The Transition and Path-Dependence in Knowledge-Intensive Industry Location: Case of Russian Professional Services

Denis Ivanov,

International Center for the Study

of Institutions and Development

- Whether there is a unique equilibrium in population or industry location pattern?

- Krugman, 1991: even temporary, idiosyncratic shocks may result in a new spatial equilibrium due to increasing returns to scale

Spatial pattern of population and individual industries is robust to war-related shocks

- Davis, Weinstein, 2002; 2008 – US bombing of Japan in WWII
- Brakman et al., 2004 – Allied bombing of Germany in WWII
- Miguel & Roland, 2011 – US bombing of Vietnam
- Mikhailova, 2012 – devastation of Soviet cities during hostilities in WWII

Natural experiment: Soviet-era central planning

- Under the Soviet central planning system, no market forces were involved in shaping industries' location patterns

- Notable examples:
  - Century-long pursuit to develop the North and Siberia (Hill&Gaddy, 2003; Mikhailova, 2004)
  - Reasons of military strategy; WWII legacy (evacuated production and research facilities)
  - Political reasons (industrialization of areas with dominant non-Russian population in order to preserve minorities' loyalty)

Professional services

Some features of professional services (PS) a.k.a. knowledge intensive business services (KIBS), high-order producer services (HOPS)

- Small amounts of physical capital used in production process, no immobile Soviet-era endowment

- Human capital is the most crucial production factor

- Relatively simple location pattern (big, prosperous and educated cities)

R&D sector and professional services

- Dramatic spending cuts in military, space exploration, academia

- Collapse of old-fashion research institutions and exodus of researchers towards industry

- Urgent need for high-skilled professionals in emerging service sector of the market economy (IT, finance, consulting)

- **Could geography of the Soviet-era R&D sector influence modern-day spatial pattern of professional servicers?**

- Sunk costs

  It is extremely costly to relocate physical capital even if it is located non-optimally

- Human capital externalities

  High-skilled workers benefit from spatial clustering, not from spatial dispersion

- Creative class theory

  Large pool of high-skilled workers is an urban amenity by itself

- Low migration due to market imperfections and poverty traps

  Industry location pattern may persist if people are stuck to places

Data

- I define professional services to comprise three industries (by statistical classification OKVED):
  - Engineering and architecture (OKVED 74.20.1)
  - Accounting, auditing and management consulting (OKVED 74.1 minus 74.11 "Legal services")
  - Information technology and computer-related services (OKVED 72)
- The sample includes 76 Russian regions (first-level administrative subdivisions)
- Cross-section regression

- Explanatory variable of interest – **number of researchers in 1991**

    Comprises R&D-related staff in specialized institutions and research subdivisions within industrial enterprises, not university lecturers

- Averaged for 2009-2011

- Treated as exogenous

Independent variables

- Controls are added to capture modern-day determinants of PS location

  Demand for consulting: GRP cost-of living adjusted (2009-2011 averaged) or overall employment in 2011 as a robustness check

  Current human capital: number of employees who hold university degree; number of R&D-involved staff in 2011

  Urbanization: weighted average of a region's cities and towns population (2010 census)

Instruments

- 1991 number of researchers in not instrumented

- Present-day variables require an instrument

- GRP with electricity consumption in 1991

- 2011 number of researchers with spending on basic research in 2011

- Other variables with their values in 1991 or 1989 (census)

Dependent 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

Dependent 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

Results: employment in PS IT- I

Dependent Log IT	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) IV	(6) IV	(7) IV	(8) IV
Log R&D_1991	0.361** (0.153)	0.298*** (0.095)	0.389** (0.154)	0.311*** (0.095)	0.503*** (0.192)	0.476*** (0.159)	0.599*** (0.208)	0.534*** (0.164)
Log R&D_2011	-0.084 (0.077)		-0.097 (0.077)		-0.243* (0.142)	-0.272* (0.144)	-0.291* (0.153)	-0.340** (0.152)
Log Graduates	0.013 (0.020)		0.011 (0.020)		-0.093 (0.251)		-0.188 (0.280)	
Log GRP	0.595*** (0.089)	0.566*** (0.091)	0.587*** (0.090)	0.555*** (0.092)	0.684*** (0.126)	0.719*** (0.109)	0.684*** (0.154)	0.753*** (0.109)
Log Urbanization	0.200*** (0.063)	0.214*** (0.060)	0.154** (0.074)	0.181** (0.068)	0.230** (0.099)	0.201*** (0.074)	0.191 (0.120)	0.139 (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

Results: employment in PS IT- II

Dependent Log IT	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) IV	(6) IV	(7) IV	(8) IV
Log R&D_1991	0.241 (0.156)	0.190* (0.101)	0.282* (0.151)	0.203** (0.099)	0.273 (0.183)	0.236** (0.103)	0.449** (0.181)	0.237** (0.103)
Log R&D_2011	-0.050 (0.073)		-0.078 (0.070)		-0.067 (0.147)		-0.120 (0.150)	
Log Graduates	-0.016 (0.017)		-0.020 (0.017)		0.054 (0.280)		-0.240 (0.313)	
Log Employment_2011	0.865*** (0.116)	0.854*** (0.125)	0.881*** (0.113)	0.860*** (0.125)	0.792*** (0.145)	0.777*** (0.148)	0.810*** (0.175)	0.798*** (0.150)
Log Urbanization	0.202*** (0.074)	0.203*** (0.068)	0.105* (0.063)	0.121 (0.058)	0.183* (0.092)	0.192*** (0.063)	0.149 (0.127)	0.117** (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

Results: employment in PS Consulting - I

Dependent 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

Dependent Log Consulting	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) IV	(6) IV	(7) IV	(8) IV
Log R&D_1991	-0.063 (0.180)	0.013 (0.108)	-0.032 (0.178)	0.041 (0.099)	-0.014 (0.232)	0.089 (0.106)	0.158 (0.321)	0.090 (0.103)
Log R&D_2011	0.086 (0.092)		0.061 (0.089)		0.232 (0.187)		0.183 (0.212)	
Log Graduates	0.006 (0.032)		0.003 (0.032)		-0.250 (0.350)		-0.552 (0.477)	
Log Employment_2011	0.985*** (0.147)	1.009*** (0.150)	1.006*** (0.145)	1.038*** (0.150)	0.838*** (0.209)	0.897*** (0.164)	0.860** (0.352)	0.944*** (0.167)
Log Urbanization	0.161** (0.076)	0.154** (0.077)	0.071 (0.091)		0.212 (0.133)	0.121 (0.080)	0.193 (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

Shares instead of absolute scores?

- Specification involving absolute scores is extremely sensitive to relevance of controls for regions' size

- Greater regions have greater number of researchers. Thus if its size is not properly controlled for, regression yields biased results

- **Use undustries' shares in employment instead of absolute regional scores?**

Results: Share of Engineering-I

Dependent Log Share Engineering	(1) OLS	(2) OLS	(3) IV	(2) IV	(2) IV	(2) IV
Log Share R&D_1991	0.416*** (0.132)	0.412*** (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)	-0.178** (0.0754)	-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)	0.119* (0.0662)	0.0960 (0.0852)	0.0622 (0.0964)	0.102 (0.0863)	0.0673 (0.0960)
Log Urbanization	0.136* (0.0686)	0.145 (0.0910)	0.152* (0.0813)	0.207** (0.0917)	0.140 (0.106)	0.165* (0.0955)
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)	0.556	0.474	0.550	0.511	0.465	0.403

Results: Share of Engineering-II

Dependent Log Share Engineering	(1) OLS	(2) OLS	(3) IV	(2) IV	(2) IV	(2) IV
Log Share R&D_1991	0.397*** (0.134)	0.394*** (0.136)	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)	-0.177** (0.0740)	-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)	0.179* (0.0898)	0.115 (0.0978)	0.0663 (0.0974)	0.123 (0.102)	0.0662 (0.101)
Log Urbanization	0.114 (0.0699)	0.118 (0.0937)	0.150** (0.0766)	0.207** (0.0806)	0.132 (0.106)	0.167* (0.0943)
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)	0.562	0.482	0.556	0.514	0.474	0.407

Results: Share of IT-I

Dependent Log Share Engineering	(1) OLS	(2) OLS	(3) IV	(2) IV	(2) IV	(2) IV
Log Share R&D_1991	0.296* (0.153)	0.315** (0.146)	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)	-0.0731 (0.0662)	-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)	0.0938 (0.0607)	0.0220 (0.124)		0.00198 (0.103)	
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)	0.526	0.407	0.265	0.241	0.064	0.307

Results: Share of IT-II

Dependent Log Share Engineering	(1) OLS	(2) OLS	(3) IV	(2) IV	(2) IV	(2) IV
Log Share R&D_1991	0.397*** (0.134)	0.394*** (0.136)	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)	-0.177** (0.0740)	-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)	0.179* (0.0898)	0.115 (0.0978)	0.0663 (0.0974)	0.123 (0.102)	0.0662 (0.101)
Log Urbanization	0.114 (0.0699)	0.118 (0.0937)	0.150** (0.0766)	0.207** (0.0806)	0.132 (0.106)	0.167* (0.0943)
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)	0.562	0.482	0.556	0.514	0.474	0.407

Productivity

- Higher productivity in areas with greater number of researchers in 1991 gives ground to believe in human capital externalities

- Lesser productivity in areas with greater number of researchers is a sign of poverty traps and overall location inefficiency

Results: Productivity - Engineering

Dependent Log Productivity_Eng	(1) OLS	(2) OLS	(3) IV	(4) IV	(5) IV	(6) IV
Log R&D_1991	0.414* (0.221)	0.370* (0.219)	0.394 (0.330)	0.352*** (0.100)	0.362 (0.334)	0.353*** (0.100)
Log R&D_2011	-0.176 (0.178)	-0.152 (0.176)	-0.0396 (0.281)		-0.00812 (0.280)	
Log GRP_per_capita_2011	0.761** (0.370)	0.795** (0.382)	0.138 (0.312)	0.161 (0.356)	0.120 (0.298)	0.123 (0.307)
Log_Urban	-0.00622 (0.121)	0.0875 (0.165)	-0.0731 (0.130)	-0.0691 (0.134)	-0.0476 (0.181)	-0.0457 (0.185)
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 for IV)	0.297	0.282	0.241	0.241	0.215	0.214

Results: Productivity - IT

Dependent Log Productivity_IT	(1) OLS	(2) OLS	(3) IV	(4) IV
Log R&D_1991	0.306 (0.277)	0.252 (0.272)	0.640 (0.401)	0.552 (0.369)
Log R&D_2011	0.147 (0.187)	0.176 (0.187)	-0.210 (0.354)	-0.119 (0.316)
Log GRP_per_capita_2011	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)	0.230 (0.225)
Observations	75	73 Moscow and St. Petersburg dropped	75	73 Moscow and St. Petersburg dropped
R^2 (centered for IV)	0.389	0.356	0.349	0.322

Entrepreneurship

- Human capital externalities may act through exchange in ideas and undertaking mutual projects

- Whether there is greater population of SMEs in regions with more R&D related staff in 1991?

Results: Entrepreneurship-I

Dependent Log Firms_Services	(1) OLS	(2) OLS	(3) IV	(4) IV
Log R&D_1991	0.368*** (0.126)	0.336** (0.135)	0.484*** (0.174)	0.412** (0.210)
Log R&D_2011	-0.066 (0.058)	-0.049 (0.061)	-0.279** (0.132)	-0.242* (0.132)
Log Grad	0.020 (0.026)	0.023 (0.026)	0.027 (0.213)	0.098 (0.236)
Log GRP	0.554*** (0.077)	0.560*** (0.079)	0.710*** (0.094)	0.710*** (0.096)
Log Urban	0.082 (0.062)	0.144* (0.073)	0.069 (0.086)	0.099 (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

Results: Entrepreneurship-II

Dependent Log Firms_Others	(1) OLS	(2) OLS	(3) IV	(4) IV	(5) IV
Log R&D_1991	0.382***	0.359***	0.436**	0.370	0.547***
	(0.075)	(0.076)	(0.192)	(0.248)	(0.109)
Log R&D_2011	-0.073	-0.062	-0.387**	-0.353**	-0.265**
	(0.052)	(0.052)	(0.154)	(0.160)	(0.116)
Log Grad	0.026	0.028	0.351	0.410	
	(0.022)	(0.022)	(0.256)	(0.311)	
Log GRP	0.494***	0.501***	0.688***	0.692***	0.555***
	(0.060)	(0.060)	(0.174)	(0.200)	(0.081)
Log Urban	0.002	0.039	-0.081	-0.056	
	(0.050)	(0.057)	(0.086)	(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

Conclusions

- Number or researchers in 1991 is correlated with present-day employment in engineering, architecture and IT; not in accounting, auditing and consulting

- Poverty traps are unlikely and human capital externalities are plausible

- Entrepreneurship is a plausible transmission mechanism for human capital externalities

Thank you
for your attention!

Contacts: d.s.ivanov@inbox.ru