Understanding heterogeneity of innovation modes: an evidence from Russian manufacturing sector

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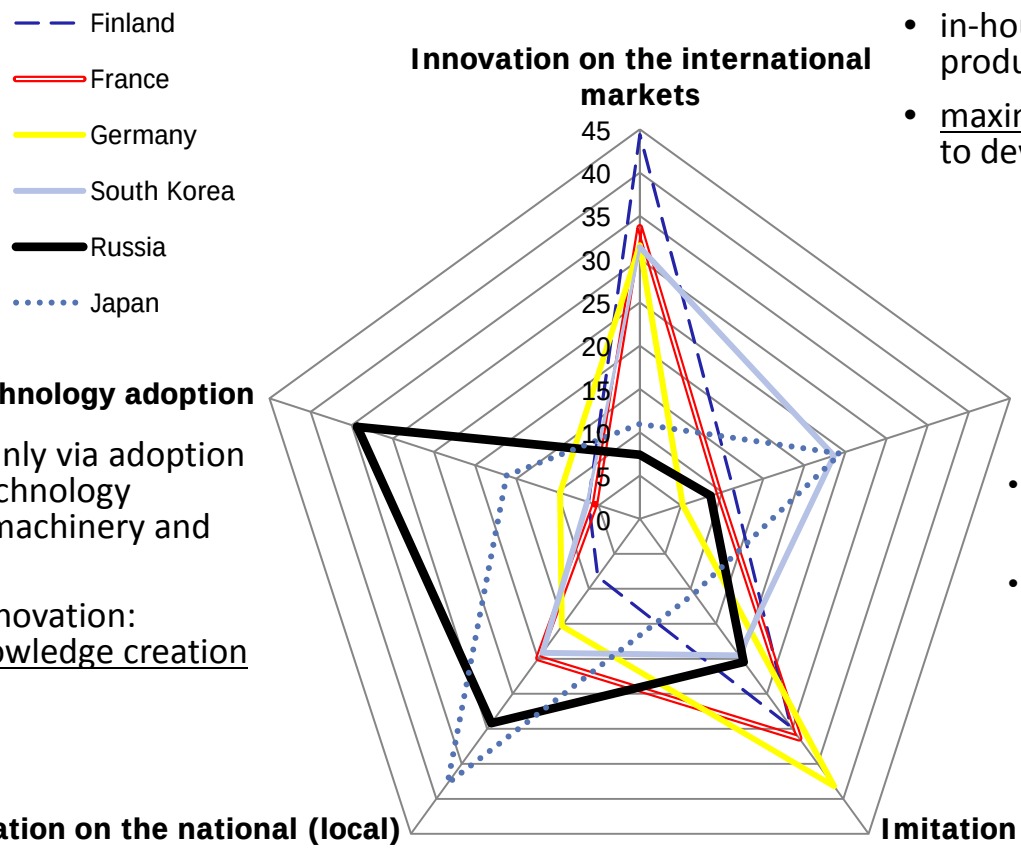
Differentiating innovation

- Innovative companies within the economy vary significantly
- This variation can be the source of inefficiency for the innovation policy
- A quest for understanding the peculiarities of innovative company types – taxonomies development
  - Innovation modes classification (OECD, 2008)

  <u>Dimensions:</u>
  - novelty to the market, implementation strategy, in-house vs. external effort

This study: econometric modeling based on innovation microdata for Russian manufacturing. 2002-2005, 2008: ~93000 companies, ~9000 innovative. Provided by ISSEK HSE

Innovation modes in Russian manufacturing



Technology adoption

- innovations mainly via adoption of embodied technology (acquisition of machinery and equipment)
- basic level of innovation: no in-house knowledge creation

- in-house development of world-novel product innovations
- maximum innovation potential, ability to develop the most radical innovation

Innovation on the national (local) market

- in-house development of product innovations new to national (local) markets, but not to international ones
- competitive leaders of Russian markets

Imitation on the national (local) markets

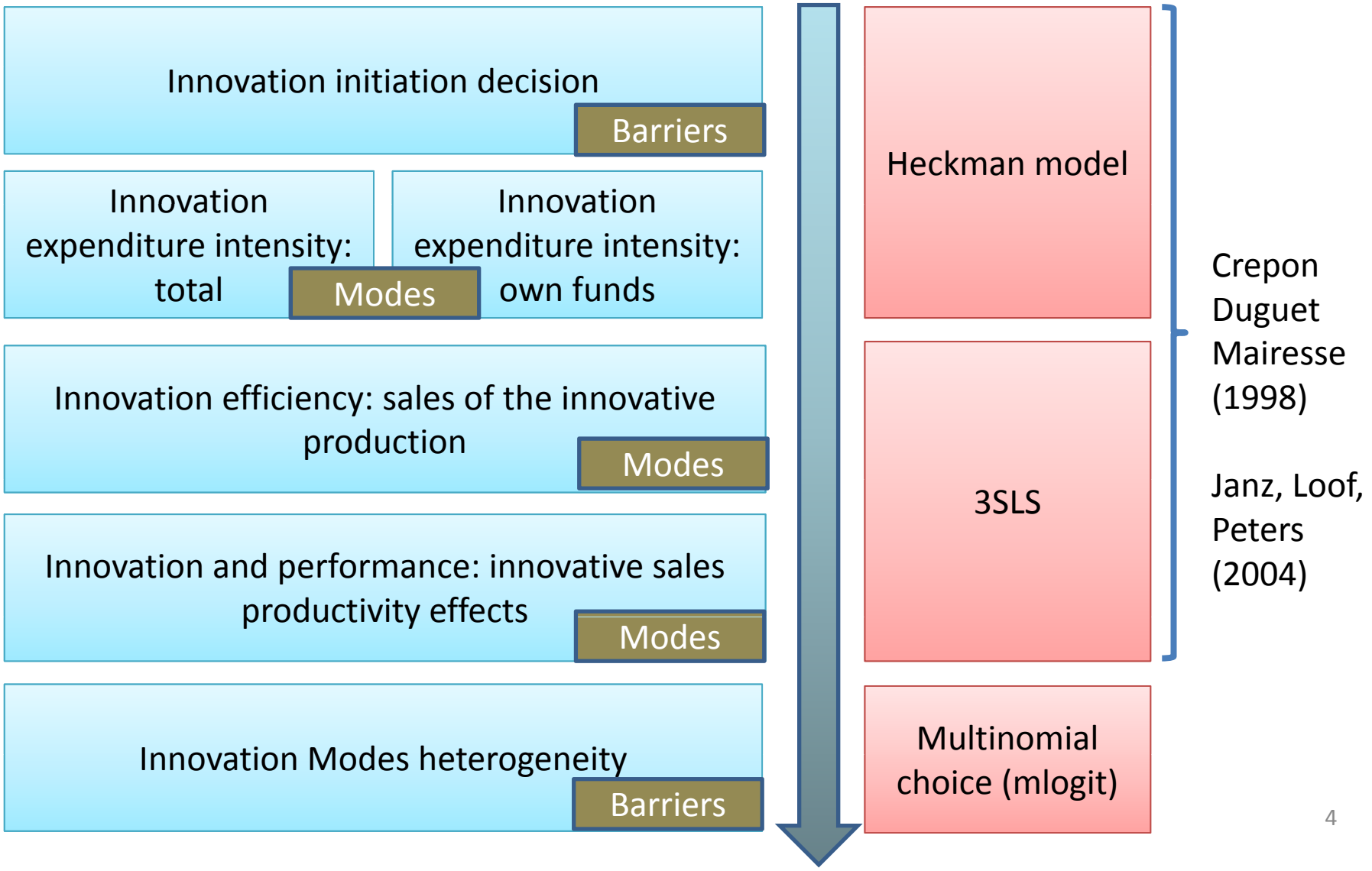
- imitation of products and technologies available on the national market
- diffusion of innovations

Imitation on the international markets

- in-house imitation of the most radical product innovations
- competitiveness in the global context

(% of innovative enterprises, 2008 or *nearest years).*

Econometric model



Innovation objectives

	Innovation intensity (effect on per-employee expenditure)
Cutting material/energy consumption	
Cutting labor costs	
Increase of flexibility of production	++
Expansion on traditional markets	
Entry to new markets	++
New products	--
Quality increase	--
Pollution reduction, ecological innovation	++
Scale increase	+++
Meeting with new technical regulation	++

- New product development and quality improvement corresponds to considerably lesser investment than of the extensive growth
- Innovation expenditure responses to the indirect incentives (e.g. environmental concerns and technical regulation)
- Increasing efficiency is not the objective for innovation expenditure

Innovation activities

	Relative cost (effect on total per-employee expenditure)	Efficiency (elasticity of sales of the innovative products by an activity)
Intramural R&D	★★★	★★★★★★★
Extramural R&D	★★	★★★
Technology acquisition		★★
Design and development	★★	★★★★★
Machinery and equipment acquisition	★★★★★★★	★★★★★★
Software development	★	★
Education and training		

- **R&D tends to be financed from the firm's own funds**
- **External funding (state, foreign) appears to increase overall expenditure intensity, but cuts own funds by more than a third.**

Innovation and property type

State companies	
Innovation expenditure intensity	★★
Innovation efficiency	★
Productivity	★

State-private companies	
Innovation expenditure intensity	★
Innovation efficiency	★★
Productivity	★★

Private companies	
Innovation expenditure intensity	★★
Innovation efficiency	★★★
Productivity	★★★

Foreign companies	
Innovation expenditure intensity	★★★★
Innovation efficiency	★★★★
Productivity	★★★★

- **Foreign companies demonstrate highest performance over all the criteria. State and state-private companies are outperformed by private firms.**

- **At the same time, the probability of starting innovation is significantly highest for state-private enterprises. State and foreign companies tend to innovate more rarely than private ones.**

Innovation and sector

High-tech	
Innovation expenditure intensity	★
Innovation efficiency	★★★★
Productivity	★

Med-high tech	
Innovation expenditure intensity	★
Innovation efficiency	★★★
Productivity	★★

Med-low tech	
Innovation expenditure intensity	★★★
Innovation efficiency	★★
Productivity	★★★

Low tech	
Innovation expenditure intensity	★★
Innovation efficiency	★★★★
Productivity	★★★

- **High-tech "miopia" vs. sectoral differentiation**

Innovation modes

	International innovators	National/local innovators	International Imitators	National/local imitators	Technology Adopters
Innovation expenditure intensity	★★	★★	★★★	★★★★	★
Innovation efficiency	★★★★★	★★★★	★★★	★★	★
Productivity	★★★	★★★	★★★★	★★	★
Formal IPR methods importance	★★		★★	—	—
Informal IPR methods importance			★★	★★★	—
State support	★	★★	★		—
Foreign funding			★★		

Cooperation

Knowledge producers

	R&D performers	Universities	Consultants
International innovators	★★	★	-
National/local innovators	★		
International imitators	★★		
National/local imitators	★★★		★
Technology adopters	-	-	

Market networks

	Clients	Suppliers	Competitors
International innovators			
National/local innovators		★★	-
International imitators	★★		
National/local imitators			
Technology adopters	★	-	★★

Barriers

	International innovators	National/ local innovators	International imitators	National/ local imitators	Technology adopters	Unfinished innovation	Non-innovative
Lack of own funds			—		—	★★★	—
Underdeveloped cooperative links						★★	
Low demand on novel products		★★			★★	—	—
Lack of state support	★★	—		—		★★	—
Inefficient innovation infrastructure	—			—		★	
Lack of information on markets				★★		★★	—
Lack of information on technologies			★★				★
Inefficient innovation-related legislature	★★		★★		—		—
Lack of qualified personnel							—
High economic risks		—	★★		—		
Low innovation potential	—		—				★★

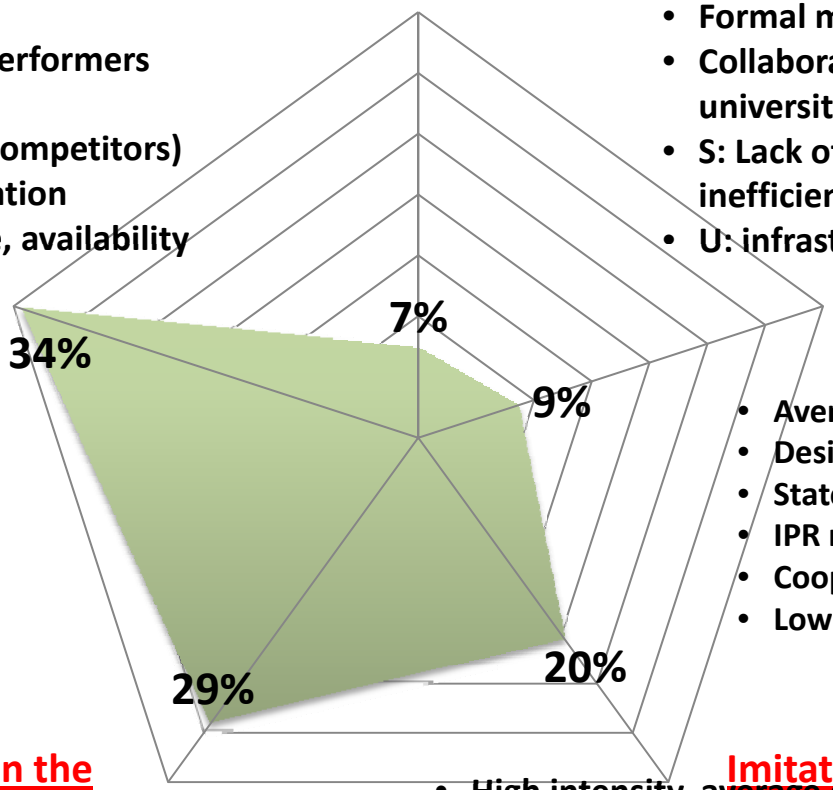
Composition of Russian innovation system

Technology adoption

- Lowest intensity and lowest efficiency
- Machinery acquisition
- No external funding
- IPR unrelated
- No cooperation with R&D performers and universities
- intra-market links (clients, competitors)
- S: lack of demand on innovation
- U: State support, legislature, availability of funds

Innovation on the international markets

- Low intensity, maximum efficiency
- Concentration on intramural R&D, cutting Extramural R&D, no tech acquisition
- State supported to some extent
- Formal methods of IPR
- Collaboration with R&D-performers, universities and clients
- S: Lack of state support, innovation regulation inefficiency
- U: infrastructure



Innovation on the national (local) market

- Average intensity, high efficiency
- Design and development
- State supported
- IPR not important
- Cooperate with R&D performers
- Low demand on innovative products

Imitation on the national (local) market

- Highest innovation intensity, low efficiency
- Machinery acquisition and in-house modification
- No external financing
- Formal unrelated, informal higly important
- Cooperation with suppliers and consultants
- S: Lack of information on the markets
- U: Regulation failure and state support

Imitation on the international markets

- High intensity, average efficiency
- Intramural R&D and machinery acquisition
- Moderate access to foreign and state funding
- Formal and Informal are of high importance
- Cooperation with R&D performers
- S: Regulation inefficiency, high economic risks, lack of information on new technologies
- U: Innovation potential problems, shortage of own funds

Innovation success

- **Reasons of failure**
  - Underfinancing
    - lack of own funds/lower absolute values
  - Underdeveloped cooperation
  - Innovation infrastructure inefficiency
  - Lack of state support
- **Reasons not to start**
  - Lack of information on the new technologies
  - Low innovation potential
  - Lack of own funds is less frequently mentioned than for innovative types
    - they don't even try

Инновационная активность (inno_active)			
Переменная	Коэффициент	Ст. Ош.	p-value
emp	0.00000944	4.82E-07	0
l_turn_emp	0.0217862	0.000766	0
emp_grad_emp	-0.0152187	0.005519	0.006
hasrddept	0.1647599	0.002275	0
ishightech	0.06816	0.003714	0
ismedhightech	0.0398052	0.002123	0
ismedlowtech	0.0000837	0.002362	0.972
issupply	-0.01337	0.018341	0.466
isstate	-0.0088587	0.002502	0
isforeign	-0.0087445	0.003244	0.007
isstateprivate	0.0159958	0.002237	0
b_lowpotential	-0.0281521	0.00205	0
b_nocoop	-0.0038098	0.002371	0.108
b_nodemand	0.0184218	0.001984	0
b_nogovsupport	0.0186628	0.001894	0
b_noinfrasructure	-0.0004407	0.002261	0.845
b_noknownmarke	0.0196913	0.002301	0
b_noknowntech	-0.0047681	0.00242	0.049
b_nolegislature	0.0331649	0.002133	0
b_nomoney	0.0758002	0.00266	0
b_nopersonnel	0.0097073	0.002118	0
b_risks	-0.0000649	0.001938	0.973
y2002	0.032243	0.002857	0
y2003	0.0091981	0.002762	0.001
y2004	0.0049935	0.002662	0.061
y2005	-0.0044346	0.002623	0.091
_cons	-3.280932	0.046845	0

Общие затраты на инновации (l_rtot_emp)				Собственные средства		
Переменная	Коэффициент	Ст. Ош.	p-value	Коэффициент2	Ст. Ош.3	p-value4
l_turn_emp	0.3580676	0.018212	0	0.3863572	0.018148	0
emp_grad_emp	1.788265	0.131038	0	1.478791	0.130574	0
has_exp_rdint	0.3891382	0.046053	0	0.3906837	0.045892	0
has_exp_rdest	0.2673961	0.051855	0	0.2415075	0.051673	0
has_exp_tech	-0.0858761	0.051046	0.093	-0.0257461	0.050868	0.613
has_exp_design	0.3368459	0.040352	0	0.3197808	0.040208	0
has_exp_machins	1.532631	0.039082	0	1.385571	0.038946	0
has_exp_software	0.0843127	0.045969	0.067	0.1448898	0.045804	0.002
has_exp_educatio	0.0681262	0.044862	0.129	0.1339659	0.044705	0.003
r_cutmoney_labor	0.0068789	0.047423	0.885	0.0093869	0.047258	0.843
r_cutmoney_mate	0.0301235	0.044548	0.499	0.0420722	0.044393	0.343
r_flexibility	0.1344946	0.039427	0.001	0.1113917	0.03929	0.005
r_marketex~a	0.0289758	0.043046	0.501	0.0242417	0.042896	0.572
r_marketex~d	0.1137902	0.045091	0.012	0.131575	0.044933	0.003
r_newproduts	-0.083178	0.051671	0.107	0.0214316	0.051491	0.677
r_quality	-0.09665	0.048123	0.045	-0.0958868	0.047955	0.046
r_reducepollution	0.1491809	0.043689	0.001	0.1637281	0.043537	0
r_scale	0.2543608	0.04108	0	0.1674765	0.040937	0
r_standards	0.1017409	0.042614	0.017	0.0791637	0.042466	0.062
ishightech	-0.011428	0.072094	0.874	0.0296513	0.071835	0.68
ismedhightech	-0.0056993	0.049174	0.908	0.0468893	0.048999	0.339
ismedlowtech	0.160043	0.051991	0.002	0.0954359	0.051806	0.065
issupply	1.109218	0.519396	0.033	0.4862786	0.517591	0.347
fund_gov	0.8934402	0.072844	0	-0.4329249	0.072588	0
fund_fdi	1.3641	0.206445	0	-0.6232125	0.205727	0.002
isstate	0.0033651	0.055237	0.951	0.0536131	0.055041	0.33
isforeign	0.3355496	0.064476	0	0.2354949	0.064245	0
isstateprivate	-0.0941986	0.043725	0.031	-0.076068	0.043568	0.081
modeo_1	0.4159809	0.077973	0	0.3437921	0.0777	0
modeo_2	0.4552146	0.078406	0	0.2509472	0.078134	0.001
modeo_3	0.4870339	0.070735	0	0.3772345	0.070488	0
modeo_4	0.5060081	0.06799	0	0.3432822	0.067755	0
modeo_5	0.3357757	0.055461	0	0.2172608	0.055268	0
ip_formal	-0.0323535	0.041214	0.432	-0.0583463	0.041071	0.155
ip_informal	-0.0292358	0.040843	0.474	-0.0162217	0.040701	0.69
y2002	-0.378568	0.058289	0	-0.1254867	0.058081	0.031
y2003	-0.3156401	0.057926	0	-0.0622548	0.05772	0.281
y2004	-0.2950381	0.055745	0	-0.1396212	0.055546	0.012
y2005	-0.2440746	0.055916	0	-0.0867343	0.055717	0.12
_cons	-2.373009	0.156666	0	-2.619879	0.156109	0

Инновационные продажи (l_i_sales_p_emp): R^2=0.34			
Переменная	Коэффициент	Ст. Ош.	p-value
l_turn_emp	0.4338263	0.0673598	0
emp_grad_emp	0.9038963	0.1920829	0
l_exp_rdint_emp	0.1791856	0.0201462	0
l_exp_rdext_emp	0.0855871	0.0260213	0.001
l_exp_tech_emp	0.0263695	0.0190898	0.167
l_exp_design_emp	0.1273389	0.019286	0
l_exp_machines_e	0.1311734	0.0145074	0
l_exp_software_e	-0.0262611	0.021843	0.229
l_exp_education_e	-0.0136165	0.0182847	0.456
modeo_1	2.307258	0.0870985	0
modeo_2	2.373625	0.0876235	0
modeo_3	2.242119	0.0809646	0
modeo_4	2.061739	0.0761514	0
modeo_5	1.565285	0.0612563	0
ip_formal	0.0859816	0.049722	0.084
ip_informal	0.2127289	0.0485337	0
fund_gov	-0.2935918	0.0901355	0.001
fund_fdi	0.5489114	0.2496074	0.028
ishightech	0.5163648	0.1589232	0.001
ismedhightech	0.4036692	0.137868	0.003
ismedlowtech	0.3052936	0.1334633	0.022
islowtech	0.5293024	0.1292927	0
isstate	-0.0773576	0.0703802	0.272
isforeign	0.2199669	0.0839444	0.009
isstateprivate	-0.0232731	0.0535252	0.664
y2002	0.8843864	0.0988013	0
y2003	0.9181378	0.0880443	0
y2004	0.9884211	0.0776687	0
y2005	0.8849495	0.0723984	0
mratio	-0.0946012	0.0504564	0.061
_cons	-3.110417	0.4981108	0

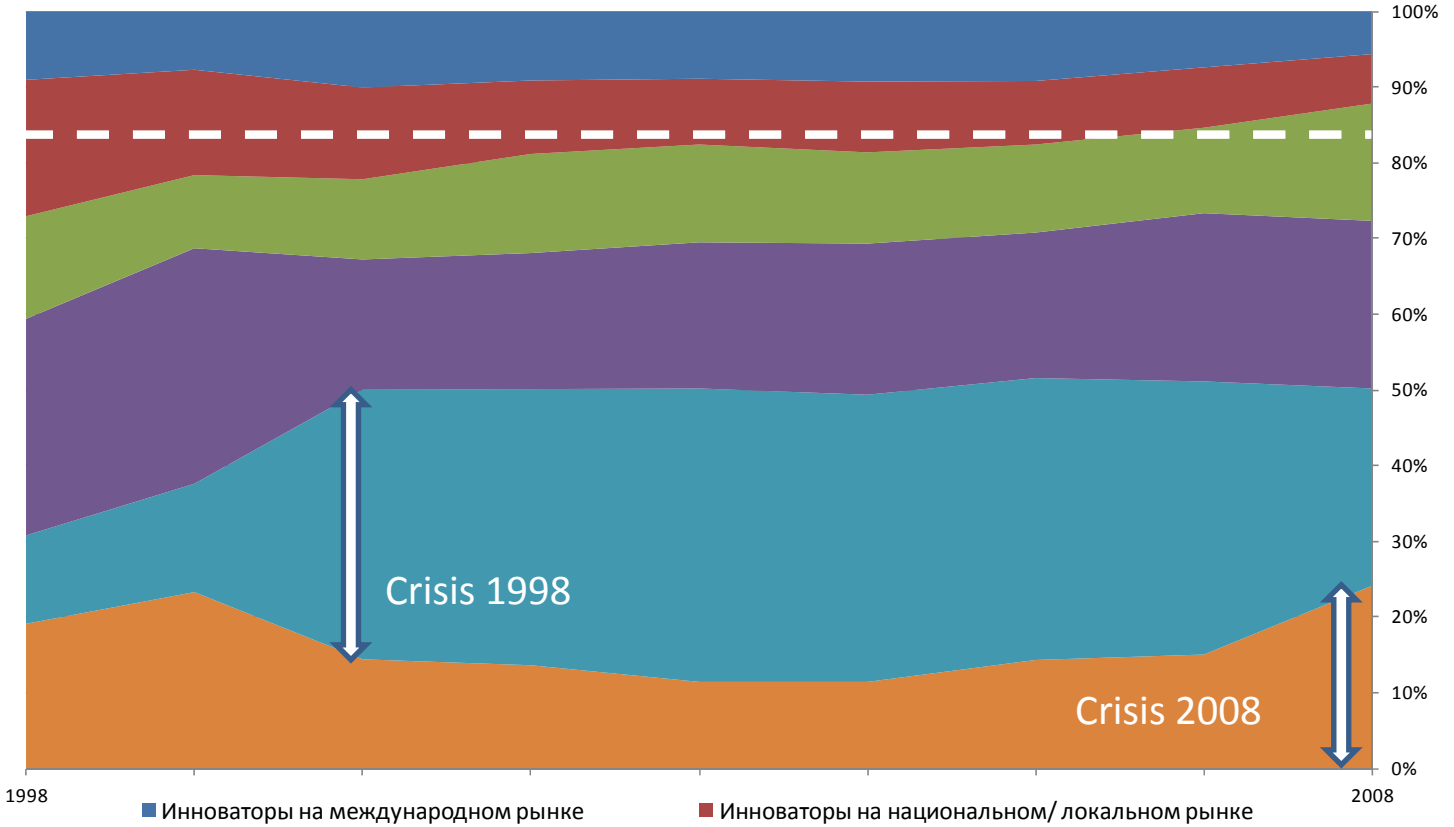
Производительность труда (l_turn_emp): R^2=0.48			
Переменная	Коэффициент	Ст. Ош.	p-value
l_invest_emp	0.1935075	0.0054525	0
emp	-0.0000132	1.49E-06	0
emp_grad_emp	1.341717	0.0677852	0
l_i_sales_emp	0.0783649	0.0093432	0
ishightech	-0.6722462	0.0628418	0
ismedhightech	-0.4106482	0.0563405	0
ismedlowtech	-0.0335831	0.0571521	0.557
islowtech	0.019938	0.0560323	0.722
isstate	-0.3133055	0.0280284	0
isforeign	0.3261125	0.0333314	0
isstateprivate	-0.0912042	0.0227716	0
y2002	-1.018348	0.0279066	0
y2003	-0.7948914	0.0287187	0
y2004	-0.5963473	0.0283299	0
y2005	-0.4360209	0.0284221	0
mratio	-0.3628566	0.0179749	0
_cons	6.410903	0.0675173	0

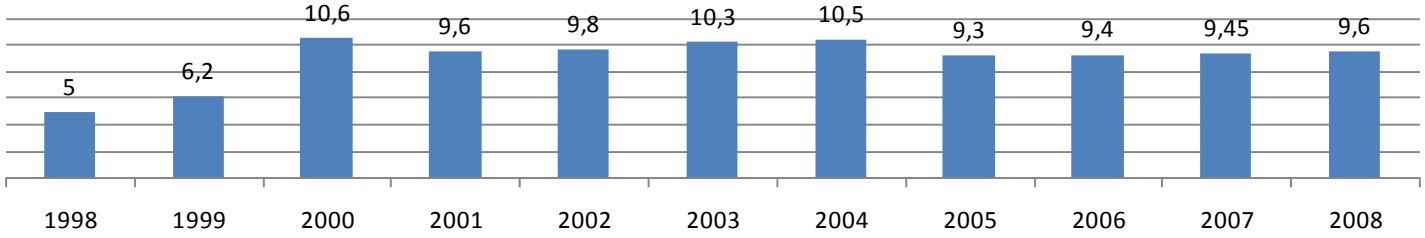
	Инноваторы на международном рынке			Инноваторы на национальном и локальном рынке		
Барьер	**Эффект**	**Ст. ош.**	**p-value**	**Эффект**	**Ст. ош.**	**p-value**
Низкий инновационный потенциал предприятия	-0.0123449	0.007174	0.085	**0.004737**	**0.0067251**	**0.481**
	-0.0029134	**0.007562**	**0.7**	0.0036688	0.007536	0.626
Низкий спрос на инновационную продукцию	-0.0018857	0.006553	0.774	**0.0075293**	0.006241	0.228
Недостаток господдержки	**0.0089025**	0.006789	0.19	-0.0117201	0.0062994	0.063
Неэффективность инновационной инфраструктуры	-0.0139627	0.007001	0.046	**0.0062383**	**0.0069374**	**0.369**
Недостаток информации о рынках сбыта	0.0015556	0.007372	0.833	-0.0033859	0.0071656	0.637
Недостаток информации о новых технологиях	0.0049921	0.007777	0.521	-0.0127927	0.0078473	0.103
Несовершенство законодательства в инновационной сфе	**0.0095294**	0.006584	0.148	-0.0067032	0.0066118	0.311
Недостаток собственных денежных средств	0.00383	0.011783	0.745	-0.0005659	0.0099375	0.955
Нехватка квалифицированного персонала	0.0042629	0.00689	0.536	0.0034895	0.0067331	0.604
Высокие экономические риски	0.0004716	0.006403	0.941	-0.013297	0.0062702	0.034

	Имитаторы на международном рынке			Имитаторы на национальном и локальном рынке		
Барьер	**Эффект**	**Ст. ош.**	**p-value**	**Эффект**	**Ст. ош.**	**p-value**
Низкий инновационный потенциал предприятия	-0.0139323	0.0079586	0.08	**0.0069174**	**0.0083373**	**0.407**
	-0.0139397	0.0085268	0.102	-0.0101817	0.0094562	0.282
Низкий спрос на инновационную продукцию	0.0009567	0.0071801	0.894	0.0000761	0.00769	0.992
Недостаток господдержки	**0.0026429**	**0.0074001**	**0.721**	-0.0168115	0.0076836	0.029
Неэффективность инновационной инфраструктуры	-0.0052943	0.0076932	0.491	-0.0120234	0.0086462	0.164
Недостаток информации о рынках сбыта	-0.0118723	0.0082591	0.151	0.0164674	0.0086792	0.058
Недостаток информации о новых технологиях	0.0224067	0.0085526	0.009	**-0.0011439**	**0.0093843**	**0.903**
Несовершенство законодательства в инновационной сфере	0.0248	0.0073062	0.001	**-0.0197555**	**0.0080944**	**0.015**
Недостаток собственных денежных средств	-0.0272404	0.0125039	0.029	**-0.0026447**	**0.012421**	**0.831**
Нехватка квалифицированного персонала	0.0037884	0.0076191	0.619	-0.0064579	0.0082616	0.434
Высокие экономические риски	**0.035111**	**0.0072487**	**0**	**-0.0062305**	**0.0076366**	**0.415**

	Технологические заимствования			Незавершенные инновации		
Барьер	**Эффект**	**Ст. ош.**	**p-value**	**Эффект**	**Ст. ош.**	**p-value**
Низкий инновационный потенциал предприятия	0.0022155	0.0114872	0.847	0.0124073	0.0086322	0.151
	-0.0107482	0.0126236	0.395	**0.0341142**	**0.009295**	**0**
Низкий спрос на инновационную продукцию	**0.0093772**	0.0106336	0.378	**-0.0160536**	**0.0081977**	**0.05**
Недостаток господдержки	**0.0027529**	**0.010765**	**0.798**	**0.0142334**	**0.0082951**	**0.086**
Неэффективность инновационной инфраструктуры	0.0049783	0.011649	0.669	**0.0200638**	**0.0088296**	**0.023**
Недостаток информации о рынках сбыта	**0.002507**	**0.0119684**	**0.834**	-0.0052718	0.0091857	0.566
Недостаток информации о новых технологиях	-0.007826	0.0128282	0.542	-0.0056362	0.0097063	0.561
Несовершенство законодательства в инновационной сфере	**-0.0193877**	**0.0110129**	**0.078**	0.011517	0.0084525	0.173
Недостаток собственных денежных средств	-0.0491458	0.0175441	0.005	**0.0757668**	**0.0160682**	**0**
Нехватка квалифицированного персонала	-0.0150789	0.011425	0.187	0.0099961	0.0086176	0.246
Высокие экономические риски	-0.0179951	0.0104842	0.086	0.00194	0.0080732	0.81

10 years of innovation modes stability





Удельный вес инновационно-активных предприятий в общем числе промышленных предприятий (%)