Productivity, learning, product innovations and competitive pressure in Russian manufacturing firms
within a project “Factor affecting productivity in Russian firms in basic non-resource industries”
together with Yu. Simachev, M. Kuzyk, S. Schuvalov, N. Zudin, M. Yurevich

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ASEEES
San Francisco, 2019
The World’s Productivity 2017

Productivity Per Person Per Hour

|-------|--------------|--------------|--------------|------------|

Productivity Per Person Per Hour (Selected 35 Countries)

Article and Sources

https://howmuch.net/articles/worlds-most-productive-countries
International Monetary Fund; Organisation for Economic Co-operation and Development
What are main features of foreign programs targeting higher productivity?

Based on: Kazakhstan 2011, Brazil 2016, India 2011, UK 2015, Finland 2016, Malaysia 1962, Korea 1978, USA 1980:

• long-term planning (without short-term expectations)
• wide coverage of participating firms (no exclusion)
• targeting not only particular sectors, but the economy as a whole
• combination of technological and organizational innovation
• usage of existing infrastructure, development institutions
• not only government organizations are included
• combination of different forms of support
• emphasis on the spread of advanced competencies, development of human capital
What’s about Russian program aimed at higher productivity?

Nacional'nyj proekt «Proizvoditel'nost' truda i podderzhka zanyatosti»

- Approved in December 2018 according to Presidential Executive Order On National Goals and Strategic Objectives issued May 7, 2018
- Currently is under review and amendments
- Main features of the program:
  - targets mainly large and medium-sized enterprises in basic non-resource sectors of the economy (agriculture, manufacturing, retail, construction, transportation)
  - chooses organizational innovations as a main instrument (among technological, product and organizational innovations)
  - has no connections with programs aimed at export potential and human capital development
  - doesn’t assume joint measures together with innovative infrastructure – techno parks, engineering centres and so on
What does empirical literature say about factors affecting productivity?
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- **Export affects productivity through “learning by doing” and “learning by exporting” effects**
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- **Innovations affect productivity**
  - Endogenous growth models: Grossman and Helpman, 1990b; Romer 1986;
  - R&D-Innovation-Productivity model proposed by Crepon et.al. 1998 and a large number of the followers: for Russia: Roud 2007, Trachuk, Linder 2017; Fedyunina, Radošević, 2019
  - Self-selection into innovation: Bustos 2011;
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- **Human capital and learning affects productivity**
  - Endogenous growth models: Romer 1986; Lucas 1988  
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- Human capital and learning affects productivity
  - Endogenous growth models: Romer 1986; Lucas 1988

- (!) There is also a relationship between export, innovations and human capital and there is competition affecting all these factors
Theoretical model based on literature survey

Source: Authors’ elaboration
Data

- Survey “Factors affecting productivity in Russian manufacturing industries” conducted by HSE in 2019
  - 4 basic non-resource industries: Agriculture, Manufacturing, Construction and Transport
  - 713 firms representative across sectors (but not across regions)
  - 4 sections in questionnaire:
    - (i) basic characteristics
    - (ii) employees and labor productivity
    - (iii) R&D, innovations and learning
    - (iv) government support
Self-estimated productivity and foreign competitors

- On average, only 46% of Russian firms have equivalent productivity according to their own estimation.
- Lag in productivity is lower for young firms, investment active firms, firms introducing digital techs, and firms working on foreign markets.

Source: Author’ calculations based on survey “Factor affecting productivity in Russian firms in basic non-resource industries”
### Change in productivity across sectors and basic indicators at the firm level 2013-2018

Descriptive stats for the firms that reported growth of productivity in 2013-2018:

<table>
<thead>
<tr>
<th>Productivity per employee</th>
<th>Agriculture</th>
<th>Manufacturing</th>
<th>Transport</th>
<th>Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 200K RUR</td>
<td><img src="image" alt="Pie Chart" /></td>
<td><img src="image" alt="Pie Chart" /></td>
<td><img src="image" alt="Pie Chart" /></td>
<td><img src="image" alt="Pie Chart" /></td>
</tr>
<tr>
<td>200-400K RUR</td>
<td><img src="image" alt="Pie Chart" /></td>
<td><img src="image" alt="Pie Chart" /></td>
<td><img src="image" alt="Pie Chart" /></td>
<td><img src="image" alt="Pie Chart" /></td>
</tr>
<tr>
<td>400-700K RUR</td>
<td><img src="image" alt="Pie Chart" /></td>
<td><img src="image" alt="Pie Chart" /></td>
<td><img src="image" alt="Pie Chart" /></td>
<td><img src="image" alt="Pie Chart" /></td>
</tr>
<tr>
<td>700-1500K RUR</td>
<td><img src="image" alt="Pie Chart" /></td>
<td><img src="image" alt="Pie Chart" /></td>
<td><img src="image" alt="Pie Chart" /></td>
<td><img src="image" alt="Pie Chart" /></td>
</tr>
<tr>
<td>&gt;1500K RUR</td>
<td><img src="image" alt="Pie Chart" /></td>
<td><img src="image" alt="Pie Chart" /></td>
<td><img src="image" alt="Pie Chart" /></td>
<td><img src="image" alt="Pie Chart" /></td>
</tr>
</tbody>
</table>

- **Revenue**
  - Agriculture: ![Graph](image)
  - Manufacturing: ![Graph](image)
  - Transport: ![Graph](image)
  - Construction: ![Graph](image)

- **Number of employees**
  - Agriculture: ![Graph](image)
  - Manufacturing: ![Graph](image)
  - Transport: ![Graph](image)
  - Construction: ![Graph](image)

- **Salary of employees**
  - Agriculture: ![Graph](image)
  - Manufacturing: ![Graph](image)
  - Transport: ![Graph](image)
  - Construction: ![Graph](image)

- **R&D spending**
  - Agriculture: ![Graph](image)
  - Manufacturing: ![Graph](image)
  - Transport: ![Graph](image)
  - Construction: ![Graph](image)

- **Export**
  - Agriculture: ![Graph](image)
  - Manufacturing: ![Graph](image)
  - Transport: ![Graph](image)
  - Construction: ![Graph](image)

- **Investment**
  - Agriculture: ![Graph](image)
  - Manufacturing: ![Graph](image)
  - Transport: ![Graph](image)
  - Construction: ![Graph](image)

**Source:** Author’ calculations based on survey “Factor affecting productivity in Russian firms in basic non-resource industries”
Export, productivity and competitiveness

Export and productivity in agriculture and manufacturing

- Self-selection into exporting in manufacturing and agriculture
- Exporters report higher tech level in comparison with Russian firms, but not in comparison to foreign ones

Technological level and distance to leaders

In comparison with Russian firms
- Significantly higher: 6.3% vs. 12.9%
- Equivalent: 79.6% vs. 81.4%
- Significantly lower: 14.1% vs. 5.7%

In comparison with foreign firms
- Significantly higher: 0.8% vs. 47.3%
- Equivalent: 47.3% vs. 51.9%
- Significantly lower: 2.4% vs. 52.6%

Source: Author’s calculations based on survey “Factor affecting productivity in Russian firms in basic non-resource industries”
## Catch up and new-to-market products

<table>
<thead>
<tr>
<th>No process and organizational innovations</th>
<th>Process and organizational innovations + share of investments in revenue &gt;10%</th>
<th>Process and organizational innovations + share of investments in revenue &gt;20%</th>
</tr>
</thead>
<tbody>
<tr>
<td>236</td>
<td>173</td>
<td>133</td>
</tr>
<tr>
<td>12,2%</td>
<td>1,7%</td>
<td>18,8%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No product innovations</th>
<th>Product innovations + share of R&amp;D in revenue &gt;1%</th>
<th>Product innovations + share of R&amp;D in revenue &gt;2%</th>
</tr>
</thead>
<tbody>
<tr>
<td>74</td>
<td>62</td>
<td>33,9%</td>
</tr>
</tbody>
</table>

- **Product, process and organizational innovations** have complementary effect on the introduction of new-to-market products.
- **Process and organizational innovations and investments in fixed assets** almost do not affect the introduction of new-to-market products.

Source: Author’ calculations based on survey “Factor affecting productivity in Russian firms in basic non-resource industries”
Employee training and competitiveness

There are some evidence of increasing differences in the skills level among firms:
• Laggards in productivity do not hire new employees
• Leaders in productivity hire new employees and train existing staff

Source: Author’ calculations based on survey “Factor affecting productivity in Russian firms in basic non-resource industries”
Empirical equations

Productivity leader\(_i\) = \(a_1 + b_{1;1}Training_i + b_{1;2}Innovation\text{ Intensity}_i + b_{1;3}Export\text{ Intensity}_i + \delta_1\text{Competition}_i + \gamma_1X_i + g_1\text{Salary fund}_i + g_2\text{Investments}_i + g_3\text{Taxes}_i + w_{1;1}\text{Region}_i + w_{2;1}\text{Industry}_i + \epsilon\)

Training\(_i\) = \(a_2 + b_{2;1}R&D_i + b_{2;2}Innovation\text{ Intensity}_i + b_{2;3}Export\text{ Intensity}_i + b_{2;4}\text{Productivity leader}_i + \delta_2\text{Competition}_i + \gamma_2X_i + g_4\text{Availability of labor}_i + w_{2;1}\text{Region}_i + w_{2;2}\text{Industry}_i + \epsilon\)

Innovation\(_i\) = \(a_3 + b_{3;1}R&D_i + b_{3;2}Training_i + b_{3;3}Export\text{ Intensity}_i + b_{3;4}\text{Productivity leader}_i + \delta_3\text{Competition}_i + \gamma_3X_i + g_5\text{Innovation barriers}_i + w_{3;1}\text{Region}_i + w_{3;2}\text{Industry}_i + \epsilon\)

R&D\(_i\) = \(a_4 + b_{4;1}Innovation_i + b_{4;2}Training_i + b_{4;3}Export\text{ Intensity}_i + b_{4;4}\text{Productivity leader}_i + \delta_4\text{Competition}_i + \gamma_4X_i + g_6\text{Access to technologies}_i + w_{4;1}\text{Region}_i + w_{4;2}\text{Industry}_i + \epsilon\)

Export\(_i\) = \(a_5 + b_{5;1}Innovation_i + b_{5;2}Training_i + b_{5;3}Export\text{ Intensity}_i + b_{5;4}\text{Productivity leader}_i + \delta_5\text{Competition}_i + \gamma_5X_i + g_7\text{Export barriers}_i + w_{5;1}\text{Region}_i + w_{5;2}\text{Industry}_i + \epsilon\)
Dependent variables

Productivity leader – a firm which is within top-20% of firms in industry according to productivity level

Export intensity – share of export in revenue >10%

R&D – share of R&D in revenue >1%

Innovation intensity – number of innovations introduced during the last 5 years / introduction of technological innovations / introduction of non-technological innovations

Training – more than 10% of employees in a firm received training during the last 5 years
Methods

We employ 3SLS procedure

- System of equations is obviously endogenous
- Estimation technique should correct simultaneity bias
- Should be at least 2-step procedure with instrumental (strongly exogenous) variables for each equation
- Dependent variables are explicitly taken to be endogenous to the system and are treated as correlated with the disturbances in the system’s equations.
- Exogenous variables serve as instruments
### Empirical results (1)

<table>
<thead>
<tr>
<th></th>
<th>Productivity leader</th>
<th>Export</th>
<th>R&amp;D</th>
<th>Innovation</th>
<th>Training</th>
</tr>
</thead>
<tbody>
<tr>
<td>Productivity leader</td>
<td>x</td>
<td>+***</td>
<td>n.s.</td>
<td>+*</td>
<td>n.s.</td>
</tr>
<tr>
<td>Export (&gt;5% in revenue)</td>
<td>+***</td>
<td>x</td>
<td>+***</td>
<td>n.s.</td>
<td>-**</td>
</tr>
<tr>
<td>R&amp;D (&gt;10% employees)</td>
<td>n.s.</td>
<td>n.s.</td>
<td>x</td>
<td>n.s.</td>
<td>+***</td>
</tr>
<tr>
<td>Innovation</td>
<td>n.s.</td>
<td>n.s.</td>
<td>+**</td>
<td>x</td>
<td>n.s.</td>
</tr>
<tr>
<td>Training (&gt;5% in revenue)</td>
<td>+*</td>
<td>+***</td>
<td>n.s.</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Owner - State</td>
<td>+*</td>
<td>-*</td>
<td>n.s.</td>
<td>-*</td>
<td>n.s.</td>
</tr>
<tr>
<td>Owner - Foreign</td>
<td>+**</td>
<td>+***</td>
<td>.**</td>
<td>n.s.</td>
<td>+*</td>
</tr>
<tr>
<td>Size (5 categories)</td>
<td>-*</td>
<td>+**</td>
<td>+*</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Age (5 categories)</td>
<td>n.s.</td>
<td>+**</td>
<td>+*</td>
<td>n.s.</td>
<td>+***</td>
</tr>
<tr>
<td>Medium competition with Russian firms</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Medium competition with foreign firms</td>
<td>n.s.</td>
<td>n.s.</td>
<td>+***</td>
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<td>-*</td>
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<tr>
<td>Strong competition with Russian firms</td>
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<td>n.s.</td>
<td>+*</td>
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<td>n.s.</td>
<td>+*</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Industry FE (4 sectors)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Region FE (23 regions)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

n.s. – not significant, * - significant at 10% level, ** - 5% level, *** - 1% level
Empirical results (2)

Diagram:
- Competition
- R&D
- Innovations
- Productivity
- Training
- Export

Arrows indicate relationships or flows between the concepts.
**Empirical results (3)**

- Productivity:
  - Training and exports increase productivity
- Training equation:
  - Doing R&D pushes firm to train its workers (sources for R&D?)
  - Smaller exporters are more involved into employee training (train to export more)
  - Productivity and innovations aren’t significant for employee training
- R&D equation:
  - Training determines higher R&D intensity
- Innovation equation:
  - Higher productivity increases innovations (self-selection into innovations)
- Export equation:
  - Higher productivity increases export (self-selection into exports)
- Competition:
  - Competition increases R&D intensity
  - Competition decreases training (fear to lose highly educated staff?)
  - No effects on productivity and innovations
Outcomes and Policy recommendations

- There is a divergence in productivity levels not only between, but also within industries and regions
- Within-industry divergence is driven by lack of innovations and human capital shortage in less-developed locations
- Government support is oriented towards relatively large firms, which are, in a nature, more productive themselves
- Organizational innovations and investments into fixed assets do not provide introduction of new products

→ Approved policy measures will further increase the divergence

- Government support should be extended to small enterprises and other sectors
- Additional measures towards productivity convergence within industries should be introduced
- Instruments should include measures promoting export activity and training programs
- Additional measures should be provided to generate positive linkages between innovation activity and productivity at the firm level