentheses. Asterisks indicate p-value:

***	<1%
**	<5%
*	<10%

Table 11

Dependent variable is Log Share IT	**(1) OLS**	**(2) OLS**	**(3) OLS**	**(4) IV**	**(5) IV**	**(6) IV**	**(7) IV**	**(8) IV**
Log Share R&D_1991	0.296* (0.154)	0.297* (0.157)	0.314** (0.148)	0.461* (0.241)	0.543*** (0.190)	0.447* (0.256)	0.395** (0.173)	0.238** (0.102)
Log Share R&D_2011	-0.0786 (0.0678)	-0.0808 (0.0729)	-0.0717 (0.0662)	-0.298 (0.248)	-0.374* (0.210)	-0.252 (0.277)	-0.173 (0.131)	
Log Share Graduates	-0.0225 (0.279)		-0.359 (0.316)	0.823 (0.702)	1.104* (0.581)	0.384 (0.960)		
Log Employment_2011	0.0108 (0.0639)	0.0122 (0.0630)	0.0154 (0.0630)	0.0664 (0.0900)	0.131* (0.0777)	0.0449 (0.0900)	0.0209 (0.0670)	0.0144 (0.0747)
Log Urbanization	0.179*** (0.0612)	0.177** (0.0695)	0.0971 (0.0612)	0.0956 (0.0913)		0.0716 (0.0753)	0.0854 (0.0577)	0.118** (0.0531)
Observations	76	76	74 Moscow and St.Petersburg dropped	76	76	74 Moscow and St.Petersburg dropped	74 Moscow and St.Petersburg dropped	74 Moscow and St.Petersburg dropped
R^2 (Centered R^2)	0.525	0.524	0.406	0.437	0.359	0.329	0.329	0.371

Heteroscedasticity-robust standard errors are in parentheses. Asterisks indicate p-value:

***	<1%
**	<5%
*	<10%

Table 12

Dependent variable is Log Emplchange	**(1) OLS**	**(2) OLS**	**(3) OLS**	**(4) OLS**	**(5) IV**	**(6) IV**	**(7) IV**
Log R&D_1991	0.011 (0.029)	0.022 (0.014)	0.008 (0.030)	0.018 (0.016)	0.054 (0.107)	0.040 (0.128)	-0.017 (0.046)
Log R&D_2011	0.001 (0.022)		0.002 (0.021)		-0.105 (0.103)	-0.109 (0.126)	
Log Empl_1991	-0.365*** (0.104)	-0.350*** (0.089)	-0.371*** (0.120)	-0.344*** (0.097)	-0.461** (0.234)	-0.516 (0.352)	-0.400** (0.154)
Log Grad	0.011 (0.009)		0.012 (0.010)		0.129 (0.102)	0.171 (0.146)	0.065 (0.073)
Log GRP	0.343*** (0.081)	0.333*** (0.067)	0.348*** (0.090)	0.332*** (0.073)	0.433** (0.194)	0.473* (0.281)	0.368*** (0.104)
Log Urban	0.009 (0.018)		0.014 (0.026)		-0.016 (0.041)	-0.009 (0.048)	0.022 (0.033)
Observations	76	76	74 Moscow and St.Petersburg dropped	74 Moscow and St.Petersburg dropped	76	74 Moscow and St.Petersburg dropped	74 Moscow and St.Petersburg dropped
R^2 (centered for IV)	0.6198	0.6119	0.5741	0.5643	-0.2269	-1.0596	0.3897

Heteroscedasticity-robust standard errors are in parentheses. Asterisks indicate p-value:

***	<1%
**	<5%
*	<10%

Table 13

Dependent variable is Log Productivity_IT	**(1) OLS**	**(2) OLS**	**(3) IV**	**(4) IV**	**(4) IV**	**(4) IV**	**(4) IV**	**(4) IV**
Log R&D _1991	0.306 (0.277)	0.252 (0.272)	0.640 (0.401)	0.617* (0.362)	0.450*** (0.160)	0.552 (0.369)	0.546 (0.350)	0.439*** (0.164)
Log R&D_2011	0.147 (0.187)	0.176 (0.187)	-0.210 (0.354)	-0.169 (0.293)		-0.119 (0.316)	-0.106 (0.280)	
Log GRP_percap	0.251 (0.335)	0.296 (0.334)	0.129 (0.632)			0.0487 (0.589)		
Log Urban	0.112 (0.168)	0.238 (0.214)	0.150 (0.187)	0.145 (0.192)	0.157 (0.184)	0.230 (0.225)	0.225 (0.242)	0.244 (0.240)
Observations	75	73 Moscow and St. Petersburg dropped	75	75		73 Moscow and St. Petersburg dropped	73 Moscow and St. Petersburg dropped	73 Moscow and St. Petersburg dropped
R^2 (centered for IV)	0.389	0.356	0.349	0.351	0.376	0.322	0.322	0.337

Heteroscedasticity-robust standard errors are in parentheses. Asterisks indicate p-value:

***	<1%
**	<5%
*	<10%

Table 14

Dependent variable is Log Productivity_Eng	**(1) OLS**	**(2) OLS**	**(3) OLS**	**(4) OLS**	**(5) IV**	**(6) IV**	**(7) IV**	**(8) IV**
Log R&D _1991	0.414*	0.248***	0.370*	0.269***	0.394	0.352***	0.362	0.353***
	(0.221)	(0.0815)	(0.219)	(0.0888)	(0.330)	(0.100)	(0.334)	(0.100)
Log R&D_2011	-0.176		-0.152		-0.0396		-0.00812	
	(0.178)		(0.176)		(0.281)		(0.280)	
Log GRP_percap	0.761**	0.724*	0.795**	0.767**	0.138	0.161	0.120	0.123
	(0.370)	(0.369)	(0.382)	(0.381)	(0.312)	(0.356)	(0.298)	(0.307)
Log Urban	-0.00622		0.0875		-0.0731	-0.0691	-0.0476	-0.0457
	(0.121)		(0.165)		(0.130)	(0.134)	(0.181)	(0.185)
Observations	76	76	74 Moscow and St. Petersburg dropped	74 Moscow and St. Petersburg dropped	76	76	74 Moscow and St. Petersburg dropped	74 Moscow and St. Petersburg dropped
R^2 (centered for IV)	0.297	0.284	0.282	0.269	0.241	0.241	0.215	0.214

Heteroscedasticity-robust standard errors are in parentheses. Asterisks indicate p-value:

***	<1%
**	<5%
*	<10%

Table 15

Dependent variable is Log Firms_Services	**(1) OLS**	**(2) OLS**	**(3) IV**	**(4) IV**
Log R&D_1991	0.368***	0.336**	0.484***	0.412**
	(0.126)	(0.135)	(0.174)	(0.210)
Log R&D_2011	-0.066	-0.049	-0.279**	-0.242*
	(0.058)	(0.061)	(0.132)	(0.132)
Log Grad	0.020	0.023	0.027	0.098
	(0.026)	(0.026)	(0.213)	(0.236)
Log GRP	0.554***	0.560***	0.710***	0.710***
	(0.077)	(0.079)	(0.094)	(0.096)
Log Urban	0.082	0.144*	0.069	0.099
	(0.062)	(0.073)	(0.086)	(0.083)
Observations	76	74 Moscow and St. Petersburg dropped	76	74 Moscow and St. Petersburg dropped
R^2 (centered for IV)	0.9233	0.9122	0.9046	0.8868

Heteroscedasticity-robust standard errors are in parentheses. Asterisks indicate p-value:

***	<1%
**	<5%
*	<10%

Table 16

Dependent variable is Log Firms_Others	**(1) OLS**	**(2) OLS**	**(3) IV**	**(4) IV**	**(5) IV**
Log R&D_1991	0.382*** (0.075)	0.359*** (0.076)	0.436** (0.192)	0.370 (0.248)	0.547*** (0.109)
Log R&D_2011	-0.073 (0.052)	-0.062 (0.052)	-0.387** (0.154)	-0.353** (0.160)	-0.265** (0.116)
Log Grad	0.026 (0.022)	0.028 (0.022)	0.351 (0.256)	0.410 (0.311)	
Log GRP	0.494*** (0.060)	0.501*** (0.060)	0.688*** (0.174)	0.692*** (0.200)	0.555*** (0.081)
Log Urban	0.002 (0.050)	0.039 (0.057)	-0.081 (0.086)	-0.056 (0.107)	
Observations	76	74 Moscow and St.Petersburg dropped	76	74 Moscow and St. Petersburg dropped	74 Moscow and St. Petersburg dropped
R^2 (centered for IV)	0.9226	0.9107	0.6891	0.8868	0.8866

Heteroscedasticity-robust standard errors are in parentheses. Asterisks indicate p-value:

***	<1%
**	<5%
*	<10%