Problems of Economic Theory

Studies of the Russian Economy

Issues of Economic Policy

Hot Topic
Round Table: New East Policy and Far East Priority. Regional Problems

2018
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Problems of Economic Theory

O.Yu. Bondarenko
A.V. Zakharov
Measurement of Social Status in Experimental Games

E. M. Bronshtein
O. M. Fatkhiev
A Note on St. Petersburg Paradox

A. G. Malanichev
Modelling of Economic Oscillations of Shale Oil Production
 Measurement of Social Status in Experimental Games

Abstract. Most social and economic interactions involve people of different social status. People define their social standing in diverse ways by virtue of their age, job position, sufficiency or some other reasons. In this paper we investigate to what extent an individual’s perception of own status can be formed through participation in an experimental economic game. In our experiment paired up subjects consequently played the Dictator game, the Trust game and the Wage-Effort game. After each game we measured the resulting subjective socio-economic status of participants with two different scales. We have shown, that it was the Dictator game that exerted the most powerful impact on participants’ perception of their own status, as the perceived status of those who had acted as dictators (allocators) turned out to be significantly higher, than that of recipients. In the other games such effect of game roles on a status of players was not found. The subjective status was also affected by such participants' personal traits, as confident behavior, gender, material well-being etc.

Keywords: social status, game theory, Dictator Game, group behavior.

JEL Classification: C72, C91, D83, Z13.

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1. Introduction

Many social interactions show an asymmetric pattern. Firms and government agencies are the examples of hierarchies with grass-root members at the bottom and leaders at the top. If an individual has an attribute, highly valued among the members of his social group, he enjoys high position within the group and becomes its formal or informal leader (Weber, 1978; Magee, Galinsky, 2008).

Possessing high status and the advantages that come along with it – such as esteem and admiration on the part of the other group members, power and access to resources – was always valued and attractive even as early as in primordial communities (Gil-White, Henrich, 2001). Striving to raise a personal status is one of the essential dimensions of human behavior (Anderson et al., 2015; Bothner et al., 2009). For this reason some individuals are willing to give up a portion of income earned in the experiment (Heffetz, Frank, 2008), while others are more trustful to those who enjoy access to valuable resources (Thye, 2000). Individuals tend to more willingly simulate behavior of higher-status individuals, than that of their peers (Gil-White, Henrich, 2001; Chudek et al., 2012). High-profile individuals often become opinion leaders and promote the spread of innovations, beliefs and consumption patterns in society.
The issue of our central focus was to find, whether it could be possible to have an individual to perceive his status as heightened or lowered through the economic experiment. To our knowledge, this study was to be the first to examine the subject. Our experiment involved playing three games, namely, “Dictator”, “Trust” and “Wage-Effort” (literally — “Labor contract” game, but these words are never found in literature), where the participants were randomly assigned to roles in each game.

After each game the participants filled in questionnaire designed to assess their subjective social status. Then two measures of social status were calculated. To calculate the first measure we used the principal component analysis of seven semantic differential scales, where the traits associated with dominance and control were places at extreme ends: dominant — subordinate, leader — follower, confident — hesitant. The second measure was calculated based on the answer to the question concerning a participant’s position on the imaginary social ladder with people of superior condition at the higher end, and those of inferior condition at the lower end of the ladder. Participants had to specify which of the ten steps they felt they occupied. We evaluated the relative status — the difference between a player’s subjective status and his game partner’s status.

Contrary to the other games the Dictator game explicitly sets up a social status asymmetry, meaning that participants in the role of allocators have higher subjective status, than their counterparts in the role of receivers. While in the Trust and Wage-Effort games the difference in the players’ subjective status is insignificant because both enjoy more symmetrical material standing and potential to make a difference to the game situation. In the Trust game, for example, a trustee (a receiver) may give back a portion of money, received from a trustor (sender), while in the Wage-Effort game a worker may choose to exert more or less efforts and so to substantially increase or decrease manager’s income. As a result players’ subjective status does differ less, than in the Dictator game.

The results obtained can be explained with the Status construction theory. As the theory says, interactions between individuals from socially different groups induce diverse self-perceptions of their own social status, since belonging to a group associated with a higher social standing ensures a higher social status (Ridgeway, 1991; Webster, Hysom, 1998; Ridgeway, Erickson, 2000).

The above process is presumably induced by the Dictator game, where the participants are split into allocators and receivers. An allocator is distinctive from a receiver by better material standing and the extent of control over the game outcome and his own gain. If both participants share the stereotype that more affluent individuals and decision makers usually enjoy a higher hierarchical standing in society than those who are less affluent or have no power to make decisions, playing the Dictator game makes an allocator form a higher subjective status while a receiver forms a lower subjective status.

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1 Scales for the first measure were constructed on the basics of scales in (Ridgeway et al., 1998). The key question for the second measure of social status was taken from (Adler et al., 2000).
The participants’ personal traits also correlate with status assessment. Confident behavior and extraversion show a positive correlation with a participant’s subjective status. Such personal traits as household material well-being, male gender and having junior siblings are also found to have a positive correlation with a subjective status.

2. Review of literature

2.1. Social status determination

Subjective social status is an individual’s perception of his own position in the social hierarchy and is determined by socio-demographic, economic and personal attributes. To evaluate an individual’s subjective status the standard question is asked on how an individual positions himself on the multi-step social ladder, given that low-profile people occupy the bottom and high-profiled — the top step (Adler et al., 2000). Dependent on the research objectives the opposite attributes of status can appear as follows: good / bad place of work; good-quality education / poor-quality education; being respected / disrespected; rich / poor; middle class / working class; wielding power (authority) / deprived of rights (Diemer et al., 2013).

Subjective status is found to be strongly associated with an individual’s health status (Adler et al., 2000) and also with his personal attributes (Bucchiol et al., 2014). Extraversion is a good predictor of a higher status (Anderson et al., 2001), and on average males consistently report higher self-esteem than females (Bleidorn et al., 2016). Subjective status also depends on a family composition, as a single child has better-quality education and higher income, and these factors positively affect his subjective status (Keister, 2003), while if a child has siblings, he is compelled to compete for parents’ attention and care (Sulloway, 1996).

The status construction theory, developed in (Ridgeway et al., 1998), supposes to form different subjective status through engaging individuals from differing groups in joint objective-oriented activities. Prior to the encounter individuals share stereotypical expectations about a status-rising potential of certain attributes (implying that well-off people, for example, are more respected in society than worse-off people).

The participants of the (Ridgeway et al., 1998) experiment were divided into two groups (Group A and Group B), based on the income earned in the course of the experiment. At the game start the participants paired up to perform a given task. After the encounter the individuals ascribed to different groups placed themselves on differing hierarchical rungs based on their actual characteristic. Thus their nominal income dif-

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2 As opposed to subjective social status the objective social status is measured with the objective indicators, determining an individual’s position within a social hierarchy. The data include income, education, prestige, power, job, property ownership and other indicators (Diemer et al., 2013). A social stratum indicator is considered to be the closest to objective social status. For various reasons an individual’s objective status not always coincide with his subjective status. For instance, an individual may subjectively identify himself as “middle class”, although by some objective attributes, such as social position, income or education, he is clearly subsumed under the “working class” category.

3 The status construction theory is associated with the Expectation states theory and Status characteristics theory (Berger et al., 1982).

4 Status attributes are divided into specific and diffusive ones. Specific attributes include numerical abilities, job competence etc. Diffusive attributes are viewed as a more abstract concept which includes gender, education, nationality (Berger, Zelditch, 1985). A status attribute is not always associated with economic differences. Several studies have suggested theoretical interpretations on how personal attributes can become status markers (Ridgeway, 1991; Ridgeway, Balkwell, 1997; Webster, Hysom, 1998; Jasso, 2001; Berger, Finek, 2006).
ferences emerged as a status attribute. Individuals whose characteristic was not in favor of their group (with a lower income) ascribed a higher status to members of the other group and did not favor the members of their own group (demonstrating the lack of in-group favoritism (Tajfel et al., 1971)). Meanwhile the members of the higher-income group ascribed the higher status to their own group and the lower one — to the opposite group.

Social status formation can be viewed in the framework of the Reference group theory (Hyman, 1942). Scientific studies distinguish between a normative reference group (which provides an individual with value attitudes and behavior patterns) and a comparative reference group (providing an individual with standards and points of reference). An individual compares him(her)self with this group members in terms of income, employment, consumption and other features, and therefore his subjective social status is shaped (Festinger, 1854)5.

2.2. Experimental economic studies of status

To our knowledge, this study is the first to investigate how an experimental behavior and a role in an experimental game can shape an individual’s subjective status, although some studies had already examined the impact of socio-economic status on behavior in economic experiments. Various approaches to establishing participants’ status were used: in some cases it was randomly ascribed by experimenters; or status was earned by the participants (for instance, based on the outcomes of accomplished tasks); or it was assumed that status should be determined by actual characteristics, such as belonging to a more prestigious school or higher-profile caste.

In (Handgraaf et al., 2008) the effect of asymmetric relations in the Ultimatum game was studied. In the classic version of the game an allocator is endowed with the budget, which he can split between himself and a receiver. The receiver may accept the proposed split or reject it, in which case neither he, nor his partner will get anything. The authors had changed the game design by introducing a coefficient, ranging from 0 to 1, which allowed an allocator to gain non-zero win, if a receiver rejected the offered split. The said coefficient allowed to a model a higher status (power) for one of the players. The higher the coefficient, the more power an allocator got and the less power was left for a receiver, and vice versa. If an allocator wielded more power, than a receiver, he offered less of a budget to him. Nevertheless, when a receiver lost control over the gain, an allocator offered him the largest portion of a budget. The explanation is that an allocator feels responsible for his counterpart, who has nothing of own.

The authors of (Ball, Eckel, 1996, 1998) simulated a market with sellers and buyers, who were ascribed status based on the results of a trivia quiz. During the experiment high-status participants were given to wear golden stars, thus conferring their status. Equilibrium market prices were higher, when high-status sellers encountered low-status buyers, and lower,

5 If individuals interact in pairs, each will be a referent for the other (Childers, Rao 1992; Williams, 2010).

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when buyers enjoyed higher status than sellers. With that high-status sellers earned more than low-status sellers.

In (Glaeser et al., 2000) the authors examined which factors affected trust and a willingness to return favor for vested confidence. As a proxy of participants’ social status real-life measures were selected: hours spent working for pay and parental educational attainment, social skills, social capital (number of friends, hours spent on volunteering) and charisma (proxied by beers drunk per week with friends and whether the individual had a sexual partner). It was found that participants with higher status were more trustworthy and more rewarded for the vested confidence.

In (D’Adda, 2011) the authors experimented with a public good game in the field. Participants were ranked by status (authority) through the social ranking exercise, aimed at identifying formal and moral leaders within the local community. Participants observed each other’s contributions to public good. It was found, that the leaders’ donations to public good affected the other participants. And to the contrary, information on contributions of other participants had only minor effect on the leaders and their actions.

3. Experiment Description

3.1. Experimental games

In November 2016 the International Laboratory for Experimental and Behavioral Economics of the National Research University Higher School of Economics held six sessions of the Experiment with 68 participants. Most of them (85%) were HSE students; 42% were males. The experiment was run on computers using the z-Tree program (Fischbacher, 2007). An experimental session lasted 1.5 hours. Instructions for each game were read aloud and then handed out in writing to the participants.

The experimental subjects successively played three games: the Dictator game, the Trust game and the Wage-Effort game. Each game was played in five rounds. During each game the pairs remained unchangeable, while for a next game the participants were paired differently. In each session the sequence of games also varied. Table 1 shows how the participants were distributed by sessions and gender.

After a game finished each subject was asked several questions to measure how he had got to perceive his own social status and that of his counterpart in the game.

We deliberately avoided such terms, as “a partner” or “an opponent” to eliminate the so-called priming effect, or the impact of the question wording on the subjects’ status self-perception (Burnham et al., 2000).

At the end of the experiment each participant filled in the questionnaire concerning his socio-demographic status, health, perception of own socio-economic standing, his emotional condition, shared social norms, confident behavior etc. We had admitted that the experimental setting could affect the answers to some questions and that answering a question
Measurement of Social Status in Experimental Games

could affect an answerer’s subjective social status. To eliminate these effects we had placed certain questions in a separate section. The said questions concerned social norms, trust, health, household material well-being and its actual/supposed changes. A randomly selected group of participants answered the questions in this section at the start of the experiment, and the remaining questions — at its end. The other participants answered all the questions at the end of the experiment.

By the end of the experiment each participant was given a gain averaging to about 600 Rubles. To calculate a gain in each game we randomly chose one of five game rounds, and distributed the gain according to the participants’ roles and decisions in that round. The resulting gain comprised a gain in each game played plus 100.00 Rubles as a participation fee.

The Dictator game. The game is asymmetrical, as one of the participants (dictator) makes a decision on how to divide a fixed budget between himself and his counterpart, who may not make any decisions or affect the gain. For our experiment we had framed the question for a Dictator as follows: “You are the allocator. What sum, ranging from zero to 100, would you like to give a receiver?” One survey paper (Levitt, List, 2007) cites, that about 60% of Dictators behaved in an altruistic manner and granted a non-zero sum to a receiver, while an average part of a budget granted equaled to 20%.

The Trust game. The scenario (Berg et al., 1995) is that one of the participants (Trustor) has to decide how much of an endowment to confide to the second participant (Trustee). A trustor is informed that the sum con-

<table>
<thead>
<tr>
<th>Sequence of games</th>
<th>Number of sessions</th>
<th>Females</th>
<th>Males</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>«Dictator», «Trust», «Wage-Effort»</td>
<td>2</td>
<td>8</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>«Wage-Effort», «Dictator», «Trust»</td>
<td>1</td>
<td>10</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>«Trust», «Wage-Effort», «Dictator»</td>
<td>1</td>
<td>10</td>
<td>4</td>
<td>14</td>
</tr>
<tr>
<td>«Dictator», «Wage-Effort», «Trust»</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>«Trust», «Dictator», «Wage-Effort»</td>
<td>1</td>
<td>6</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>6</strong></td>
<td><strong>39</strong></td>
<td><strong>29</strong></td>
<td><strong>68</strong></td>
</tr>
</tbody>
</table>

Table 1

Sequence of games played

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fided to a Trustee, will increase by a factor (in our experiment it is tripled). Then a Trustee may return back to a Trustor any part of the increased sum. Research studies evidence, that on average Trustors confide to the Trustees about 50% of an endowment, while Trustees, desiring to reward the confidence vested return back to the Trustors about 50% of the tripled sum (Levitt, List, 2007).

**The Wage-Effort game.** This game is similar to the Trust game, except one participant playing a role of a Manager, and his counterpart – of a Worker. A Manager has to decide what portion of his capital to give to a Worker as a wage. A Worker chooses one of his efforts levels, which he related to a particular costs level. Higher efforts correspond to a higher Manager’s profit and a lower Worker’s wage. Based on experiments Workers choose higher efforts for higher wage (Fehr et al., 1993).

### 3.2. Status measurement

At the end of each game the participants had to assess first themselves and then their counterparts against the 7-grade semantic differential scale with the opposite poles corresponding to the opposite character traits. A participant had to choose which point of the scale corresponded to his opinion – whether it gravitated towards one of the poles or the middle (Table 2). As in (Ridgeway et al., 1998), we selected the personal traits, associated with a particular standing in the social hierarchy. Three out of seven scales were inverted to eliminate the inertia effect, when participants’ to repeatedly place their answers at one and the same end of a scale. Later the said three scales were inverted back to normal for the purpose of our analysis.

**Table 2**

<table>
<thead>
<tr>
<th>Scales for subjective status measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Please fill in this short questionnaire.</td>
</tr>
<tr>
<td>Which of the listed below traits are most relevant to your personality?</td>
</tr>
<tr>
<td>1. Secondary</td>
</tr>
<tr>
<td>2. Hesitant</td>
</tr>
<tr>
<td>3. Low status</td>
</tr>
<tr>
<td>4. Subordinate</td>
</tr>
<tr>
<td>5. With no control over resources</td>
</tr>
<tr>
<td>6. Dependent</td>
</tr>
<tr>
<td>7. Passive</td>
</tr>
</tbody>
</table>

Also the standard procedure related to a social ladder was proposed to assess participants’ subjective status (Adler et al., 2000, The MacArthur Scale): “There are people in our society who hold the top positions and people, who hold the lower ones. Please, specify which step best represents where you think you stand on the ten-step hierarchical ladder, where 1 — is the lowest, and 10 — the highest step”. For our analysis we took the modified
question from the questionnaire for adults used in 2015 for the last wave of the Russian Longitudinal Monitoring Survey (RMEZ in Russian). After assessing his proposition, each participant answered the similar questions concerning his counterpart in the previous game.

3.2. Questionnaire

The questionnaire, which the participants had to fill in at the end of the games (again note, that some of them did it prior to the experiment) can be symbolically divided into several sections.

**Basic socio-demographic questions.** This section included questions on gender, age, education, employment and whether a respondent is the HSE student. The section also comprised questions concerning parents’ educational attainment, existence of siblings, the job, current income status and its supposed changes. These data was needed for objective assessment of participants’ social status.

**Social norms and confidence.** To measure the general level of confidence in people we included the standard World Values Survey question about confidence in people\(^6\). To build the “social norms” measure we asked five questions on tolerance towards the following minor law violations: bribe-taking, tax evasion, public transport fare-dodging, illegal receipt of government subsidies etc. Then we had summed up the answers and created a dummy variable “high social norms” for the lower third of respondents, who had shown the least tolerance to misconducts.

**Emotional condition measurement.** The notion of positive / negative affect is used as one of the methods to classify an individual’s emotional condition (Watson, Clark, Tellegen, 1988). Positive affect is associated with pleasurable engagement, vigor and concentration, — contrary to negative affect, associated with unpleasurable engagement and apathy. It is a common practice to correlate a level of affect with personal traits, which determine a personal disposition towards positive and negative reactions. Positive affect, for example, is the core of extraversion (Smillie et al., 2015), and is used as a tool to measure extraversion in our experiment.

An individual is given a list of ten positive and ten negative emotions (descriptors) and is asked to specify to what extent he felt each emotion throughout the day (in the other cases a time period may vary, for instance, a week, a month etc.). We use PANAS scale adopted for Russian-language experimentees (Osin, 2012). Both the positive and negative affect are calculated by summing up scores on weighted descriptors.

**Confident (active) behavior.** High social status can be associated with proactive attitude and confident behavior. So, we asked participants to specify, how frequently they had to assume responsibility, to take an initiative or to influence others in the past year, namely:

- take a lead in the group;
- argue the point of view opposing to that of his mentor / leader at school / at work (office);

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\(^6\) World Values Survey (http://www.worldvaluessurvey.org/wvs.jsp).
overpersuade one of his acquaintances / colleagues / friends in favor of a decision, other than he (she) had already made;

- set him(her)self as a model for the others to follow.

The answers were assessed against the ten-grade scale with the highest score for “Frequently had” answer and the lowest – for “Did not have” answer. We derived questions from the several standard leadership scales\(^7\) and also from studies on relationship between leadership skills and earnings (Kuhn, Weinberger, 2002). A special question was asked on whether respondents had taken an active part in any sports, civil society or other organization in the period surveyed.

### 4. Experimental Results

#### 4.1. Behavior in the games

Table 3 presents the data on average performance of players. In the Dictator game the average donation was 29% of the initial endowment, and in 70% of cases donations were non-zero. The average donation was decreasing in 1–4 rounds and grew in the 5\(^{th}\) round. On average the males donated not so much, as the females\(^8\). In the Trust game the sum given by a trustee were growing in 1–4 rounds and decreased in the 5\(^{th}\) round. In the Wage-effort game the average wage was 36 out of 100 currency units (c.u.). A worker’s level of efforts was growing gradually in 1–4 rounds and abruptly decreased in the 5\(^{th}\) round; on average, the males used to exert more efforts, than the females.

The regression analysis of players’ behavior has shown that donations in the Dictator game, (money returned back in the Trust game and worker’s wage in the Wage-Effort game) tended to be lower in the last round, than in the earlier ones (Appendix, Tables B6–B10). The games sequence affected the players’ behavior. A participant performing as a trustee in the

<table>
<thead>
<tr>
<th>Average</th>
<th>Total</th>
<th>Females</th>
<th>Males</th>
<th>Round</th>
</tr>
</thead>
<tbody>
<tr>
<td>«Dictator», the sum, granted by an allocator</td>
<td>29</td>
<td>31</td>
<td>26</td>
<td>32</td>
</tr>
<tr>
<td>«Trust», the sum, confided by a trustor to a trustee</td>
<td>57</td>
<td>54</td>
<td>61</td>
<td>54</td>
</tr>
<tr>
<td>The sum returned back by a trustee (maximum — 300)</td>
<td>71</td>
<td>67</td>
<td>76</td>
<td>70</td>
</tr>
<tr>
<td>«Wage-Effort», a worker’s wage (out of 100)</td>
<td>36</td>
<td>37</td>
<td>36</td>
<td>40</td>
</tr>
<tr>
<td>A worker’s level of effort</td>
<td>0.61</td>
<td>0.58</td>
<td>0.64</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Table 3

Outcomes of the Dictator, the Trust and the Wage-Effort games, currency units (c.u.)

\(^7\) International Personality Item Pool, (IPIP) (https://ipip.ori.org/).

\(^8\) Our participants played a bit more altruistic, than played the subjects of experimental researches involving the Dictator game, where the average donation was 28% of an endowment (Engel, 2011). Females’ donations indeed turned to be higher, as evidenced by other studies (Andreoni, Vesterlund, 2001; Engel, 2011).
Trust game tended to return back to a trustor less money, if prior to this game he had performed as an allocator in the Dictator game. And on the contrary, if prior to the Trust game a participant had played a manager’s role in the Wage-Effort game, becoming a trustee he tended to return back more money to a trustor. In the Wage-Effort game a manager also tended to give lower wage to a worker, if in the previous Dictator game he had performed as an allocator, while a worker tended to exert more efforts. The other players’ characteristics had an insignificant impact on their game behavior: elder participants tended to grant more money as allocators in the Dictator game and to get less wage as workers in the Wage-Effort game. Also in this game the males tended to exert more efforts, than the females.

4.2. Subjective status and game roles

The players’ subjective status seriously depended on a role played in the Dictator game; and allocators reported significantly higher subjective status, than receivers did. Figure 1 shows how differently the players assessed their own status and that of their counterparts against all seven scales, presented in the Table 2. The difference in status, or a relative status, was calculated against each scale as a difference between a player’s assessment of own status and his assessment of his partner’s status. For example, if a player assessed himself against the “hesitant — confident” scale as 5 out of 7 and his counterpart — as 3 out of 7, the relative status of the player would be 2. An allocator assessed himself higher, than a receiver, since the differences in assessments were statistically significant at the level of at most 1% for all the scales except for the “hesitant — confident” scale. In the Trust and Wage-Effort games the roles played had no impact on players’ status. No any significant difference between a trustor and a trustee was found across any of seven scales in the Trust game (Figure 2). As for the Wage-Effort game, the results were similar, and subjective status of managers and workers proved to be the same (Figure 3)10.

Figure 1
Relative status for the Dictator game

Figure 2
Relative status for the Trust game

9 T-test and Wilcoxon test results for each scale are shown in the Appendix, see Tables B1A and B1B.

10 We have designed our experiment so that a participant could compare himself with his partner and thus we considered the relative status values.
The principal components method, used for reducing calculations, produced the same outcome. The first component showed positive correlation with the seven scales from Table 2 (Appendix, Table B2). Therefore it could be reasonably considered as an aggregate indicator of subjective status. This measure is significantly higher for allocators in the Dictator game (1%). However, this indicator differed insignificantly for a trustor and a trustee in the Trust game. The same was true for managers and workers in the Wage-Effort game.

The second indicator of difference between a player’s own status and that of his game partner, or a relative status (2), is calculated based on the answer to the question about a position on a social ladder, scaled from 1 to 10. Higher status corresponded to a higher value of an indicator. The relative status was calculated similar to the first indicator in each scale. The relative status in the Dictator game was positive for an allocator and negative for a receiver, with the statistically significant difference.

Our results are confirmed by the regression analysis. We evaluated the model

\[ Y_{ij} = \beta_0 + \sum \beta_j R_{ij} + \beta_2 x_i + \varepsilon_{ij} \]

where (for the purpose of the model) an observation meant a subjective status of a player in one of three experimental games. Therefore with 68 players we obtained 204 observations. The dependent variable \( Y_{ij} \) is a subjective status of a player \( i \) in a game \( j \). As a subjective status measure the meanings of the first principal component according to seven scales were taken (Appendix, Table B2). Independent variables: \( R_{kj} \) is a dummy variable, showing whether a player \( i \) performed a role \( k = 0.1 \) in a game \( j \). In each observation \( ij \) one of these six variables was 1, and the others — 0. For instance, if a game \( j \) was the Dictator game and a player \( i \) performed as an allocator, \( R_{allocator, Dictator, I} = 1 \). A worker in the Wage-Effort game was chosen as the basic category for these dummy variables.

As the control variables \( x_i \) we have analyzed the participants’ socio-demographic characteristics, their material well-being, the existence of sib-

---

Figure 3
Difference in status for the Wage-Effort game

Figure 4
Relative status, the second indicator

---

11 If we separately consider how a participant assesses his own status and that of his partner, an allocator’s own status would show only a minor difference from a receiver’s own status in the Dictator game. The player tends to assess his partner’s status significantly lower, than his own.
lings, confident behavior, positive affect etc. (more detailed description is
given in 3.3)\textsuperscript{12}.

Let us consider the first model with dummy variables for the roles
performed in games and with control-variables. If a participant performed
as an allocator in the Dictator game, he would assess his partner’s status
lower, and his own relative status would be higher (Table 4); and if a partici-
 pant performed as a receiver in the Dictator game, his relative status would
be lower, while his assessment of a partner’s status would be higher\textsuperscript{13}. The
Student’s test indicated the substantial difference between the roles of an
allocator and a receiver in the Dictator game and no difference between
the roles in the other games. The sequence of games did not matter: the
results would not change, whether the Dictator game was played first, in
between the Trust and Wage-Effort games or was the last to be played. The
game behavior had a little effect on players’ status (Appendix, Table B11):
the larger the sum confided by a trustor, the lower were both his own and
his relative status.

Males turned out to have a higher status, both own and relative. This
effect is quite understandable, as evidenced by empirical studies on male
and female self-esteem. The youngest or a single child in a family is likely
to have lower subjective and relative status. Some researchers suggest that
the youngest child in a multiple-children family gets less of the resources as
compared to his elder siblings (Chen, Liu, 2014; Keister, 2003). The better-
off a player’s family, the higher both subjective and relative status he has.
The reasonable explanation: income is one of the determinants of objective
social status (Diemer et al., 2013).

Table 4
Model 1\textsuperscript{14}

<table>
<thead>
<tr>
<th>Variable</th>
<th>A player’s own status</th>
<th>A partner’s status</th>
<th>Relative status</th>
<th>Relative status (2)\textsuperscript{15}</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
</tr>
<tr>
<td>Allocator (Dictator</td>
<td>0.305 (0.377)</td>
<td>–1.742*** (0.511)</td>
<td>0.591*** (0.207)</td>
<td>0.560*** (0.201)</td>
</tr>
<tr>
<td>game)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Receiver (Dictator</td>
<td>–0.766 (0.562)</td>
<td>1.269*** (0.477)</td>
<td>–0.590** (0.263)</td>
<td>–0.335 (0.237)</td>
</tr>
<tr>
<td>game)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trustor (Trust game)</td>
<td>–0.0986 (0.446)</td>
<td>0.331 (0.421)</td>
<td>–0.133 (0.200)</td>
<td>–0.0454 (0.223)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trustee (Trust game)</td>
<td>–0.282 (0.397)</td>
<td>0.546 (0.473)</td>
<td>–0.241 (0.157)</td>
<td>–0.237 (0.213)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manager (Wage-Effect</td>
<td>–0.473 (0.456)</td>
<td>0.295 (0.483)</td>
<td>–0.228 (0.206)</td>
<td>0.115 (0.211)</td>
</tr>
<tr>
<td>game)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\textsuperscript{12} For the descriptive statistics of continuous and fixed variables see the Appendix.

\textsuperscript{13} The same models were analyzed separately for each game. The effect of a player’s game role on his status persisted.

\textsuperscript{14} Errors are clustered by subjects.

\textsuperscript{15} The second indicator of difference between a player’s own status and that of his partner was determined through
the question concerning a player’s position on the 10-step social ladder (See para 3.2 above). A higher status corresponded to a higher indicator value.
As shown by the expanded model (Table 5), a subject’s higher own and relative status and a lower partner’s status correspond to a higher index of confident behavior18. As the research studies prove, a more confident behavior corresponds to a pronounced extraversion, and individuals with strongly pronounced extraversion19 usually have higher subjective status (Anderson et al., 2001).

<table>
<thead>
<tr>
<th>Variable</th>
<th>A player’s own status (1)</th>
<th>A partner’s status (2)</th>
<th>Relative status (3)</th>
<th>Relative status (2)15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sequence of games</td>
<td>–0.0705</td>
<td>0.0657</td>
<td>–0.0411</td>
<td>–0.0434</td>
</tr>
<tr>
<td></td>
<td>(0.155)</td>
<td>(0.184)</td>
<td>(0.0734)</td>
<td>(0.0821)</td>
</tr>
<tr>
<td>Male gender</td>
<td>0.929***</td>
<td>–0.540*</td>
<td>0.429**</td>
<td>0.326**</td>
</tr>
<tr>
<td></td>
<td>(0.414)</td>
<td>(0.283)</td>
<td>(0.162)</td>
<td>(0.153)</td>
</tr>
<tr>
<td>Age</td>
<td>–0.0222</td>
<td>–0.0276</td>
<td>0.00215</td>
<td>–0.00720</td>
</tr>
<tr>
<td></td>
<td>(0.0414)</td>
<td>(0.0309)</td>
<td>(0.0173)</td>
<td>(0.0155)</td>
</tr>
<tr>
<td>Parental educational attainments</td>
<td>–0.737</td>
<td>–0.107</td>
<td>–0.184</td>
<td>0.0185</td>
</tr>
<tr>
<td></td>
<td>(0.442)</td>
<td>(0.234)</td>
<td>(0.155)</td>
<td>(0.180)</td>
</tr>
<tr>
<td>Material well-being</td>
<td>0.476*</td>
<td>–0.334**</td>
<td>0.235**</td>
<td>0.239**</td>
</tr>
<tr>
<td></td>
<td>(0.252)</td>
<td>(0.166)</td>
<td>(0.0896)</td>
<td>(0.119)</td>
</tr>
<tr>
<td>Single child</td>
<td>–1.232*</td>
<td>0.118</td>
<td>–0.397*</td>
<td>–0.308</td>
</tr>
<tr>
<td></td>
<td>(0.631)</td>
<td>(0.404)</td>
<td>(0.203)</td>
<td>(0.254)</td>
</tr>
<tr>
<td>Youngest child</td>
<td>–2.363***</td>
<td>0.481</td>
<td>–0.833***</td>
<td>–0.637**</td>
</tr>
<tr>
<td></td>
<td>(0.805)</td>
<td>(0.492)</td>
<td>(0.285)</td>
<td>(0.293)</td>
</tr>
<tr>
<td>Eldest child</td>
<td>–0.321</td>
<td>0.354</td>
<td>–0.194</td>
<td>–0.113</td>
</tr>
<tr>
<td></td>
<td>(0.698)</td>
<td>(0.436)</td>
<td>(0.246)</td>
<td>(0.255)</td>
</tr>
<tr>
<td>Constant</td>
<td>–0.0157</td>
<td>1.765</td>
<td>–0.523</td>
<td>–0.521</td>
</tr>
<tr>
<td></td>
<td>(1.608)</td>
<td>(1.206)</td>
<td>(0.614)</td>
<td>(0.667)</td>
</tr>
<tr>
<td>Observations</td>
<td>19216</td>
<td>192</td>
<td>192</td>
<td>192</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.211</td>
<td>0.249</td>
<td>0.269</td>
<td>0.201</td>
</tr>
<tr>
<td>Allocator = Receiver (Dictator game)</td>
<td>0.0696</td>
<td>2.24e−07</td>
<td>5.17e−05</td>
<td>0.00141</td>
</tr>
<tr>
<td>Trustor = Trustee (Trust game)</td>
<td>0.714</td>
<td>0.632</td>
<td>0.625</td>
<td>0.442</td>
</tr>
</tbody>
</table>

Note: Estimators, significant at the levels of 1, 5 and 10%, are marked with symbols “***”, “**” and “*” respectively.

As shown by the expanded model (Table 5), a subject’s higher own and relative status and a lower partner’s status correspond to a higher index of confident behavior18. As the research studies prove, a more confident behavior corresponds to a pronounced extraversion, and individuals with strongly pronounced extraversion19 usually have higher subjective status (Anderson et al., 2001).

16 A portion of observations was lost due to the program malfunction.
17 The Student’s test on the means’ difference.
18 The index of confident behavior was calculated with the principal components method as an aggregated indicator based on four questions (See the experiment description).
19 Extraversion is one of the Big Five personality traits. If the index of confident behavior is replaced with extraversion, instrumented through the positive affect, the effect would be of the same direction, but weaker. The correlation between a positive affect and leadership traits is 0.41. We have not measured extraversion with the Big Five questionnaire.
Measurement of Social Status in Experimental Games

Higher relative status is also characteristic of people with a higher social norm index. We measured this index through the questions on how tolerant were the participants to the minor law violations\textsuperscript{20}.

\textbf{Table 5}

\textbf{Model 2}

<table>
<thead>
<tr>
<th>Variable</th>
<th>A player’s own status</th>
<th>A partner’s status</th>
<th>Relative status</th>
<th>Relative status (2)\textsuperscript{21}</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
</tr>
<tr>
<td>Allocator (Dictator game)</td>
<td>−0.234 (0.322)</td>
<td>−1.643*** (0.538)</td>
<td>0.401* (0.202)</td>
<td>0.558” (0.223)</td>
</tr>
<tr>
<td>Receiver (Dictator game)</td>
<td>−1.134** (0.549)</td>
<td>1.380*** (0.463)</td>
<td>−0.735*** (0.259)</td>
<td>−0.303 (0.235)</td>
</tr>
<tr>
<td>Trustor (Trust game)</td>
<td>−0.209 (0.489)</td>
<td>0.306 (0.421)</td>
<td>−0.161 (0.226)</td>
<td>−0.0107 (0.271)</td>
</tr>
<tr>
<td>Trustee (Trust game)</td>
<td>−0.477 (0.401)</td>
<td>0.797 (0.436)</td>
<td>−0.368* (0.188)</td>
<td>−0.292 (0.248)</td>
</tr>
<tr>
<td>Manager (Wage-Effort game)</td>
<td>−0.527 (0.458)</td>
<td>0.0552 (0.526)</td>
<td>−0.178 (0.235)</td>
<td>0.127 (0.269)</td>
</tr>
<tr>
<td>Sequence of games</td>
<td>−0.195 (0.185)</td>
<td>0.0423 (0.200)</td>
<td>−0.0730 (0.0937)</td>
<td>−0.0220 (0.0968)</td>
</tr>
<tr>
<td>Male gender</td>
<td>0.833** (0.361)</td>
<td>−0.315 (0.286)</td>
<td>0.333** (0.149)</td>
<td>0.216 (0.149)</td>
</tr>
<tr>
<td>Age</td>
<td>0.230* (0.118)</td>
<td>−0.0236 (0.0789)</td>
<td>0.0736* (0.0404)</td>
<td>0.0145 (0.0481)</td>
</tr>
<tr>
<td>Parental educational attainment</td>
<td>−0.425 (0.365)</td>
<td>0.268 (0.259)</td>
<td>−0.198 (0.150)</td>
<td>−0.0167 (0.178)</td>
</tr>
<tr>
<td>Material well-being</td>
<td>0.576** (0.253)</td>
<td>−0.312* (0.185)</td>
<td>0.260*** (0.0859)</td>
<td>0.315** (0.119)</td>
</tr>
<tr>
<td>Single child</td>
<td>0.201 (0.450)</td>
<td>0.156 (0.478)</td>
<td>0.0318 (0.213)</td>
<td>0.251 (0.277)</td>
</tr>
<tr>
<td>Younger child</td>
<td>−1.647*** (0.540)</td>
<td>0.889* (0.509)</td>
<td>−0.724*** (0.256)</td>
<td>−0.440 (0.330)</td>
</tr>
<tr>
<td>Older child</td>
<td>0.0631 (0.581)</td>
<td>0.228 (0.438)</td>
<td>−0.0338 (0.244)</td>
<td>0.337 (0.278)</td>
</tr>
<tr>
<td>Growth in material well-being</td>
<td>0.659* (0.370)</td>
<td>0.844*** (0.226)</td>
<td>−0.0456 (0.139)</td>
<td>−0.0515 (0.128)</td>
</tr>
<tr>
<td>Expectations of growth in material well-being</td>
<td>0.721 (0.440)</td>
<td>0.173 (0.298)</td>
<td>0.173 (0.161)</td>
<td>0.0391 (0.168)</td>
</tr>
</tbody>
</table>

\textsuperscript{20} See the experiment description. Answers to seven questions were summed up, and the dummy variable was introduced; with the value of 1 for those, whose resultant score belonged to the upper third.

\textsuperscript{21} The second indicator of difference between a player’s own status and that of his partner was determined through the question concerning a player’s position on the 10-rung social ladder (See paragraph 3.2 above). A higher status corresponded to a higher indicator value.
It turned out that many personal traits had no any effect on subjective status or status difference. These included trust (how much a player trusted in people), parental educational attainment, employment (did a player worked, was it full or partial employment), activism in civil society, sports or other organizations, subjective mental and physical state.

### 5. Conclusion

This paper investigated to what extent the participation in the “Dictator”, “Trust” and “Wage Effort” experimental games could create some asymmetry in players’ subjective statuses as a result of playing a particular game role. It was shown that the Dictator game led to the strongest difference in subjective status of players, performing as allocators and as receivers. The allocators assessed their own status as higher than that of their counterparts, and the receivers — vice versa, while allocators assessed their partner’s status as lower, than their own, and receivers assessed their partners’ status as higher, than their own. The effect turned out to be sustainable since it remained the same despite the difference in methods of subjective status measurement. In the Trust and Wage-Effort games differences in players’ statuses were not dependent on the roles they played. The participants with pronounced confident and extraverted behavior assessed both their own and relative statuses as higher, than those of their partners.

We have found some effects of gender and family composition on status. Males had higher subjective status, than females, and these results were consistent with available scientific knowledge\(^{23}\). Being a single or the youngest child in a family leads to a lower subjective status. The results obtained can be helpful for further experiments, where different subjective social status would be established through the roles assignment.

\(^{22}\) In some sessions the questions on confident behavior were not presented.

\(^{23}\) E.g., see (Bleidorn et al., 2016).
APPENDIX
A. The Experiment Guidelines

Opening remarks to the participants
Dear participants,

You are taking part in the study of economic behavior. The experiment will last for two academic hours. At the end of the experiment you will be compensated with rewards, depending on how you performed during the experiment. You are not allowed to talk to each other. Also please turn off your cell telephones and other communication devices.

If you’ve got a question, please, raise your hand and consult the assistant at any moment of the experiment. The experiment will be held in several stages. Guides to each stage will be placed at your tables and read aloud.

The Dictator game guidelines

Part 1A
A. This stage of the experiment consists of five rounds. At first the participants are randomly paired by the experimenter. In each pair one of the participants will act as an allocator, the other — as a receiver. You will not know beforehand, who is going to be your counterpart. During this stage of the experiment the pairs will remain unchanged.

B. At the start of each round an allocator will be given the capital of 100 currency units (c.u.). If you act as an allocator you may decide, what part of your capital should be given to the participant playing in pair with you as a receiver.

C. Your gain in each round will be calculated as follows:
   i) if you are an allocator: your gain = 100 c.u. — (the sum given to a receiver);
   ii) if you are a receiver, your gain = (the sum given to you by an allocator).

D. At the end of the stage one of five rounds played will be chosen randomly and your gain at this stage will equal to what you have gained in the chosen round. Exchange rate will be 1 c.u. = 2.5 Rubles.

The Trust game guidelines

Part 1B
A. This stage of the experiment consists of five rounds. At first the participants are randomly paired. In each pair one of the participants will act as a trustor (as a sender), the other — as a trustee. You will not know beforehand, who is going to be your counterpart. During this stage of the experiment the pairs will remain unchanged.

B. At the start of a round each trustor will be given the capital of 100 currency units (c.u.). If you are a trustor you may decide what part of your capital should be given to the participant playing in pair with you as a trustee.
C. The capital given to a trustee is tripled by the experimenter. Then a trustee may return back to a trustor any amount of the now-tripled capital.

D. Your gain in each round will be calculated as follows:
   i) if you are a trustor: your gain = 100 — (the sum given to a trustee) + (the sum received from a trustee);
   ii) if you are a trustee, your gain = 3 × (the sum received from a trustor) — (the sum returned back to a trustor).

E. At the end of the stage one of five rounds played will be chosen randomly and your gain at this stage will equal to what you have gained in the chosen round. Exchange rate will be 1 c.u. = 2.5 Rubles.

The Wage-Effort game guidelines

Part 1C

A. This stage of the experiment consists of five rounds. At first the participants are randomly paired. In each pair one of the participants will act as a manager, the other — as a worker. You will not know beforehand, who is going to be your counterpart. During this stage of the experiment the pairs will remain unchanged.

B. At the start of a round each manager will be given the capital of 100 c.u. Each worker will receive the capital of 20 c.u. If you are a manager you may decide which part of your capital should be given to your counterpart — a worker — as his wage. The wage may vary in the range from zero through to 100 c.u.

C. After getting a wage a worker decides, which level of labor efforts to exert. A worker’s efforts may equal to 0.1; 0.2; ...; 1.0.

D. Your gain in each round will be calculated as follows:
   i) if you are a manager: your gain = 100 — a worker’s wage) × (a worker’s efforts);
   ii) if you are a worker, your gain = 20 + (your wage) — (costs of efforts),
   where the costs of efforts are determined based on the following table:

<table>
<thead>
<tr>
<th>Efforts</th>
<th>0.1</th>
<th>0.2</th>
<th>0.3</th>
<th>0.4</th>
<th>0.5</th>
<th>0.6</th>
<th>0.7</th>
<th>0.8</th>
<th>0.9</th>
<th>1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>8</td>
<td>10</td>
<td>12</td>
<td>15</td>
<td>18</td>
</tr>
</tbody>
</table>

E. At the end of the stage one of five rounds played will be chosen randomly and your gain at this stage will equal to what you have gained in the chosen round. Exchange rate will be 1 c.u. = 2.5 Rubles.
Measurement of Social Status in Experimental Games

The after-game survey

Please fill in a short questionnaire.
Which of the listed below traits are most relevant to your personality?

- Dominant
- Confident
- High status
- Leader
- In control over resources
- Dependent
- Passive
- Secondary
- Hesitant
- Low status
- Subordinate
- No control over resources
- Independent
- Active

There are people in our society who hold top positions and people, who hold the lower ones. Please, specify which rung best represents where you think you stand on the ten-rung hierarchical ladder, where 1 is the lowest rung, and 10 — the highest.

Figure A1
Participant’s status

Which of the listed below traits are most relevant to a person, with whom you have interacted in the past game?

- Dominant
- Confident
- High status
- Leader
- In control over resources
- Dependent
- Passive
- Secondary
- Hesitant
- Low status
- Subordinate
- No control over resources
- Independent
- Active

There are people in our society who hold top positions and people, who hold the lower ones. Please, specify which rung best represents where you think a person, with whom you have interacted in the past game, stands on the 10-rung hierarchical ladder, where 1 is the lowest rung, and 10 — the highest.

Figure A2
Partner’s status

Survey at the beginning / at the end of the experiment

1. Please, specify your health condition against the following scale:
   1 (often feel sick) 2 3 4 5 6 7 8 9 10 (usually stay healthy)

2. How would you describe your family’s current material position?
   A. Money is barely sufficient for living.
   B. Money is enough for living, but buying clothes puts a serious strain on our finance.
   C. Money is enough for living and buying clothes, but buying a TV set, a refrigerator of washing-machine would be difficult now.
   D. Money is enough to buy major appliances, but we cannot afford a new car.
E. Our earnings are enough for everything except for such expensive purchases, as a country cottage, an apartment.
F. We have no material problems and if needed we can afford a country cottage, an apartment.
G. Cannot say.

3. How would you rate the changes in your and your family’s material position in the past 12 months?
   A. Significantly improved.
   B. Improved.
   C. Remained the same.
   D. Deteriorated.
   E. Significantly deteriorated.

4. How do you think your material position will change over the next 12 months: improve, deteriorate or remain the same?
   A. Will significantly improve.
   B. Will improve.
   C. Will remain the same.
   D. Will deteriorate.
   E. Will significantly deteriorate.

5. Do you think most people can be trusted, or you need care in dealing with people?
   A. Most people are trustworthy.
   B. One can’t be too careful in dealing with people.

   Answering questions 6–10, please, specify which of the following behaviors can be excused, against the scale where “1” – can never be excused and “10” – can always be excused.

6. Receipt of government subsidies by someone not dually eligible to get them
   1 2 3 4 5 6 7 8 9 10

7. Public transport fare-dodging
   1 2 3 4 5 6 7 8 9 10

8. Stealing another’s property
   1 2 3 4 5 6 7 8 9 10

9. Tax evading if it is be possible
   1 2 3 4 5 6 7 8 9 10

10. Accepting bribes using own official position
    1 2 3 4 5 6 7 8 9 10

**After-experiment survey**

1. Please specify your age in complete years.
2. Please specify your gender.
3. Are you a student of National Research University – Higher School of Economics?
   A. Yes.
   B. No.
4. Now what year (at the University) are you in?
5. What faculty are you in?
6. What is your father’s education?
A. Secondary school.
B. Secondary vocational school.
C. Incomplete higher education.
D. Higher school.
E. Academic degree.
F. Cannot say.

7. What is your mother’s education?
   A. Secondary school.
   B. Secondary vocational school.
   C. Incomplete higher education.
   D. Higher school.
   E. Academic degree.
   F. Cannot say.

8. Do you have siblings?
   A. Yes, I’m the younger child.
   B. Yes, I’m the middle child.
   C. Yes, I’m the eldest child.
   D. No.

9. Are you currently working?
   A. Yes, I am working full time.
   B. Yes, I am working part time.
   C. Yes, I am working off-the-books.
   D. No, I am not employed.
   E. Cannot say.

10. What follows is the list of adjectives, describing various feelings and emotions. Please, read each one and evaluate the extent you experienced this feeling or emotion during the day on a scale from 1 to 5.

   1 — Almost no time or not at all; 2 — Slightly; 3 — Moderately; 4 — Considerably; 5 — Very strongly.

   A. Interested
   B. Distressed
   C. Excited
   D. Upset
   E. Strong
   F. Guilty
   G. Scared

   H. Hostile
   I. Interested
   J. Proud
   K. Irritable
   L. Alert
   M. Ashamed
   N. Inspired

   O. Nervous
   P. Determined
   Q. Attentive
   R. Anxious
   S. Active
   T. Afraid
   U. Inspired

11. Please, specify which of the actions listed below you had to undertake last year? (1 — “Definitely had not to”; 10 — “Definitely had to”).

   A. Take a lead in the group.
   B. Argue the point of view opposing to that of my mentor / leader at school / at work.
   C. Overpersuade one of my acquaintances / colleagues / friends in favor of a decision, other than he (she) had already made.
D. Set myself as a model for the others to follow.

12. Are you an activist in a sports organization / environmental watchdog organization / trade union / political organization / professional association?
   A. Yes.
   B. No.
   C. Cannot say.

**B. Text-relevant Tables and Figures**

**Table B1A**
Test on means difference for relative status*

<table>
<thead>
<tr>
<th>No.</th>
<th>Characteristic</th>
<th>Allocator and receiver, the Dictator game</th>
<th>Trustor and trustee, the Trust game</th>
<th>Manager and worker, the Wage-Effort game</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dominant — secondary</td>
<td>0.0001 (0.398)</td>
<td>0.6405 (0.28)</td>
<td>0.6145 (0.515)</td>
</tr>
<tr>
<td>2</td>
<td>Confident — hesitant</td>
<td>0.0519 (0.288)</td>
<td>0.2077 (0.29)</td>
<td>0.1587 (0.303)</td>
</tr>
<tr>
<td>3</td>
<td>High status — low status</td>
<td>0.0001 (0.31)</td>
<td>0.9557 (0.262)</td>
<td>0.3207 (0.267)</td>
</tr>
<tr>
<td>4</td>
<td>Leader — subordinate</td>
<td>0.0001 (0.365)</td>
<td>0.9147 (0.272)</td>
<td>0.3772 (0.320)</td>
</tr>
<tr>
<td>5</td>
<td>In control over resources — with no control over resources</td>
<td>0.0000 (0.426)</td>
<td>0.6300 (0.300)</td>
<td>0.8692 (0.321)</td>
</tr>
<tr>
<td>6</td>
<td>Independent — dependent</td>
<td>0.0000 (0.404)</td>
<td>0.7669 (0.245)</td>
<td>0.2244 (0.292)</td>
</tr>
<tr>
<td>7</td>
<td>Active — passive</td>
<td>0.0001 (0.349)</td>
<td>0.1827 (0.297)</td>
<td>0.6338 (0.296)</td>
</tr>
</tbody>
</table>

*Note: P-values based on the standard t-test are displayed in the table (unequal variances). For each group compared (allocator, receiver, manager etc.) the number of observations for each measure was 34. Standard errors are displayed in italics.*

**Table B1B**
Test on means difference for relative status (Wilcoxon rank sum test)

<table>
<thead>
<tr>
<th>No.</th>
<th>Characteristic</th>
<th>Allocator and receiver, Dictator game</th>
<th>Trustor and trustee, Trust game</th>
<th>Manager and worker, Wage-Effort game</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dominant — secondary</td>
<td>0.0004</td>
<td>0.5912</td>
<td>0.4204</td>
</tr>
<tr>
<td>2</td>
<td>Confident — hesitant</td>
<td>0.0546</td>
<td>0.1995</td>
<td>0.1940</td>
</tr>
<tr>
<td>3</td>
<td>High status — low status</td>
<td>0.0010</td>
<td>0.4491</td>
<td>0.3312</td>
</tr>
<tr>
<td>4</td>
<td>Leader — subordinate</td>
<td>0.0005</td>
<td>0.6898</td>
<td>0.6022</td>
</tr>
<tr>
<td>5</td>
<td>In control over resources — with no control over resources</td>
<td>0.0001</td>
<td>0.8066</td>
<td>0.8292</td>
</tr>
<tr>
<td>6</td>
<td>Independent — dependent</td>
<td>0.0001</td>
<td>0.6931</td>
<td>0.2424</td>
</tr>
<tr>
<td>7</td>
<td>Active — passive</td>
<td>0.0050</td>
<td>0.1518</td>
<td>0.4811</td>
</tr>
</tbody>
</table>

*Note: P-values based on the Two-sample Wilcoxon rank sum (Mann-Whitney) test are displayed in the table. For each group being compared (allocator, receiver, manager etc.) the number of observations for each measure was 34.*
### Table B2

The first component of status measures

<table>
<thead>
<tr>
<th>Variable</th>
<th>1st component</th>
<th>Difference in status</th>
<th>Player’s own status</th>
<th>Partner’s status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dominant — secondary</td>
<td></td>
<td>0.40</td>
<td>0.39</td>
<td>0.40</td>
</tr>
<tr>
<td>Confident — hesitant</td>
<td></td>
<td>0.32</td>
<td>0.34</td>
<td>0.35</td>
</tr>
<tr>
<td>High status — low status</td>
<td></td>
<td>0.37</td>
<td>0.39</td>
<td>0.36</td>
</tr>
<tr>
<td>Leader — subordinate</td>
<td></td>
<td>0.41</td>
<td>0.42</td>
<td>0.42</td>
</tr>
<tr>
<td>In control over resources — with no control over resources</td>
<td></td>
<td>0.39</td>
<td>0.38</td>
<td>0.39</td>
</tr>
<tr>
<td>Independent — dependent</td>
<td></td>
<td>0.38</td>
<td>0.34</td>
<td>0.36</td>
</tr>
<tr>
<td>Active — passive</td>
<td></td>
<td>0.37</td>
<td>0.37</td>
<td>0.36</td>
</tr>
<tr>
<td>Explained dispersion</td>
<td></td>
<td>0.71</td>
<td>0.69</td>
<td>0.61</td>
</tr>
</tbody>
</table>

### Table B3A

Student’s test for aggregate status measures (standard $t$-test)

<table>
<thead>
<tr>
<th>Status</th>
<th>Allocator and receiver, Dictator game</th>
<th>Trustor and trustee, Trust game</th>
<th>Manager and worker, Wage-Effort game</th>
</tr>
</thead>
<tbody>
<tr>
<td>Player’s own status</td>
<td>0.0645 (0.306)</td>
<td>0.4737 (0.255)</td>
<td>0.8240 (0.252)</td>
</tr>
<tr>
<td>Partner’s status</td>
<td>0.0000 (0.303)</td>
<td>0.7421 (0.206)</td>
<td>0.8488 (0.249)</td>
</tr>
<tr>
<td>Player’s own status (2)</td>
<td>0.1254 (0.278)</td>
<td>0.6853 (0.251)</td>
<td>0.4921 (0.257)</td>
</tr>
<tr>
<td>Partner’s status (2)</td>
<td>0.0015 (0.272)</td>
<td>0.4955 (0.214)</td>
<td>0.6818 (0.52)</td>
</tr>
<tr>
<td>Relative status</td>
<td>0.0000 (0.148)</td>
<td>0.7210 (0.215)</td>
<td>0.7762 (0.112)</td>
</tr>
<tr>
<td>Relative status (2)</td>
<td>0.0010 (0.396)</td>
<td>0.8916 (0.32)</td>
<td>0.3242 (0.287)</td>
</tr>
</tbody>
</table>

**Note:** For each group compared (allocator, receiver, manager etc.) the number of observations for each measure was 34. The standard errors are displayed in italics.

### Table B3B

Wilcoxon test for aggregate status measures (Wilcoxon rank sum test)

<table>
<thead>
<tr>
<th>Status</th>
<th>Allocator and receiver, Dictator game</th>
<th>Trustor and trustee, Trust game</th>
<th>Manager and worker, Wage-Effort game</th>
</tr>
</thead>
<tbody>
<tr>
<td>Player’s own status</td>
<td>0.2107</td>
<td>0.2696</td>
<td>0.5718</td>
</tr>
<tr>
<td>Partner’s status</td>
<td>0.0000</td>
<td>0.4146</td>
<td>0.8058</td>
</tr>
<tr>
<td>Player’s own status (2)</td>
<td>0.2264</td>
<td>0.4660</td>
<td>0.6206</td>
</tr>
<tr>
<td>Partner’s status (2)</td>
<td>0.0019</td>
<td>0.3079</td>
<td>0.4793</td>
</tr>
<tr>
<td>Relative status</td>
<td>0.0001</td>
<td>0.6455</td>
<td>0.4609</td>
</tr>
<tr>
<td>Relative status (2)</td>
<td>0.0049</td>
<td>0.9018</td>
<td>0.3291</td>
</tr>
</tbody>
</table>

**Note:** $P$-values based on the Two-sample Wilcoxon rank-sum (Mann – Whitney)-test is displayed in the table. For each group compared (allocator, receiver, manager etc.) the number of observations for each measure was 34.
Table B4
Descriptive statistics of selected variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Number of observations</th>
<th>Average</th>
<th>Standard deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leadership behavior</td>
<td>162</td>
<td>-1.39e-08</td>
<td>1.65</td>
<td>-4.64</td>
<td>1.61</td>
</tr>
<tr>
<td>Own status (2)</td>
<td>192</td>
<td>6.25</td>
<td>2.10</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Partner’s status (2)</td>
<td>192</td>
<td>5.95</td>
<td>2.01</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Receipt of government subsidies by someone not dually eligible to get them</td>
<td>204</td>
<td>3.88</td>
<td>2.11</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>Public transport fare-dodging</td>
<td>204</td>
<td>5.31</td>
<td>2.36</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Theft of another’s property</td>
<td>204</td>
<td>1.85</td>
<td>1.22</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Tax evasion</td>
<td>204</td>
<td>3.94</td>
<td>2.40</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>Accepting a bribe</td>
<td>204</td>
<td>2.49</td>
<td>1.88</td>
<td>1</td>
<td>8</td>
</tr>
</tbody>
</table>

Table B5
Descriptive statistics of dummy variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Number of observations</th>
<th>Percent of observations, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relatively high material position</td>
<td>19</td>
<td>28</td>
</tr>
<tr>
<td>Material position has improved</td>
<td>16</td>
<td>24</td>
</tr>
<tr>
<td>Expect for their material position to improve next year</td>
<td>26</td>
<td>38</td>
</tr>
<tr>
<td>Trusting in people generally</td>
<td>15</td>
<td>22</td>
</tr>
<tr>
<td>HSE students</td>
<td>52</td>
<td>76</td>
</tr>
<tr>
<td>Father’s educational attainment</td>
<td>50</td>
<td>74</td>
</tr>
<tr>
<td>Mother’s educational attainment</td>
<td>56</td>
<td>83</td>
</tr>
<tr>
<td>Having siblings</td>
<td>41</td>
<td>60</td>
</tr>
<tr>
<td>The youngest child</td>
<td>39</td>
<td>19</td>
</tr>
<tr>
<td>Working (full or part time employment)</td>
<td>34</td>
<td>50</td>
</tr>
<tr>
<td>Activists of sports, civil society or other organization/ association</td>
<td>21</td>
<td>31</td>
</tr>
</tbody>
</table>

Table B6
The sum, given by the allocator in the Dictator game

<table>
<thead>
<tr>
<th>Variable</th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Round</td>
<td>-0.912**</td>
<td>-0.912**</td>
</tr>
<tr>
<td></td>
<td>(0.364)</td>
<td>(0.369)</td>
</tr>
<tr>
<td>Trustor (the Trust game)</td>
<td>0.716</td>
<td>-5.309</td>
</tr>
<tr>
<td></td>
<td>(6.978)</td>
<td>(7.352)</td>
</tr>
<tr>
<td>Trustee (the Trust game)</td>
<td>4.247</td>
<td>0.929</td>
</tr>
<tr>
<td></td>
<td>(6.887)</td>
<td>(8.494)</td>
</tr>
</tbody>
</table>

*Acted as the trustor in the sessions, where the Trust game was played prior to the Dictator game.*
The ending of table B6

<table>
<thead>
<tr>
<th>Variable</th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manager</td>
<td>-2.390</td>
<td>-2.410</td>
</tr>
<tr>
<td></td>
<td>(6.886)</td>
<td>(6.804)</td>
</tr>
<tr>
<td>Worker</td>
<td>5.715</td>
<td>5.250</td>
</tr>
<tr>
<td></td>
<td>(6.279)</td>
<td>(5.854)</td>
</tr>
<tr>
<td>Male gender</td>
<td></td>
<td>-5.949</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(6.763)</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td>1.822***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.660)</td>
</tr>
<tr>
<td>Mother’s educational attainment</td>
<td></td>
<td>-10.990</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(8.544)</td>
</tr>
<tr>
<td>Father’s educational attainment</td>
<td></td>
<td>-8.649</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(8.554)</td>
</tr>
<tr>
<td>Trusting in people</td>
<td></td>
<td>-2.150</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(5.937)</td>
</tr>
<tr>
<td>Well-off family</td>
<td></td>
<td>3.238</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(7.401)</td>
</tr>
<tr>
<td>Working</td>
<td></td>
<td>-2.296</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(6.366)</td>
</tr>
<tr>
<td>Having siblings</td>
<td></td>
<td>2.434</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(6.137)</td>
</tr>
<tr>
<td>Constant</td>
<td>29.76***</td>
<td>10.25</td>
</tr>
<tr>
<td></td>
<td>(4.625)</td>
<td>(15.790)</td>
</tr>
<tr>
<td>Observations</td>
<td>340</td>
<td>340</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.018</td>
<td>0.127</td>
</tr>
</tbody>
</table>

Note: The robust standard errors are displayed in italics. Estimators, significant at the levels of 10, 5 and 1%, are marked with symbols *, ** and *** respectively.

Table B7
The sum given by a trustor in the Trust game

<table>
<thead>
<tr>
<th>Variable</th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Round</td>
<td>0.053</td>
<td>0.053</td>
</tr>
<tr>
<td></td>
<td>(1.301)</td>
<td>(1.316)</td>
</tr>
<tr>
<td>Allocator (the Dictator game)</td>
<td>-9.097</td>
<td>-11.560</td>
</tr>
<tr>
<td></td>
<td>(10.00)</td>
<td>(9.634)</td>
</tr>
<tr>
<td>Receiver (the Dictator game)</td>
<td>-6.811</td>
<td>-10.040</td>
</tr>
<tr>
<td></td>
<td>(9.240)</td>
<td>(8.558)</td>
</tr>
<tr>
<td>Manager</td>
<td>12.840</td>
<td>15.250</td>
</tr>
<tr>
<td></td>
<td>(12.050)</td>
<td>(12.500)</td>
</tr>
</tbody>
</table>
The ending of table B7

<table>
<thead>
<tr>
<th>Variable</th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worker</td>
<td>12.240</td>
<td>11.180</td>
</tr>
<tr>
<td></td>
<td>(10.350)</td>
<td>(9.492)</td>
</tr>
<tr>
<td>Male gender</td>
<td>7.152</td>
<td>6.531</td>
</tr>
<tr>
<td>Age</td>
<td>0.079</td>
<td>(1.636)</td>
</tr>
<tr>
<td>Mother’s educational attainment</td>
<td>15.18*</td>
<td>(7.650)</td>
</tr>
<tr>
<td>Father’s educational attainment</td>
<td>-2.126</td>
<td>(8.279)</td>
</tr>
<tr>
<td>Trusting in people</td>
<td>-2.965</td>
<td>(8.446)</td>
</tr>
<tr>
<td>Well-off family</td>
<td>-14.360*</td>
<td>(8.037)</td>
</tr>
<tr>
<td>Working</td>
<td>-0.574</td>
<td>(7.544)</td>
</tr>
<tr>
<td>Having siblings</td>
<td>-7.511</td>
<td>(7.469)</td>
</tr>
<tr>
<td>Constant</td>
<td>58.00***</td>
<td>54.69</td>
</tr>
<tr>
<td></td>
<td>(6.208)</td>
<td>(36.65)</td>
</tr>
<tr>
<td>Observations</td>
<td>340</td>
<td>340</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.020</td>
<td>0.085</td>
</tr>
</tbody>
</table>

**Note:** The robust standard errors are displayed in italics. Estimators, significant at the levels of 10, 5 and 1%, are marked with symbols *, ** and *** respectively.

Table B8

The sum returned back to a trustor by a trustee in the Trust game

<table>
<thead>
<tr>
<th>Variable</th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The sum given by a trustor</td>
<td>1,439***</td>
<td>1,428***</td>
</tr>
<tr>
<td></td>
<td>(0.049)</td>
<td>(0.051)</td>
</tr>
<tr>
<td>Round</td>
<td>-2.988**</td>
<td>-2.987**</td>
</tr>
<tr>
<td></td>
<td>(1.314)</td>
<td>(1.328)</td>
</tr>
<tr>
<td>Allocator (the Dictator game)</td>
<td>0.0815</td>
<td>0.885</td>
</tr>
<tr>
<td></td>
<td>(3.941)</td>
<td>(4.015)</td>
</tr>
<tr>
<td>Receiver (the Dictator game)</td>
<td>-9.893*</td>
<td>-9.930*</td>
</tr>
<tr>
<td></td>
<td>(5.366)</td>
<td>(5.449)</td>
</tr>
<tr>
<td>Manager</td>
<td>10.620*</td>
<td>12.880**</td>
</tr>
<tr>
<td></td>
<td>(5.844)</td>
<td>(5.244)</td>
</tr>
</tbody>
</table>
### Table B8

<table>
<thead>
<tr>
<th>Variable</th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worker</td>
<td>0.842</td>
<td>-0.689</td>
</tr>
<tr>
<td></td>
<td>(5.942)</td>
<td>(5.654)</td>
</tr>
<tr>
<td>Male gender</td>
<td>-0.167</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(3.963)</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>0.0252</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.380)</td>
<td></td>
</tr>
<tr>
<td>Mother’s educational attainment</td>
<td>4.489</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(4.269)</td>
<td></td>
</tr>
<tr>
<td>Father’s educational attainment</td>
<td>0.0724</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(4.138)</td>
<td></td>
</tr>
<tr>
<td>Trusting in people</td>
<td>-3.656</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(5.140)</td>
<td></td>
</tr>
<tr>
<td>Well-off family</td>
<td>-2.356</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(3.965)</td>
<td></td>
</tr>
<tr>
<td>Working</td>
<td>-6.125</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(3.817)</td>
<td></td>
</tr>
<tr>
<td>Having siblings</td>
<td>0.495</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(4.461)</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>-0.831</td>
<td>-0.428</td>
</tr>
<tr>
<td></td>
<td>(5.064)</td>
<td>(10.280)</td>
</tr>
<tr>
<td>Observations</td>
<td>340</td>
<td>340</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.778</td>
<td>0.782</td>
</tr>
</tbody>
</table>

**Note:** The robust standard errors are displayed in italics. Estimators, significant at the levels of 10, 5 and 1%, are marked with symbols “*”, “**” and “***” respectively.

### Table B9

The worker’s wage

<table>
<thead>
<tr>
<th>Variable</th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Round</td>
<td>-0.979*</td>
<td>-0.979*</td>
</tr>
<tr>
<td></td>
<td>(0.579)</td>
<td>(0.586)</td>
</tr>
<tr>
<td>Allocator (the Dictator game)</td>
<td>-5.508</td>
<td>-7.763**</td>
</tr>
<tr>
<td></td>
<td>(3.554)</td>
<td>(3.671)</td>
</tr>
<tr>
<td>Receiver (the Dictator game)</td>
<td>-3.643</td>
<td>-3.967</td>
</tr>
<tr>
<td></td>
<td>(3.655)</td>
<td>(3.876)</td>
</tr>
<tr>
<td>Trustor (the Trust game)</td>
<td>2.262</td>
<td>4.485</td>
</tr>
<tr>
<td></td>
<td>(3.467)</td>
<td>(3.745)</td>
</tr>
</tbody>
</table>
### Table B9

<table>
<thead>
<tr>
<th>Variable (the Trust game)</th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trustee</td>
<td>1.335</td>
<td>0.554</td>
</tr>
<tr>
<td></td>
<td>(3.789)</td>
<td>(3.775)</td>
</tr>
<tr>
<td>Male gender</td>
<td>2.234</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>–0.700**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.325)</td>
<td></td>
</tr>
<tr>
<td>Mother’s educational attainment</td>
<td>–5.443</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(3.290)</td>
<td></td>
</tr>
<tr>
<td>Father’s educational attainment</td>
<td>0.524</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(3.555)</td>
<td></td>
</tr>
<tr>
<td>Trusting in people</td>
<td>2.453</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(4.089)</td>
<td></td>
</tr>
<tr>
<td>Well-off family</td>
<td>0.468</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(3.362)</td>
<td></td>
</tr>
<tr>
<td>Working</td>
<td>–3.009</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.975)</td>
<td></td>
</tr>
<tr>
<td>Having siblings</td>
<td>–2.391</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(3.140)</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>41.11***</td>
<td>61.14***</td>
</tr>
<tr>
<td></td>
<td>(2.893)</td>
<td>(8.447)</td>
</tr>
<tr>
<td>Observations</td>
<td>340</td>
<td>340</td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.027</td>
<td>0.073</td>
</tr>
</tbody>
</table>

**Note:** The robust standard errors are displayed in italics. Estimators, significant at the levels of 10, 5 and 1%, are marked with symbols *, ** and *** respectively.

### Table B10

The worker’s efforts

<table>
<thead>
<tr>
<th>Variable (the Dictator game)</th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worker’s wage</td>
<td>0.015***</td>
<td>0.015***</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.001)</td>
</tr>
<tr>
<td>Round</td>
<td>–0.012</td>
<td>–0.013</td>
</tr>
<tr>
<td></td>
<td>(0.009)</td>
<td>(0.009)</td>
</tr>
<tr>
<td>Allocator</td>
<td>0.098**</td>
<td>0.085**</td>
</tr>
<tr>
<td></td>
<td>(0.040)</td>
<td>(0.037)</td>
</tr>
<tr>
<td>Receiver (the Dictator game)</td>
<td>0.064</td>
<td>0.050</td>
</tr>
<tr>
<td></td>
<td>(0.043)</td>
<td>(0.037)</td>
</tr>
<tr>
<td>Trustor (the Trust game)</td>
<td>–0.013</td>
<td>–0.009</td>
</tr>
<tr>
<td></td>
<td>(0.039)</td>
<td>(0.043)</td>
</tr>
</tbody>
</table>
The ending of table B10

<table>
<thead>
<tr>
<th>Variable</th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trustee (the Trust game)</td>
<td>0.001</td>
<td>−0.027</td>
</tr>
<tr>
<td></td>
<td>(0.037)</td>
<td>(0.040)</td>
</tr>
<tr>
<td>Male gender</td>
<td>0.082***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.025)</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>−0.004</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.006)</td>
<td></td>
</tr>
<tr>
<td>Mother’s educational attainment</td>
<td>−0.097***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.034)</td>
<td></td>
</tr>
<tr>
<td>Father’s educational attainment</td>
<td>−0.024</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.037)</td>
<td></td>
</tr>
<tr>
<td>Trusting in people</td>
<td>0.058</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.035)</td>
<td></td>
</tr>
<tr>
<td>Well-off family</td>
<td>−0.008</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.033)</td>
<td></td>
</tr>
<tr>
<td>Working</td>
<td>−0.079***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.030)</td>
<td></td>
</tr>
<tr>
<td>Having siblings</td>
<td>0.038</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.032)</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>0.046</td>
<td>0.229</td>
</tr>
<tr>
<td></td>
<td>(0.044)</td>
<td>(0.151)</td>
</tr>
<tr>
<td>Observations</td>
<td>340</td>
<td>340</td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.571</td>
<td>0.610</td>
</tr>
</tbody>
</table>

**Note:** The robust standard errors are displayed in italics. Estimators, significant at the levels of 10, 5 and 1%, are marked with symbols "*", "**" and "***" respectively.

Table B11

Regression models of status measures

<table>
<thead>
<tr>
<th>Variable</th>
<th>Status</th>
<th>own</th>
<th>partner’s</th>
<th>relative</th>
<th>relative (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
</tr>
<tr>
<td>Allocator (the Dictator game)</td>
<td>0.279</td>
<td>-1.730***</td>
<td>0.579***</td>
<td>0.551***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.377)</td>
<td>(0.515)</td>
<td>(0.209)</td>
<td>(0.200)</td>
<td></td>
</tr>
<tr>
<td>Receiver (the Dictator game)</td>
<td>-0.773</td>
<td>1.272***</td>
<td>-0.593**</td>
<td>-0.338</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.552)</td>
<td>(0.475)</td>
<td>(0.259)</td>
<td>(0.257)</td>
<td></td>
</tr>
<tr>
<td>Trustor (the Trust game)</td>
<td>-0.108</td>
<td>0.335</td>
<td>-0.137</td>
<td>-0.0487</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.440)</td>
<td>(0.427)</td>
<td>(0.201)</td>
<td>(0.223)</td>
<td></td>
</tr>
<tr>
<td>Trustee (the Trust game)</td>
<td>-0.310</td>
<td>0.559</td>
<td>-0.253</td>
<td>-0.246</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.395)</td>
<td>(0.475)</td>
<td>(0.156)</td>
<td>(0.209)</td>
<td></td>
</tr>
</tbody>
</table>
The ending of table B11

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Manager</td>
<td>-0.465</td>
<td>0.291</td>
<td>-0.225</td>
<td>0.118</td>
</tr>
<tr>
<td></td>
<td>(0.438)</td>
<td>(0.491)</td>
<td>(0.206)</td>
<td>(0.205)</td>
</tr>
<tr>
<td>Sequence of games</td>
<td>-0.0596</td>
<td>0.0607</td>
<td>-0.0363</td>
<td>-0.0398</td>
</tr>
<tr>
<td></td>
<td>(0.153)</td>
<td>(0.185)</td>
<td>(0.0732)</td>
<td>(0.0827)</td>
</tr>
<tr>
<td>Male gender</td>
<td>1.033**</td>
<td>-0.588**</td>
<td>0.475***</td>
<td>0.360**</td>
</tr>
<tr>
<td></td>
<td>(0.407)</td>
<td>(0.277)</td>
<td>(0.155)</td>
<td>(0.151)</td>
</tr>
<tr>
<td>Age</td>
<td>-0.0181</td>
<td>-0.0295</td>
<td>0.00395</td>
<td>-0.00585</td>
</tr>
<tr>
<td></td>
<td>(0.0533)</td>
<td>(0.0363)</td>
<td>(0.0233)</td>
<td>(0.0191)</td>
</tr>
<tr>
<td>Parental educational</td>
<td>-0.697</td>
<td>-0.125</td>
<td>-0.166</td>
<td>0.0318</td>
</tr>
<tr>
<td>attainments</td>
<td>(0.440)</td>
<td>(0.229)</td>
<td>(0.152)</td>
<td>(0.177)</td>
</tr>
<tr>
<td>Material position</td>
<td>0.467*</td>
<td>-0.330**</td>
<td>0.232***</td>
<td>0.237**</td>
</tr>
<tr>
<td></td>
<td>(0.241)</td>
<td>(0.156)</td>
<td>(0.0801)</td>
<td>(0.112)</td>
</tr>
<tr>
<td>Single child</td>
<td>-1.197**</td>
<td>0.102</td>
<td>-0.382**</td>
<td>-0.296</td>
</tr>
<tr>
<td></td>
<td>(0.519)</td>
<td>(0.419)</td>
<td>(0.167)</td>
<td>(0.222)</td>
</tr>
<tr>
<td>The youngest child</td>
<td>-2.422***</td>
<td>0.508</td>
<td>-0.859***</td>
<td>-0.657**</td>
</tr>
<tr>
<td></td>
<td>(0.735)</td>
<td>(0.508)</td>
<td>(0.266)</td>
<td>(0.270)</td>
</tr>
<tr>
<td>The eldest child</td>
<td>-0.410</td>
<td>0.395</td>
<td>-0.232</td>
<td>-0.143</td>
</tr>
<tr>
<td></td>
<td>(0.607)</td>
<td>(0.444)</td>
<td>(0.213)</td>
<td>(0.227)</td>
</tr>
<tr>
<td>The sum trusted</td>
<td>-0.0121*</td>
<td>0.00563</td>
<td>-0.00533*</td>
<td>-0.00403</td>
</tr>
<tr>
<td></td>
<td>(0.00697)</td>
<td>(0.00430)</td>
<td>(0.00256)</td>
<td>(0.00249)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.573</td>
<td>1.491</td>
<td>-0.264</td>
<td>-0.325</td>
</tr>
<tr>
<td></td>
<td>(1.723)</td>
<td>(1.283)</td>
<td>(0.667)</td>
<td>(0.666)</td>
</tr>
<tr>
<td>Observations</td>
<td>192</td>
<td>192</td>
<td>192</td>
<td>192</td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.235</td>
<td>0.255</td>
<td>0.291</td>
<td>0.214</td>
</tr>
<tr>
<td>Allocator — Receiver</td>
<td>0.0649</td>
<td>1.48e-07</td>
<td>2.83e-05</td>
<td>0.00116</td>
</tr>
<tr>
<td>(the Dictator game)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trustor — Trustee</td>
<td>0.690</td>
<td>0.621</td>
<td>0.603</td>
<td>0.434</td>
</tr>
<tr>
<td>(the Trust game)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: The robust standard errors are displayed in italics. Estimators, significant at the levels of 10, 5 and 1%, are marked with symbols “*”, “**” and “***” respectively.

REFERENCES


Measurement of Social Status in Experimental Games


Received 17.05.2018
A Note on St. Petersburg Paradox

Abstract. St. Petersburg paradox, formulated by N. Bernoulli in the early 18th century, led to introduction of the utility function concept (D. Bernoulli, G. Cramer) as a way to resolve the paradox. This paradox played an important role in the development of decision making theory. In the 20th century, the paradox attracted the attention of many researchers, including the Nobel Prize winners — P. Samuelson, R. Aumann, L. Shapley. D. Bernoulli assumed that payments grow exponentially with the coin tosses iterations’ number. The growth rate of payments is higher than the exponential one in the generalized St. Petersburg paradox. The utility functions of Bernoulli and Cramer don’t lead to the resolution of the paradox in this case. In 1934, K. Menger showed the necessity and sufficiency of the boundedness of the utility function for resolving of the generalized St. Petersburg paradox. A brief overview of existing literature on this subject matter is provided, as well as the authors’ suggested approach to resolve the classical paradox using discounting of monetary flows and granting a special role to the temporal lags in consecutive coin tosses iterations. The adaptation of the proposed approach to the generalized St. Petersburg paradox is also described. The suggested approach is deemed to be an alternative to the traditional one, based on utility function. Specifically, it allows solving the inverse problem: i.e. to find the unambiguous moments of possible payments for given the payments’ sizes, force of interest and price of the game.

Keywords: St. Petersburg paradox, discounting, Menger theorem.

JEL Classification: C730.

DOI: 10.31737/2221-2264-2018-38-2-2

St. Petersburg paradox was formulated by N. Bernoulli in the early XVIII century. The gist of it is as follows: Peter offers Paul a game: a coin is tossed in the “honest” game. If it is “heads” in first iteration, Peter pays Paul 1 unit (in the original text it was a ducat), if it is “heads” in the second iteration — 2 units, if it is “heads” in the \( n \)-th toss — then \( 2^n \) units. What is a “fair” value of such a game, i.e. how many ducats will it take to have Paul partake in this game? Naturally, this value should be equal to the average cash, received by Paul.

Given that the probability of the first “heads”, the result at the \( n \)-iteration is equal to \( 1/2^n \), the average cash of a win is

\[
1 \times \frac{1}{2} + 2 \times \frac{1}{2^2} + \ldots + 2^n \times \frac{1}{2^{n+1}} + \ldots = \frac{1}{2} + \frac{1}{2} + \ldots = \infty.
\]

The paradox of this result led G. Cramer (in his letter to N. Bernoulli) and D. Bernoulli (Bernoulli, 1738) to introduce a function of mathematical probability that would reflect Paul’s subjective perception. Later this function was named utility function. In the XX century this paradox caught atten-

\[1\text{ The authors express their gratitude to the anonymous reviewer for his critique and suggestions of (Seidl, 2013) paper.}\]
tion of a number of prominent researchers — P. Samuelson, R. Aumann, L. Shapley (Samuelson, 1977; Aumann, 1977; Shapley, 1977). Utility functions suggested by G. Cramer and B. Bernoulli increase as $\sqrt{n}$, $\ln n$ respectively. D. Bernoulli took into accounted for the utility function depending on Paul’s initial capital.

The utility function of a financial asset $f(x)$ should possess the following properties:

1) increase;
2) concavity;
3) $f(0) = 0$.

These properties are well known and left with no comment. With additional standard assumption of differentiation:

4) $f’(0) = 1$.

Property (4) is a condition of normalization. It is customary to assume that utility of small sum is equal to their sum.

Utility functions, proposed by G. Cramer and D. Bernoulli, are slightly modified and have the following form: $f(x) = 2(\sqrt{x + 1} - 1)$ and $f(x) = \ln(x + 1)$. The modifications are implemented to ensure that properties 1–4 hold.

«Fair» assessment of the game $x^*$ when Paul’s capital is zero (after the initial payment for game participation) is determined using equation $\sum_{n=1}^{\infty} \frac{1}{2^n} f(x^*) = \sum_{n=1}^{\infty} \frac{M}{2^n}$. The computation shows that Cramer-type function gives the price of the game equal to 1.87, and for Bernoulli-type — 1.76.

At the same time, if the growth of payments is assumed to be higher (for example, $2^{2^n}$), then the considered utility functions don’t eliminate the paradoxical result. In such case, it is more productive to use utility function that increases slower, more specifically, — for a given velocity of payments growth, it can be assumed to be equal to $\ln(\ln(x + 1) + 1)$. Nevertheless, there are multiple payoffs amounts for which this function will not yield a rational outcome.

It is natural to raise a question here of whether there are universal utility functions that can be applied to arbitrary function of payoffs. P. Samuelson named such game super-Petersburg one. This problem was considered by K. Menger (Menger, 1934).

**Menger theorem.** Game has a finite price with the use of utility function $f(x)$ for any sequence of possible payoffs $a_1,...,a_n,...$ when and only when function $f(x)$ is limited.

**Proof.**

1. Let $f(x) \leq M$. Then for any sequence $a_1,...,a_n,...$ inequality $\sum_{n=1}^{\infty} \frac{f(a_n)}{2^n} \leq \sum_{n=1}^{\infty} \frac{M}{2^n} = M$ holds.

2. Let utility function $f(x)$ be not limited. Let’s construe a sequence $a_1,...,a_n,...$ inductively in the following form. Assume $a_1$ thus, that $f(a_1) \geq 2$. Let $a_1,...,a_n$ be already construed. Assume value of $a_{n+1}$ such as
It is possible because the utility function is not limited. Then series $\sum_{n=1}^{\infty} \left( f(a_n) / 2^n \right)$ diverges.

P. Samuelson (Samuelson, 1977) assessed Menger’s result as the main achievement of the theory of this paradox, obtained after contributions by D. Bernoulli. However, at the same time, some studies (Peters, 2011) subjected Menger’s propositions to criticism which we deem largely unfounded. R. Aumann (Aumann, 1977) posited assumption of limited utility function unacceptable in principle using a rather witty argument based on the cost of life. We note the high evaluation for Menger’s result by J. von Neumann and O. Morgenstern (Neumann, Morgenstern, 1947) is nevertheless well merited.

While utility function is being used, its selection remains quite arbitrary. In essence, such selection serves to attend to a concrete task ignoring exogenous considerations. Usually it is linked to players’ risk aversion (P. Samuelson noted that Peter was taking bigger risks) — but how this linkage plays out is far from obvious.

Recently this paradox attracted specialists in different, sometimes unexpected, areas (see, for instance, (Ivanitsky, 2010)). There have been also experimental studies of similar games (see, for example, (Cox et al., 2009)). Literature on this paradox is quite extensive (see, for example, surveys (Samuelson, 1977; Seidl, 2013)). The resolution of the paradox is oftentimes seen as proposed game infeasibility due to limited resources. More specifically, L. Shapley (Shapley, 1977) and P. Samuelson (Samuelson, 1977) viewed the game infeasible because Peter could not comply with the terms of the contract. D. Brito (Brito, 1975) proposed natural time limits like Pauls’ life longevity. We, however, deem the constraint of resources surmountable, at least theoretically. Even if one’s life span is limited, there remains a possibility of passing the game to the heirs. As for the limited nature of resources, one should not ignore the contradiction between the dynamic nature of the game and resources being given in a static picture: Peter’s means and resources can possibly grow up with time. This idea was expressed in в (Durand, 1957; Székely, Richards, 2004). Thus the game can potentially be infinite. O. Peters (Peters, 2011) applied methods of statistical mechanics for this purpose, noting non-ergodic nature of the system under consideration.

It is noted in (Seidl, 2013) that the attempts to resolve the paradox in question are frequently focused on the transformation of amounts of payoffs or probabilities. More specifically, C. Seidl used modifications of probabilities in the spirit of M. Yaari’s theory of dual utility (Yaari, 1987). Such approach, as a rule, leads to positive probability of the infinite horizon of the game.

In our opinion though, there is yet an important factor that was not given due attention: this is a factor of time or otherwise the time intervals between coin tosses. The factor of time from a different perspective was fea-
A Note on St. Petersburg Paradox

nature of a game depends on whether coin tosses happens once a minute or once an hour or once a month. If one or the other rate of interest (or \( \delta \) — force of interest as the continuous analog of interest rate) is being used, then the average discounted value of payoffs is equal to

\[
\sum_{n=0}^{\infty} \left( e^{-\delta \tau} \frac{2^{n-1}}{2^n} \right) = 1 / \left( 2 \left( 1 - e^{-\delta} \right) \right) ,
\]

where \( \tau \) — interval between the tosses. It is natural to assume (Székely, Richards, 2004), that the accrual would characterize the speed of Peter’s means increasing. However, in super-Petersburg game, this approach is non-usable. At the same time, a minor modification allows to include this case too.

Let \( a_1 < a_2 < \ldots < an < \ldots \) be values of payoffs at the end of the game after 1, 2, ..., \( n \), ... coin tosses. Let’s assume that coin is being tossed in moments \( t_1 < t_2 < \ldots < tn < \ldots \), i.e. we allow coin tosses through unequal intervals of time. Assume \( t_1 = 0 \), \( tn+1 \), with \( n \geq 0 \) to be defined inductively: \( a_n e^{-\delta t_n} = a_{n+1} e^{-\delta t_{n+1}} \). It means that \( t_{n+1} - t_n = (\ln(a_{n+1} / a_n)) / \delta \). Average discounted game price in this case is equal to

\[
\sum_{n=1}^{\infty} \left( a_n e^{-\delta t_n} / 2^n \right) = \sum_{n=1}^{\infty} \left( a_n / 2^n \right) = a_1 .
\]

This is, of course, not the only way to construe moments of the coin tosses.

The proposed approach to the solution of the St. Petersburg and super-Petersburg paradoxes is based on discounting and ordering of the moments of the coin tosses and is deemed as an alternative to the conventional application of utility function. Similar considerations can be effectively used under the conditions of uncertainty, when there is a possibility to manage time characteristics of analyzed processes.

REFERENCES


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Modelling of Economic Oscillations of Shale Oil Production

Abstract. Shale oil production is considered to be one of the important determinants of oil price slump in 2014–2016. According to some experts, shale oil became a new market “regulator”, ousted OPEC. Shale oil production is characterized by non-trivial dynamics. After an accelerated growth in 2010–2015, a period of fluctuations in production caused by the volatility of oil prices followed. The paper develops approach to the shale production modelling on the base of the analytical solutions of differential equation with retarded argument. The differential equation reflects the fact that production change consists of a sum of new debits and the natural process of base production decline. Besides, possibilities of origination and prerequisites of endogenous economic oscillations of shale oil production are studied. Calculations, implemented for economic and technological characteristics given for the period from December 2014 to May 2017, showed a possibility of oil production oscillation with a period of 33 months that does not contradict observations. In general, the proposed approach can be used as a nonlinear structural method for forecasting oil production and corresponding price component, connected to production change.

Keywords: mathematical simulation, differential equation with retarded argument, oil production, oil supply, shale oil, tight oil, economic oscillation, decline curve analysis.

JEL Classification: Q47, Q47, E32.

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1. Introduction

Despite the rapid development of green technologies, oil remains one of the main energy sources that ensure the development of the global economy. The high level of oil prices a few years ago raised the share of oil exploration and production costs to 4% of global GDP. Oil exporting countries received more than $1 trillion a year for oil supplies and used these funds to develop infrastructure, modernize production and increase the public welfare (Woetzel et al., 2017).

But after the decline of oil prices in mid-2014, the situation changed. This led to a slowdown in the development of OPEC countries, a recession in Russia, a weakening of investment in the US economy and a curbing of inflation in developed countries (Buckley, 2016; Hatzius et al., 2016). It is believed that an important role in the fall in oil prices was played by the growth of oil production at the USA shale deposits (Baffes et al., 2015).

The development of shale oil production is caused by a number of economic, technological, geological and institutional factors, the combination of which caused “the oil shale revolution” namely in the USA, and not in other countries where non-traditional hydrocarbon resources are occurred. Starting in 2012, the combination of high oil prices and a drop in production costs under the pressure of improved horizontal drilling, fracturing and 3D seismic technologies shifted the production of shale oil to the active growth phase, and in 2014 it reached 4% of the world market.

Additional materials revealing the mathematical technique of finding the roots of the equations under consideration are posted on the website of the Journal of the New Economic Association: http://journal.econorus.org/japp.phtml
Achieving a critical market share with a new resource, reinforced by a number of other factors (increased production in OPEC countries, removal of sanctions from Iran, a threat of overflow of oil storage in the US, etc.), led to a rapid drop in oil prices—from $110 bbl in early 2014 to $30 bbl in January 2016 (Yergin, Burkhard, 2017).

The decline in prices below the cost of production hit the oil producers. After a peak of 5.47 mln bbl/d in March 2015, production at the US shale deposits began to decline and fell to a minimum of 4.75 mln bbl/d in July 2015—December 2016 (Fig. 1). The growth of oil prices in the second half of 2016 led to an increase in investment activity, ramping up in the number of operating rigs in the US and the subsequent acceleration of oil production since early 2017.

Thus, it can be assumed that the oil production experienced a half-period of some oscillatory dynamics (17–22 months from peak to minimum). The growth and subsequent decline in oil production, respectively, negatively, and then positively influenced its price. The short investment cycle of the US shale industry compared to the three other types of oil resources (Fig. 2) turned into a new world price regulator, ousting OPEC to the second place. So, the analysis of the dynamics of shale oil production is rather important and relevant task for understanding the formation of the global oil price, which in turn is an important factor in the development of both global and Russian economies.

In the modern scientific literature, there are few publications on the study of the dynamics of the production of shale oil in the United States using mathematical models. Most likely this is due to a short period of time that has passed since understanding the importance of a new resource for the world oil market. There are several surveys (Curtis, 2015, Goryacheva, Milovidov, 2016, Hughes, 2016), but mathematical models of production are found mainly in non-peer-reviewed publications, for example, in the reports of bank analysts and energy agencies. Among the Russian and foreign authors who built models of shale oil production we can note the works (Lasky, 2016; Bjørnland et al., 2016; Zolina, 2014).

Existing approaches to mathematical modeling of oil production usually explore the only one factor (geological, technological, economic or institutional) and rarely—their aggregates (Brandt, 2010). An attempt of an integrated approach to the description of the extraction of shale oil on the basis of the ordinary differential equation of the first order was undertaken in (Malanichev, 2017a, 2017b).
This paper continues the study of oil production using analytic solutions of a differential equation. The theory of differential equations with a retarded argument was applied (see, for example, (Gevorkyan, 2004)). Therefore, the problem is formulated in continuous rather than discrete time (that is, solutions of a differential, but not a difference, equation are studied), which makes possible to obtain production dynamics in continuous differentiable analytic functions.

The model constructed refers to the structural approaches. It ensures the implementation of the material balance. The coefficients have a clear economic or physical meaning. The structural approach has 4 additional advantages in comparison with non-structural (empirical) research methods:

1) allows to carry out sensitivity analysis, for example, for the development of regulation policies;
2) does not require extensive statistical data for model learning, so it is able to effectively analyze non-stationary data series and transition modes. The coefficients of the model do not become insignificant and do not change their signs when the sample size is changed;
3) the theory of differential equations allows us to systematically investigate the conditions that determine a particular type of solutions (periodic or aperiodic, stable or unstable), hypothesize about the functional form of possible solutions, determine equilibrium points of the system, and study their stability;
4) the main advantage of the structural approach derives from the shortcomings of the empirical models, which are «the difficulties of justifying the applicability limits and the narrow range of initial data, under which these dependencies can be used» (Eskin, 1989).

The proposed approach is based on the differential equation of oil production (Malanichev, 2017a), which expresses the preservation of the material balance. According to the balance, changes in the quantity of production of shale oil consists of production from new wells drilled in the current month (new debits) and a decrease in production from existing wells (legacy production change):

\[
dq / dt = q_{\text{new}} - cq,
\]

where \( t \) — time, months; \( q \) — oil production quantities, mln bbl/d; \( q_{\text{new}} = eN \) — oil production from the new wells (new debits), mln bbl/d. A well is considered new one month after its completion; \( e \) — rig productivity, mln bbl/d. (the ratio of oil produced from new wells to the number of
rigs); $N$ — a number of rigs; $c$ — constant of decline rate of legacy production.

Equation (1) is an analogue of a linear inhomogeneous equation that describes the dynamics of production capacities (Eskin, 1989) or the natural output $q$ (Lukyanov, 2013) in general form, without reference to any specific industry:

$$\frac{dq}{dt} = K(t) / k - rq(t),$$

where $K(t)$ — investments; $k$ — capital intensity of unit capacity; $r$ — the rate of capacity disposal, or the wear factor (depreciation coefficient).

The analogy between these equations is well traced if we assume that the capital intensity of a unit capacity is inversely proportional to the rig’s efficiency ($k \sim 1/e$), and the investment is proportional to the number of drilling rigs ($K \sim N$).

Various assumptions about the terms of equation (1) make it possible to come to important conclusions about the oil production in the United States and to show the consistency of this approach to the existing models. In particular, in (Malanichev, 2017a) it was shown that the classical model of the superposition of production decline curves and the Hubbert extraction curve are the solutions of the proposed equation. The assumption that the performance of drilling rigs is described not as a $S$-shaped but as a bell-shaped curve leads to the conclusion that rig’s productivity and production simultaneously reach a peak at a certain point in time, after which the indicators will decrease due to depletion of the resource.

A prospective production can be estimated using a particular solution of the inhomogeneous differential equation (1), which determines the steady-state point for $t \rightarrow \infty$ and $dq/dt = 0$:

$$q_{st} = eN / c.$$

The production is directly proportional to the new debits (productivity multiplied by rig’s number) and inversely proportional to the constant of decline rate. The trajectory of production from initial quantity to its steady-state is described by solution of the Cauchy problem of (1):

$$q(t) = \left(q_0 - q_{st}\right)e^{-ct} + q_{st},$$

$\text{gде } q(t=0) = q_0$ — the initial production quantity.

Evaluation by formula (2) at the current market parameters gives $q(t \rightarrow \infty) = 6.25 \text{ mln bbl/d}$. This result may be somewhat overestimated with respect to the current market conditions typical for May 2017, since neither the level of recoverable reserves nor the limitation of market capacity (demand) are taken into account. Another disadvantage of the proposed approach is the latent assumption that all the summands of equations (1) are functions of time and are considered at the same instant $t$. In fact, this is not the case, since the price dynamics is translated into a change in output with a certain delay, the average value of which is estimated by market experts in 4–6 months (Vigna et al., 2017). The delay is explained by the length of the making and implementing the investment decisions.
In the economy, investment time lags are an important characteristic of the production process and one of the reasons for the emergence of economic oscillations (Hansen, 1951). According to A. Hansen, economic oscillations arise because of the mechanisms of lagging and leading. Economic cycles with 7–12 years’ duration due to the investment lag were opened by the French economist K. Jougliar in 1862. Then these cycles were studied by Polish economist M. M. Kalecki (López, Assous, 2011). He received an equation describing the change in the capital stock that turned out to be similar to equation in this paper studies.

Such oscillation processes can emerge not only in the economy as a whole, but also at the level of individual industries. More often, longer waves are studied, called “supercycles”. For example, researchers from the McKinsey World Institute (Woetzel et al., 2017) explain the rush of investment inflow and the growth in energy and metal production observed by the growth of the Chinese economy in the last 15 years. They believe that by now the cycle has ended and a phenomenon similar to China is not expected, so the emergence of another super cycle with a half-period of about 15 years is unlikely.

An opposite point of view is expressed in the analysts of the Central Bank of Turkey (Erdem, Ünalms, 2016). In their opinion, the super cycle of oil prices is still in force, the last peak was reached in 2012, and now the world economy is on the downward phase of the super cycle. Bank’s specialists note the lack of modern works, studying industry’s long-term oscillations. Unfortunately, it is even more difficult to single out scientific works that analyze and model shorter fluctuations in mining industries, and in particular in the oil industry. Among the known studies it is worth noting the work (Cuaresma et al., 2009), in which an attempt was made to use the harmonic series to predict oil prices. However, as noted earlier, unstructured approaches have certain limitations and remain outside the scope of this study.

The emergence of a new oil resource with a short investment cycle exacerbated the problem of studying the dynamics of oil production in the United States and analyzing the possibility of the appearance of oscillations in this new “regulator” of the global oil market. Thus, the main purpose of this work is to study the possible trajectories of the production of US shale oil, depending on macroeconomic, technological and geological parameters in conditions of limited demand and investment lag. Particular attention is paid to the study of the conditions for the emergence of both damped and increasing oscillations in shale oil production.

This study is based on the data of EIA’s Drilling Productivity Report (EIA, 2017a). The report provides the latest information on the number of active drilling rigs and their productivity for the seven key shale oil producing regions responsible for 92% of the shale oil production (Utica, Permian Midland, Niobrara, Marcellus, Nyanesville, Eagle Ford and Bakken regions). The parameters of equation (1) are obtained by summing or averaging the
data for these regions (for example, the volumes of production are sum-
marized, and the productivity of drilling rigs is weighed by their number in
each region). The dynamics of the WTI oil price, affecting the investment,
is taken from the report EIA STEO (EIA, 2017b).

2. Differential equation of oil production
with retarted argument

The use of price as an input parameter in the models of the dynam-
ics of oil production is a fairly common approach that has been applied by
Russian (Afanasyev, 2017, Trofimchuk, 2015, Kolpakov, Semikashev, 2016)
and foreign authors (Benes et al. 2012; Uri, 1982; Kaufmann, 1991). In works
(Baffes, 2015, Curtis, 2015, Lasky, 2016, Trofimchuk, 2015; Kolpakov, 2016;
Benes et al., 2012; Uri, 1982; Kaufmann, 1991) the authors also noted the
importance of taking into account the lags between the oil prices, invest-
ments and oil production, which for various types of oil resources varies
from 0.1 to 14 years (see Fig. 2). The lags are revealed both by econometric
studies and by the expert’s estimates.

The lag consists of two components: the lag between price change
and investment decision making and the lag between the investment deci-
sion and the implementation of investment decision. It takes about three
months for market participants to believe in the stable price increases and
decision making to increase production (Vigna, 2017). Drilling crews are
hired, drilling equipment is rented. The latter is tracked by weekly pub-
lished by «Baker Hugs» bulletin. For simplicity of approach, we simulate
this process using a linear regression equation without a constant:

\[ N(t) = k' p(t - 3), \]

where \( p(t - 3) \) – WTI oil price, taken three months ago from time \( t \); \( k' = 11.3 \) –
an empirical constant, taken from regression analysis for period 2010–2016
(Fig. 3). Regression equation (4) does not take into account some practically
important, but theoretically difficult features.

Firstly, the constant of the equation does not reflect the growth
of labor productivity and changes in production costs, which have very
dynamic characteristics of the production of shale oil. In particular, the cost
of production on the deposits of Permian Midland fell from $85 in 2013 to
$39 bbl in 2016 (Malanichev, 2017a).

Secondly, market participants in deciding whether to hire drilling
equipment and crews for its servicing may proceed not only from the cur-
cent price of oil and cost, but also the expectations of future values of these
indicators. For example, the relationship between the price of oil and the
number of active drilling rigs may depend on the direction of the price
dynamics (falling or increasing). Producers attempt to yield additional
profit by selling increased volumes of oil at higher price.

Thirdly, some players can hedge their operations, i.e. conclude a
contract for the supply of oil in the future at a fixed price, the level of which
is determined by the value of the relevant futures.
These factors make the process of predicting the number of rigs highly uncertain. Construction of more complicated model of rig counts is beyond the scope of this paper.

The sample of regression analysis (4) contains 32 values, which is enough to make judgments about the statistical significance of the obtained coefficient \( k' \). Its positive value leads to the fact that as the price of oil increases, the number of drilling rigs increases. The high value of the coefficient of determination \( R^2 = 0.85 \) indicates a close statistical relationship between the resulting variable (rig counts) and the explanatory variable (WTI crude oil price). The absolute value of the \( t \)-statistic exceeds 2, which confirms the statistical significance of the coefficient \( k' \) in (4).

Drilling takes at least two weeks; then another 1.5 months the well is completed: casing installation, cementing, perforating, fracturing, etc. Production from a newly drilled well begins only two months later:

\[
q_{\text{new}}(t) = eN(t - 2) = kp(t - 5),
\]

where \( k = ek' \).

The price could be expressed via production from inverse demand law, taken in linear form:

\[
p = b' - a'q,
\]

where \( a' \) and \( b' \) are positive empirical coefficients.

This form of law assumes that the price of oil depends only on the volume of shale oil production \( q(t) \). The extraction of other types of oil resources is included in the constant \( b' \). The dynamics of the other oil types’ production can be taken into account by introducing the law of variation of parameter \( b'(t) \) with time \( t \); however this option is left for future studies.

If we substitute the dynamics of the shale oil production in (6), the output of the equation will be the dynamics of the change in the price component of WTI oil, caused by a change in the volumes of shale oil production only. The dynamics of this component in the general case will differ from the dynamics of the price of the WTI oil brand, since the production of oil other than shale varies with time. However, at the initial time the price \( p \) coincides with the value of WTI oil price. For the sake of simplicity, we will consider the production of other types of oil to be constant.

Estimates of coefficients \( a' \) and \( b' \) will be obtained through data from available sources. For example, calculations on the general equilibrium model show that each additional 1 mln bbl/ d reduces the world oil price by \( \varepsilon = 14\% \) (Word Bank, 2015). The coefficient \( a' \) is proportional to
the oil price \( p_0 \), at which the coefficients are calculated, and the elasticity \( \varepsilon \):

\[ a' = \varepsilon p_0. \quad (7) \]

The coefficient \( a' \) corresponds to the slope of the demand curve: the greater the elasticity and the base oil price, the greater the angle of inclination to the horizontal axis, the less elastic the demand for price. In other words, the oil price change does not turn into a stronger change in demand.

The coefficient \( b' \) determines the point of intersection of the demand curve with the vertical axis, i.e. it corresponds to the price at zero production volume. The coefficient also depends on the elasticity and basic price at which the calculation is made. An additional parameter is the production volume at the initial time \( q_0 \) at which the demand curve is estimated:

\[ b' = (1 + \varepsilon q_0) p_0. \quad (8) \]

Substituting (6) into (5), then (5) into (1) and denoting the lag by \( \tau \), we arrive at an inhomogeneous linear differential equation with constant coefficients and a retarded argument:

\[ \frac{dq}{dt} + a q(t - \tau) + cq = b, \quad (9) \]

where \( a = a'k; \ b = b'k; \ c \) — positive empirical coefficients.

If one removes the assumption of a constant production of oil, different from shale, then the coefficient \( b \) becomes variable in time. However, the study of an inhomogeneous equation with a variable right-hand side lies outside the framework of this paper.

It is important to understand that the time lag in the economy is generally not a single and constant quantity, but can be distributed over time and this distribution may change with time as well. Then the number of drilling rigs can be expressed through the price at different times:

\[ N(t) = \sum_{w=0}^{W} K_{w} \cdot p(t - \tau) + K'(t) \quad (10) \]

where \( \tau \) — lag (months); \( W \) — maximal number of lags (months); \( K_{w}(t) \) — individual contribution of the price with this lag to the number of rigs. The combination of these coefficients shows the structure of the lag; \( K'(t) \) — the residual component of the lag’s distribution.

The productivity of drilling rigs until August 2016 was continuously increasing, which was mainly due to the improved technology. More powerful drill drives was used, longer horizontal bore-wells were drilled, multi-stage re-fracturing was carried out, bushings drilling was applied, etc. In (Malanichev, 2017a) it was shown that the rig’s productivity can be approximated by a bell-shaped function describing the dynamics of the production volume:

\[ e = E_{w} q, \quad (11) \]

where \( E_{w} \) — an empirical constant characterizing the maximum achievable extraction efficiency. In other words, performance can not only grow, but also fall due to depletion of the resource and the complexity of access to it.
Substituting (6) in (10), then (11) and (10) in (5), new production will be calculated using formula

$$q_{\text{new}}(t) = q(t) \sum_{\tau=0}^{\infty} K_{\tau} q(t - \tau) + K(t),$$

where $K_{\tau} = E_{\tau} K_{\tau}$, $K(t) = E_{\tau} K(t)$.

Substitution of (12) into (1) transforms the original differential equation into a non-linear equation where production quantities $q$ are in the first and second degrees. This step allows us to apply equation (1) for the production forecast using endogenous productivity of the drilling rigs.

Another direction in the model development could be the use of the time-dependent right-hand side of equation (9), which reflects the change in demand with time.

One of the reasons of demand volatility could be economic or industrial cycles. They could be modelled by harmonic functions instead the constant coefficient $b$ in (9). Thus, we have outlined a few areas for further researches, but this paper is devoted to solving a simpler linear equation with constant coefficients (9).

### 3. Solutions of the equation and their analysis

The equation (9) is a linear ordinary differential inhomogeneous first-order equation with constant coefficients and a retarded argument. The mathematical problem is to find its solution satisfying the initial condition $q(t = 0) = q_0$, i.e. to solve the Cauchy problem. The general solution of (9) consists of a combination of the general solution of the corresponding homogeneous equation and one particular solution of the inhomogeneous equation.

We seek the solution of the homogeneous equation by the Euler method:

$$q(t) = q_0 e^{\lambda t},$$

where $q_0$— the initial quantity of oil production (mln bbl/d) at the time $t = 0$; $\lambda$ — a characteristic number. Substituting solution (13) into the homogeneous equation corresponding to (9), we take a transcendental characteristic equation that does not in general have analytic solutions:

$$\lambda + a e^{\lambda t} + c = 0.$$ \hspace{1cm} (14)

The nature of the solution will largely depend on the type of roots of this equation (real or complex) and their sign. We differentiate (14) with respect to $\lambda$ and find the value of the single real root

$$\lambda = \ln(\alpha \tau) / \tau.$$ \hspace{1cm} (15)

Substitution (15) into the characteristic equation (14) gives

$$F = \ln(\alpha \tau) + c \tau + 1 = 0.$$ \hspace{1cm} (16)

Consequently, the condition for the existence of a single root is that the criterion $F$ is zero ($F = 0$). The sign of this criterion helps to make judgments about the number and nature of the roots. Possible variants of the roots of this equation, the criterion for their appearance and the characterization
of the dynamics of the extraction of shale oil, are given in Table 1.

Table 1

<table>
<thead>
<tr>
<th>Number and type of roots</th>
<th>Criterion $F$</th>
<th>Oil production dynamics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 or 2 real</td>
<td>$F \leq 0$</td>
<td>damped $\alpha \tau &lt; 1$</td>
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<td></td>
<td></td>
<td>increasing $\alpha &gt; 0$, necessary condition $\alpha &gt; \omega$</td>
</tr>
</tbody>
</table>

Note. The parameter $\alpha$ is introduced and discussed in section 3.2.

Source: formed by author.

For $F < 0$, equation (14) has two real roots. In this case, the solution of the homogeneous differential equation is the combination of exponentials (13), and the real roots are negative. More interesting is the situation of nonintersection of curves for $F > 0$, when two complexes conjugate roots arise, and the solution of the homogeneous differential equation has a oscillatory character.

The control calculation of the parameters of various solutions of the differential equation of oil production (9), depending on the roots’ types of the characteristic equation, is given in Table 2. Some of the parameters described in the table are introduced in the following sections.

Table 2

<table>
<thead>
<tr>
<th>Type</th>
<th>Parameter</th>
<th>Notation</th>
<th>Oil production modes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>damped boundary</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>aperiodic</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>oscillatory</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>oscillatory</td>
</tr>
<tr>
<td>Parameters</td>
<td>Oil price, USD/bbl.</td>
<td>$p_0$</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>Productivity, mln bbl/d.</td>
<td>$e$</td>
<td>0.0007</td>
</tr>
<tr>
<td></td>
<td>Lag, months</td>
<td>$\tau$</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Criterion</td>
<td>$F$</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>First root, 1/month</td>
<td>$\lambda_1$</td>
<td>-0.26</td>
</tr>
<tr>
<td></td>
<td>Second root, 1/month</td>
<td>$\lambda_2$</td>
<td>-0.92</td>
</tr>
<tr>
<td></td>
<td>Oscillation frequency, 1/month</td>
<td>$\omega$</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Oscillation period, month</td>
<td>$T$</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>Damping coefficient, 1/month</td>
<td>$\alpha$</td>
<td>-0.16</td>
</tr>
</tbody>
</table>

Note. For all calculations $\varepsilon = 14\%$ and $k^\prime = 11.3$.

Source: formed by author.
3.1. Real roots case

In the case of the single real root of the characteristic equation (14), for \( F = 0 \), the solution of the Cauchy problem of the differential equation (9) has the form:

\[
q(t) = \left( q_0 - \frac{b}{c + a} \right) (a \tau)^{-t} + \frac{b}{c + a}.
\]  

(17)

By analogy with mechanical oscillations, the equation describes the so-called boundary damping mode (Fig. 4). Because \( a \tau < 1 \), for \( t \to \infty \), the solution tends to a constant \( \frac{b}{c + a} \). Estimation of the long-term production value by this formula gives \( q_s = 5.6 \text{ mln bbl/d} \). This means that, compared to the minimum level of December of 2016, the volume of production can increase by 5.6–4.75 = 0.85 mln bbl/d. This value may be underestimated, since equation (6) does not take into account the annual growth in demand, which over the past decade averages 1.2 mln bbl/d. The growth in demand may be partly offset by an increase in supply by other market players (Canada, Brazil, OPEC members, the Russian Federation and other countries).

A decrease of the coefficient \( a \), lag \( \tau \), or the drop of decline rate of legacy production \( c \) will lead to a negative criterion value (16) \( F < 0 \), which indicates the case of two real roots of the characteristic equation (14). In this case, there is no exact analytic solution of equation (14), and its approximate value is calculated. The solution of the Cauchy problem of the differential equation (9) has the form:

\[
q(t) = \frac{1}{2} \left( q_0 - \frac{b}{c + a} \right) \left( e^{-\tau t} + e^{\tau t} \right) + \frac{b}{c + a},
\]  

(18)

that corresponds to the aperiodic damping mode (Fig. 4). It is important to note that, as in the theory of mechanical oscillations, in the boundary regime the system under investigation is approaching its equilibrium value more rapidly than in the aperiodic regime.

3.2. Two complex conjugated roots case

The complex value of the roots of the characteristic equation (14) arises when the criterion \( F \) (16) is positive \( (F > 0) \):

\[
\lambda = a \pm i \omega.
\]  

(19)

The shale oil production, as well as its price, can, under otherwise equal conditions, experience periodic oscillations with frequency \( \omega \) and responds to equation

\[
q(t) = Ae^{\alpha t} \cos(\omega t + \varphi),
\]  

(20)
where the constants $A$ (the amplitude of the oscillations) and $\varphi$ (the phase of the oscillations) are found from the initial conditions. The oscillations can be damped ($\alpha < 0$) or increasing ($\alpha > 0$) depending on the real part $\alpha$ of the complex root $\lambda$.

The solution of the Cauchy problem for the general solution (20) of the inhomogeneous differential equation is found as:

$$q(t) = \left(q_0 - b \frac{b}{c+a}\right) \cos(\omega t e^{at} + \frac{b}{c+a} . \tag{21}\right)$$

At $\tau = 7$, this solution shows the oscillatory character of the dynamics of oil production as it tends to its equilibrium (see Fig. 4). The presence of stable oscillations ensures the fastest achievement of an equilibrium production $5.65 \text{ mln bbl/d}$, but from 15 to 21 months of the calculation period, production exceeded this value and amounted to $5.68 \text{ mln bbl/d}$.

Since periodic oscillations can be not only damped, but also increasing, the condition for the presence of increasing oscillations is the positive value of the real part $\alpha$ of the complex root $\lambda$ (19). It is not difficult to show that the inequality $\alpha > 0$ is valid under the condition

$$\omega \sin(\phi) > 0. \tag{22}$$

Taking into account that $\sin(\phi) \leq 1$, a softer but simpler form of the criterion (necessary condition) can be described by the formula

$$a \omega > 0. \tag{22'}$$

Table 2 showed a hypothetical set of indicators that led to the emergence of increasing oscillations, which had to double the price and productivity in comparison with the previous calculation ($p_0 = 150/\text{bbl}, e = 0.0014 \text{ mln bbl/d}$). Criterion $F = 2.26$ is positive, it indicates the presence of two complex conjugate roots.

With such parameters, the solution oscillates around an asymptote that tends to its long-term production value of $10.1 \text{ mln bbl/d}$ (Fig. 5). However, the oscillation amplitude with each period ($T = 23$ months) increases. In the first period, the production volume reaches $17.1 \text{ mln bbl/d}$, and then falls to $0.8 \text{ mln bbl/d}$. In the second period, the maximum is $22.4 \text{ mln bbl/d}$, and the minimum value outside the research area becomes negative, which has no economic sense.

It is clear that the regime of increasing oscillations is of theoretical interest and can not be realized in the real economy, faced with a lot of restrictions (for example, availability of sites, equipment and personnel, as well as various stabilizing feedbacks in the system) that are not taken into account in this model.
However, one can draw an important qualitative conclusion: a significant increase in the components from which the indicator $a$ is composed (price and productivity) can lead to the emergence of a rapidly growing response to the extraction of shale oil.

4. Comparison of calculated and actual values

The proposed theory has rather a qualitative than a quantitative nature, since equation (9) is formulated in a linear form with constant coefficients and a right-hand side, which does not fully correspond to the observational data. At the present stage of the study, this was done consciously to obtain and study analytic solutions, and it would be strange to expect the fully correspondence to the actual data. Nevertheless, to compare the gap between theory and practice, a comparison of the calculated and actual data was carried out. The initial data for the calculation and the results are shown in Fig. 6.

![Comparison of actual and calculated data: a) oil production; b) WTI oil price](image-url)
The comparison was conducted for 2014–2017, when production reached a maximum, then a minimum, and then began to grow again. Not only the calculated and actual volumes of production are compared, but also the dynamics of the component of the price of WTI oil, determined by the factor of shale oil production in the United States, calculated according to the formula (6). The production rate, the initial price, the connection of the number of drilling rigs to the price, the productivity of drilling rigs, and the rate of decline in production are taken to be constant equal to the actual values of December 2014. The calculated curve was adjusted by OLS to the actual one using a variation in the elasticity of demand \( \varepsilon = 25\% \) and the lag \( \tau = 8 \) months.

This set of indicators corresponds to the mode of damped oscillations with a period of 33 months, a damped constant \( \alpha = -0.07 \) and an equilibrium production 5.2 mln bbl/d. The model underestimated the minimum value of oil production in the fall of 2016, as it does not take into account the influence of other countries that increase production (Iraq, Iran, Saudi Arabia, the Russian Federation and some others).

However, the neglect of the continuous increase in drilling efficiency, which in 2017 reached the value \( e = 0.0007 \), resulted in the model underestimating the production at the end of the period.

The calculation of the price component caused by the change in the production of shale oil showed an acceptable correspondence to the dynamics of the actual oil price. The growth in oil production from January 2014 to March 2015 negatively affected the price component, which corresponds to the dynamics of the actual price, if seasonal fluctuations are neglected. The period of decline in production, which lasted until the autumn of 2016, corresponds to an increase in the price component. However, the growth in the actual price began only in February 2016. Before that, the actual price of oil continued falling due to the growth in oil exports from Iran after partial lifting of sanctions and strengthening of dollar on the background of tightening the policy of Federal Reserve System of the USA.

5. Conclusions

This paper studies the dynamics of oil production in shale plays in the US using analytical solutions of an ordinary differential equation with a retarded argument. This approach in the economy is usually applied to the analysis of macroeconomic cycles. The developed apparatus of analytical solutions of differential equations made it possible to show the nature of the emerging of endogenous economic oscillations in oil production and to obtain the following results.

1. To describe the dynamics of shale oil production in the United States, a differential first-order equation with a retarded argument is formulated. The retarded argument is caused by a lag between the dynamics of oil prices and making and implementing the investment decisions (drilling,
Modelling of Economic Oscillations of Shale Oil Production

2. By analogy with the theory of mechanical oscillations, four types of solutions are identified that can come out in various combinations of macro- and microenvironment parameters (prices, productivity of drilling rigs, lags, elasticity demand, the rate of production decline):

- damped: boundary, aperiodic and oscillatory modes;
- increasing oscillatory.

The conditions for emerging of these production modes have been studied and their criteria have been formulated. In particular, the increase in drilling efficiency, oil prices and lags leads to dampening oscillations of production. The most probable reasons for the emerging oscillatory dynamics in the future are the change of price and lag. With a certain combination of external conditions, the oscillations from the damped mode can transit to an increasing one, which, apparently, are only a theoretical and practically unrealizable result.

3. Calculations for the period from December 2014 to May 2017 showed the possibility of oil production oscillations with a period of 33 months, which does not contradict the observational data.

4. The model allowed predicting possible trajectories of damped oil production to its equilibrium value of 5.6 mln bbl/d. It is clear that this value will change with time under the shifts in the micro- and macro-environments. An equilibrium estimate of the shale oil production potential was applied to assess the strategy of Saudi Arabia’s behavior in work (Malanichev, 2016).

In general, the proposed approach can be used as a nonlinear structural method for forecasting the growth of shale oil production and oil price changes associated with it.

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Negative Net Worth of Manufacturing Companies: Corporate Governance and Industry Expectations

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Negative Net Worth of Manufacturing Companies: Corporate Governance and Industry Expectations

Abstract. Transparent and effective corporate governance positively influences the financial stability of the company: it increases the investment attractiveness and reduces the costs of lending. For Russia, this problem is relatively new. And at the moment, corporate management in the manufacturing industry continues to be characterized by a high concentration of ownership and a combination of ownership and management functions. In this paper, using logistic regression we investigate the impact of corporate governance factors and industry expectations on a negative net worth of the companies in the period 2011–2015. The results showed, in particular, the probability of a negative company’s net worth is higher, the lower the index of business confidence in the industry; the presence of agency problem; the smaller the number of members in the board of directors; the higher ownership concentration; and, if company is not privately owned or joint-stock company in the manufacturing industry. Robustness of the coefficients of the final specification was confirmed.

Keywords: manufacturing industry, negative net worth, probability of default, logistic regression, corporate governance, industry expectations.

JEL Classification: C25, G32, G33, G34, L60.

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1. Introduction

Transition to the innovation economy, where the human capital, as well as the knowledge and information, are the drivers of economic growth, advance progressively. These drivers are based mainly on the industrial economic development, on industry as the major growth driver. This harmonious symbiosis may be the platform for the stable economy in the long run. The manufacturing industry is the major element in the structure of the Russian industry in goods shipped of the own production and the average annual number of employees — about two thirds and three quarters correspondently.

Decision of strategic tasks aimed at the transition of the economy to the road with high-technology components (at putting the economy on the rails with high-technology compartments) requires this road to be reliable and correctly oriented (these rails to be of high quality). Another words, they should keep up the drive of the breakthrough technologies and cope with driving pressure distribution (that is diversification of the economy). Railroad in this story is the effectiveness of Russian manufacturing industry. We cannot develop the diversification of economy and draw down the oil-gas development in the long-run.

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1 The authors thank for the useful comments, that helped to improve the article the participants of the Second World Congress on Comparative Economics (National Research University, St. – Petersburg) and the participants of the 26th Annual Conference on the Society for Risk Analysis, Europe, Lisbon, Portugal), as well as an anonymous reviewer.
According to RosStat, the share of manufacturing industry in the Russian economy is declining, but still it remains the most important sectors of economy: its gross value added in GDR (about 13.4% in 2011–2015) is less only than the trade and commercial services, while the number of employed (about 14.7% in the same period) is less only compared to trade. In the long run the competitive positions of manufacturing industries in the home and world markets are important components of the country’s stability factors. Diversity in the manufacturing industries in location, size and behavior would contribute to the complex analysis of effectiveness of the present economic policies, as well as to designing the market institutions in Russia (Kusnetsov, 2014). In 2014–2015, at the close of the world financial markets, high volatility of the exchange rate, the rate of interest growth, as well as decrease of effective consumer demand and investment demand in the manufacturing industries we could observe monthly maximums of the bankrupts in some industries. There is multiple negative net worth of many companies, meaning multiple bankruptcies, or restructuring of businesses. Any crisis events allow us to observe the present situation in the industry through a system of risk management: new factors, tendencies, and the tectonic shifts if the market structure.

There are a number of foreign articles, where the authors made the estimates of bankruptcy expectations on the basis of different empirical data and the explaining factors. At the same time there are much less home researches of bankruptcy expectations, because the Russian authors have already made the estimates of the financial (Karminsky, 2009; Totmyanina, 2011; Salnikov et al., 2012) and macroeconomic factors (Peresetsky et al., 2011), as well as the factors related to technical efficiency (Mogilat, Ipatova, 2016).

Never the less, the Russian economic literature does not investigate the corporate governance as (1) a factor of financial stability, and (2) not a factor of bankruptcy but a factor of negative net worth of many companies, that often precedes a bankruptcy. Some fragment attempt of research of the connections between the factors of corporate governance with probability of bankruptcies were in concern of XVII International April conference on the problems of economic and social development (Fedorova et al., 2017).

The research of probability of the negative net worth of companies instead of probability of bankruptcies is a very special task. Not any negative net worth of companies leads to a company bankruptcy. Such an approach we get a chance to estimate the starting point of coming company’s problems beforehand – another words – to see negative net worth of companies, but not the final point – that is decision of the arbitration court to declare the debtor bankrupt. In particular, the activities in banking sector (withdraw of the licenses from the banks) is a solid platform for the research of probability and the size of negative net worth of the companies (Mamonov, 2017; Karminsky, Kostrov, 2017).
Mass privatization of the 1990s revealed the weakness of the corporate governance mechanisms — and the dispersed ownership of the ‘working collectives’ (enterprises’ collectives) was quickly changed by the high-concentrated ownership with no institutes of its rights’ protection, weak stock market and no competitive management. The controlling shareholder became the leading actor, often participating in the corporate governance as the chief executive officer (CEO). The stimuli to create a new effective structure of corporate governance appeared much later, after 1998 crisis, when the economists understood, that the further business development would be based on international standards mobilizing the best practices. At the start the practice of corporate governance looked like improving company reputation and home business sustainability before the foreign investors (Pappe, 2012). Later, after the national stock market had developed, the economists realized that optimal corporate structuring could be an effective tool for corporate governance, providing the growth of income within the market economy.

In 2000s the planned improvement in regulating norms and mechanisms of enforcement to its implementation reduced the tension in corporate conflicts (Shprenger, 2012). In the mid-2000s a model of co-owners’ alliance changed the model of individual ownership of big Russian companies: the explosive growth of leading companies made them too expensive for an individual owner. That is why diversification of investment capital was quite a natural trend (Pappe, Antonenko, 2011).

It is interesting to understand a role of corporate governance for the Russian companies in the manufacturing sector and its influence on the financial stability on the basis of the mentioned structural specifications.

We make a two-step evaluation of the probability of negative net worth of companies in the manufacturing sector: the basic model founded on the financial parameters, and the final model being founded on the additional factors of corporate governance and industry expectations.

The article has the following structure. International and national experience of corporate governance is analyzed in Part 2. There are the sources and characteristics of data and the algorithm of cleaning the samples in Part 3. In Part 4 we give a description of empirical research, which is a two-step evaluation of the probability of negative net worth of companies. Part 5 shows the regression estimates and the results of their stability testing. In the conclusion attention is focused on the principle conclusions on the structure peculiarities of corporate governance structuring of the companies in manufacturing sector, influencing their financial stability.

2. International and Russian experience of corporate governance analysis

We focus on the estimate of the probability of negative net worth of companies that is the negative net between the assets and liabilities of the companies. The articles on analysis of net worth of companies (NWC)
note that decrease in the companies’ worth may provoke negative net worth of the companies, and this process depends on the amount and length of decline in gross output, price of the assets, as well as the quality of management (Chen, 2001). Negative net worth of the companies is a real market process, which takes place in the financially vulnerable companies, mainly on the periods of crisis. Negative net worth of the companies provokes their further restructuring, or bankruptcies (Mamonov, 2017).

Sometimes the companies, trying to keep its image, are concealing negative net worth of companies, produce fake financial accounting, as well as make the companies to function till the moment when defrauded investor would go to the arbitration court and start the bankruptcy procedure. But thorough study of this problem is not the author’s priority.

The 2013 Central Bank (further CB) policy of cleaning the bank sector form unfair and unstable actors gave a secure (reliable) platform for the national research in modelling negative net worth of the banks (NNWB) (Mamonov, 2017; Karminsky, Kostrov, 2017). One of the earliest and noted articles in the subject in the foreign literature is the research of C. James, based on the American banking system data (James, 1991). One of the major trigger for the negative net worth are the risk operations of the banks as well as the macroeconomic instability, reducing the investment activities, aggregate demand and supply. These ideas make us understand that the negative effect from negative net worth of the banks may become the realization of the system risks of the borrowers.

But what influences the probability of the negative net worth of a company? First — the financial performance of a company and macroeconomic environment (solvent consumer and investor). But we can always find the persons taking the decisions behind the particular performances figures. The system of corporate governance may be a deposit either of its effective development in the market economy, or the reason of its stagnation.

One of the classic examples of good corporate governance importance is Enron affair — that is a collapse of the major and once the most innovative American energy company because of ineffective system of inside and outside activity control, as well as the agency problem (a conflict between the interests of managers and owners) (Jensen, 1986).

Modern researches note the necessity of thorough investigation in ownership structure changes and the problems of corporate governance in the Russian companies (for example, (Iwasaki, 2014; Dolgopyatova, 2016)).

The foreign authors stress three basic parameters that design the hypothesis on the influence of corporate governance factors on the company’s financial stability: the characteristics of general manager, board of directors and ownership structure. General hypothesis on the role of value added of corporate governance factors in levelling-up the prognostic quality of the models were confirmed by the foreign authors (Ciampi, 2015; Liang et al., 2016). Let us note a special trend — the estimate of probability of general manager retirement because of company’s poor financial perfor-
There are outside, as well as inside mechanisms of company control. The outside mechanism — to issue an initial public offering, meaning publicity and openness of corporate activities. The total holding of more than one office (general manager) by the major owners is the main tool of inside control over the company; it takes place because of poor national financial market development. Since 1990s this mechanism has wide spread — that is high ownership concentration (ownership dispersion was quickly concentrated in a small group of owners), poor corporate legislation and law enforcement procedures, as well as the agency problem (Kyznecov et al., 2014).

We can find several approaches to the analysis for the chairman of the board of directors (CEO-duality situation — in the foreign literature). Because of specifics of the joint-stock company’s functioning in Russia, we shall test another factor — a combination of executive and control functions, when CEO-owner also takes the position of chief executive officer (CEO). We consider international experience very informative and useful for hypothesis on «CEO-owner» formulation.

Firstly, the mere fact of «CEO-duality» in the company may be taken by the market as empowering the CEO with unlimited authorities, that indicates bad corporate governance practices (for example, (Shailer, Wang, 2015; Daily, Dalton, 1994; Elloumi, Gueyie, 2001)). This fact be simultaneously become the reason for reducing company’s credit rating (Ashbaugh-Skaife et al., 2006). Second, in case of combination of ownership and management there are no conflicts between the general manager and the owners — another words there is no agency problem. Third, director-co-owner would tightly connect his personal reputation to that of the company, enhancing some extra-stimuli for the company’s stable development (Ciampi, 2015). Fourth, X-theory management style of the employees’ motivation is found more often in Russia. The managers are sure to continuously motivate the employees to work; they need a continuous supervision, because the employees do not want to take initiative and carry out their duties for the good of the company. On the contrary, management style, based on Y-theory, suppose the employees have the inner stimuli for self-control and self-management within the working process. And this drive is a reliable platform for nominating the outside CEO, whose motivation would differ from that of the workers’ be only one point — personal material benefit. So, in most cases it is difficult to state trusting relationships with the chief executive officer.

So, the first hypothesis states: combination of ownership and government functions in our country may positively contribute to the financial stability of the company.

2 According to Fed-Act-208 («Joint-stock companies») (26 December 1995): a person exercising the functions of single executive body (general manager), can not simultaneously be the Chairman of the Board of directors (Supervisory council).

3 A prominent researcher in leadership, Douglas McGregor, proposed two contradicting theories on human motivation: theories «X» and «Y». The author himself noted that in theory «X» he saw the prerequisites of authoritarian management, as well as in theory «Y» — he saw the prerequisites of democratic management.
Hypothesis 1 (H1). In case there is combination of ownership and governance functions (CEO-owner), there a probability of negative net worth of the company is much lower.

The authors think, the problems of industry expectations influence on the financial stability of a company in the real sector, provided by the company managers, are hardly the subject of research (could not find the academic research articles). Still there is an assumption, that this factor may provoke the negative net worth of the companies and play a role of either insight of the managers, or as self-fulfilling prognosis. For estimating industrial expectations we took index of business confidence (IBC) as a proxy-indicator. For every manufacturing industry a monthly index was cleared of seasonality effects. Further, we proposed, that the next year expectations are created by the experts beforehand (for example, during the second half of the year). In the second half of the year (From August to December) the projects are being closed, the results of the year are formed (balanced), the budget (for the next year is made up) as well as the next year strategy. The average (mean) of IBC for the half of the current year will be responsible (adequate) for next year’s industry expectations.

Hypothesis 2 (H2). The higher (lower) are industry expectations of business managers, the lower (higher) is a probability of negative net worth of the company in the industries in concern.

In the present research a number of business co-owners are a measure of ownership concentration, — those co-owners, who elect a Board of directors to represent their interests. The more varied are the interests, the greater a number of a Board of directors and the better the expert knowledge, probably, is necessary for successful company’s management. Still more, such a measure of dispersed concentration of ownership (company’s ownership is allocated between a number of co-owners) may provide a more effective supervision over manager’s activities. Creating and estimating the company’s executive bodies (including elections of the CEO), and monitoring the financial reports are the major functions of the Board of directors (Weisbach, 1988; Darrat, Gray, 2016).

Hypothesis 3 (H3). Numerous owners decrease the probability (expectancy) of getting the negative net worth of a company.

The analysis of ownership concentration is based on the following criteria: high level of ownership concentration — controlling block of shares with the owners’ (> 50%); mean/average level of ownership concentration — the major owner possesses the controlling block of shares (more than 25%, but less than 50%); low level of ownership concentration — much dispersed ownership (all the owners possess less than 25%) (Dolgopyatova, 2010). In mid-2000s high ownership concentration was the immanent character of the Russian corporate sector. But with growing competition, improving the institutes and the quality of management the market motives were becoming the important for the most owners: profit-seeking, net worth
of the company’s growth, and increasing the market share (Dolgopyatova, Ivasaki, Yakovlev, 2009). Competitiveness monitoring data\(^4\) in the late 2000s shows the tendency of reducing ownership concentration in a number of enterprises. In 2005 a high level of ownership concentration was a characteristic of the \(\frac{3}{4}\) of the enterprises, in 2009 it was marked only in \(\frac{2}{3}\) of enterprises. This level of ownership concentration could be seen in different industries, in the enterprises of various sizes, as well as in the listed and non-listed companies (Dolgopyatova, 2010). A multi-country study (La Porta et al., 1999) showed that dispersed ownership is not a rule. In our research we never the less assume, that high ownership concentration is the reason for high risks, and the higher the concentration, the higher are the risks of negative net worth of the company.

**Hypothesis 4 (H4).** The higher ownership concentration, the higher the probability of negative net worth of the company (perhaps, there is a U-shaped dependence).

So, in this article we also tested the influence of the forms of ownership and institutional-legal forms on the financial stability of the companies.

It is quite probable, that private business is more sensitive to negative net worth of the company, since poor investment attractiveness and failure in carrying out the liabilities, private business has much less resources for raising capitalization (as compared to the public companies). This idea may help organizing more careful risk-management in the private companies, not to get a negative net worth of the company. It is worth mentioning that public company may have a positive effect – a reduction of cost of capital eases the debt burden for a company, as the case for Chinese companies listed at the stock exchange (Shailer et al., 2015).

What theoretical conclusions can be drawn, if blocking shares (more than 50\%) in the chartered capital belongs to the other company – that an institutional owner (Morrelec et al., 2012)? – On the ony hand, if the major owner generates profit by himself and possesses a share in the market, so he (it) may be considered a good guarantee in case of financial problems. But on the other hand, the weak point of this statement is the dependence and inflexibility of the affiliated companies because of their probably and not a priority position (by default), that may cause negative net worth of the companies.

The companies listed at the stock exchanges as a rule are characterized by dispersed ownership, being ready to follow the strategic behavior, as well as by better quality of management and using various management technologies, that (no doubt) strengthen their financial stability.

Study of these three ideas lays the basis for Hypothesis 5.

**Hypothesis 5 (H5).** If a company is a private property, then negative net worth of a company is less expected. The affiliated companies (with owner – legal entity) in the ownership structure, a negative net worth of a company is more expected. If company is a joint-stock company, then negative net worth of a company is less expected.

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\(^4\) Questioning of 1000 enterprises in manufacturing industry with more than 100 employees, but not more than 10000 employees (see in details (Dolgopyatova, 2010)).
2. Sampling for empirical research

The information basis was created using the following resources: database SPARK-Interfax, database Ruslan, database RosStat and Central Bank of Russia. The analysis of the Russian (example, (Grigoreva, 2013; Karminsky, 2015)) and the foreign (example, (Beaver, 1966; Altman, 1968; Ohlson, 1980; Shumway, 2001; Barboza et al., 2017)) articles on estimating the companies’ risks allowed us to construct a variety of financial indicators.

All the explanatory financial variables were divided into seven groups: a size of a company, its profitability, liquidity, business activities, financial stability, unpaid debts and development dynamics (Karminsky, 2009; “SPAR-Interfax system”). This was done to get a clear picture and easy choice of a variable in each group with the best differentiating and predictive power. Since the aim of this article is to study the influence of corporate management and industry expectations on the financial stability of a company, we added two corresponding groups. The descriptive statistics of the explanatory variables (introduced into the final regression equations) can be found in Table 1.

One of the model parameters is a year time lag that is in accord with Basel Committee’s on bank Supervision (BCBS) recommendations. This time interval is enough to take preventive measures. Factor analysis of negative net worth of the company is carried on the data on medium-size and big business in manufacturing industries (Russian Classification of Types of Economic Activity (OKVED) — 15–37) for 2011–2015. A sample was cleared from the companies with missing data in the financial reporting. A range of explaining variables was further cleared from statistical outliers (99.5 and 0.5%). Sample consists of joint-stock companies and limited liability companies. Practically 70% of a sample is private business. A frequency of interesting us events within industries is at the acceptable level (not less than 7.0%). The exception is leather production and leather products, because in the period in question there was no negative net worth of the companies. Further analysis this branch will be connected to textiles and clothing manufacture (Table 2).

Methodology of prognostic model estimates requires dividing a general sample into two parts: instructive and control. The important criterion is a share of the event in question in such a sample. These shares are to be quite comparable, not to run across a problem of retraining. In our case the sample was divided into two types of division (Table 3). The optimal way of division was chosen using the established criterion: instruction of model took part in 2012–2014, testing (control) the model — in 2011 and 2015.

---

5 The companies, which sales income exceeded 400 mln rubles in 2011–2015.
Table 1
Descriptive statistics of the financial and corporate variables

<table>
<thead>
<tr>
<th>Group</th>
<th>Variable</th>
<th>Description</th>
<th>Test on means equality</th>
<th>factor, NW</th>
<th>Average value</th>
<th>Standard deviation</th>
<th>Median</th>
<th>Minimum value</th>
<th>Maximum value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent variable</td>
<td><strong>NNW</strong> (Negative Net Worth)</td>
<td>1 — if total assets are less than total liabilities, 0 — otherwise</td>
<td></td>
<td>1</td>
<td>14.37</td>
<td>1.04</td>
<td>14.18</td>
<td>10.65</td>
<td>19.07</td>
</tr>
<tr>
<td>Size of a company</td>
<td><strong>Size_R</strong></td>
<td>Natural logarithm of sales revenue</td>
<td></td>
<td>0</td>
<td>14.45</td>
<td>1.04</td>
<td>14.23</td>
<td>8.83</td>
<td>19.73</td>
</tr>
<tr>
<td>Profitability</td>
<td><strong>ROA</strong></td>
<td>Net profit / Total assets</td>
<td>***</td>
<td>1</td>
<td>0.07</td>
<td>0.11</td>
<td>0.04</td>
<td>-2.13</td>
<td>2.48</td>
</tr>
<tr>
<td>Development dynamics</td>
<td><strong>D_ROA</strong></td>
<td>A number of running years with negative ROA</td>
<td>***</td>
<td>1</td>
<td>1.67</td>
<td>1.78</td>
<td>1</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>Liquidity</td>
<td><strong>Net_working_capital</strong></td>
<td>(Working assets − Short-term liabilities) / Total assets</td>
<td>***</td>
<td>1</td>
<td>-0.14</td>
<td>0.39</td>
<td>-0.09</td>
<td>-1.63</td>
<td>0.87</td>
</tr>
<tr>
<td>Business activities</td>
<td><strong>Turn_assets</strong></td>
<td>Assets turnover = Income / Total assets</td>
<td>***</td>
<td>1</td>
<td>1.6</td>
<td>1.55</td>
<td>1.13</td>
<td>0.08</td>
<td>12.01</td>
</tr>
<tr>
<td></td>
<td><strong>Z_A_m</strong></td>
<td>Z_A module, as Z_A &lt; 0 — operation risks, and Z_A &gt; 0 — approaching the bankruptcy</td>
<td>***</td>
<td>1</td>
<td>0.27</td>
<td>0.3</td>
<td>0.17</td>
<td>0</td>
<td>2.07</td>
</tr>
<tr>
<td>Financial stability</td>
<td><strong>Real_value</strong></td>
<td>(Fixed assets + Stocks + Construction in progress) / Total assets</td>
<td>***</td>
<td>1</td>
<td>0.64</td>
<td>0.22</td>
<td>0.68</td>
<td>0.01</td>
<td>0.98</td>
</tr>
<tr>
<td>Unpaid debts</td>
<td><strong>ZB_A</strong></td>
<td>(Loans (short-term) + Loans (long-term)) / Total assets</td>
<td>***</td>
<td>1</td>
<td>0.63</td>
<td>0.39</td>
<td>0.67</td>
<td>0</td>
<td>2.49</td>
</tr>
<tr>
<td></td>
<td><strong>Lt_debt_ratio</strong></td>
<td>Long-term liabilities / Total assets</td>
<td>***</td>
<td>1</td>
<td>0.41</td>
<td>0.42</td>
<td>0.31</td>
<td>0</td>
<td>2.49</td>
</tr>
</tbody>
</table>

Negative Net Worth of Manufacturing Companies...
<table>
<thead>
<tr>
<th>Group</th>
<th>Variable</th>
<th>Description</th>
<th>Test on means equality</th>
<th>factor, NWW</th>
<th>Average value</th>
<th>Standard deviation</th>
<th>Median</th>
<th>Minimum value</th>
<th>Maximum value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corporate governance</td>
<td>Private</td>
<td>1 — if Russian classification of forms of ownership (OKOPF) of a company is 16, 0 — otherwise</td>
<td>...</td>
<td>1</td>
<td>0.55</td>
<td>0.5</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Number_co-owners</td>
<td>Number of co-owners (in SPARK database – 10–11 major owners present)</td>
<td>...</td>
<td>1</td>
<td>1.78</td>
<td>1.41</td>
<td>1</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>CEO_owner</td>
<td>1 — it CEO is co-owner of a company (has a share in statutory capital), 0 — otherwise</td>
<td>...</td>
<td>1</td>
<td>0.05</td>
<td>0.23</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Ownership_concentration</td>
<td>Maximum ownership concentration in co-owners</td>
<td>...</td>
<td>1</td>
<td>0.85</td>
<td>0.24</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Low_concentration</td>
<td>1 — if maximum ownership concentration in co-owners does not exceed 25%, 0 — otherwise</td>
<td>1</td>
<td>0.04</td>
<td>0.19</td>
<td>0.04</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Medium_concentration</td>
<td>1 — if maximum ownership concentration of co-owners is 25–50%, 0 — otherwise</td>
<td>.</td>
<td>1</td>
<td>0.06</td>
<td>0.24</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>High_concentration</td>
<td>1 — if maximum ownership concentration in co-owners exceeds 50%, 0 — otherwise</td>
<td>.</td>
<td>1</td>
<td>0.13</td>
<td>0.34</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>High_concentration1</td>
<td>If there is major co-owner (&gt; 25%)</td>
<td>.</td>
<td>1</td>
<td>0.76</td>
<td>0.43</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>High_concentration2</td>
<td>No major co-owner (&gt; 25%)</td>
<td>.</td>
<td>1</td>
<td>0.09</td>
<td>0.29</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Industry expectations</td>
<td>Inst_control</td>
<td>1 — if one legal entity &gt; 50%, 0 — otherwise</td>
<td>...</td>
<td>1</td>
<td>0.42</td>
<td>0.49</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>IPU_h</td>
<td>(Business confidence index of the companies in manufacturing industries according two-letters indication in the Russian Classification of Types of Economic Activity (OKVED1) (from 2009), % mean for half a year</td>
<td>...</td>
<td>1</td>
<td>-2.47</td>
<td>3.4</td>
<td>-2.53</td>
<td>-11.33</td>
<td>3.33</td>
</tr>
</tbody>
</table>

*Resource: SPARK-Interfax, filled by the authors.*

*Note. «*» — significance at 10% level; «**» — significance at 5% level; «***» — significance at 1% level.*
### Table 2

Sample structure and frequency of negative net worth of the companies across the industries

<table>
<thead>
<tr>
<th>Russian classification of forms of ownership (OKOPF) / Russian Classification of Types of Economic Activity (OKVED) 1</th>
<th>Signification</th>
<th>Number of companies (total)</th>
<th>Number of negative net worth</th>
<th>Event frequency, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public joint-stock company</td>
<td>PAO</td>
<td>555</td>
<td>36</td>
<td>6.5</td>
</tr>
<tr>
<td>Non-public joint-stock company</td>
<td>NPAO</td>
<td>729</td>
<td>79</td>
<td>10.8</td>
</tr>
<tr>
<td>Limited liability company</td>
<td>OOO</td>
<td>1411</td>
<td>186</td>
<td>13.2</td>
</tr>
<tr>
<td>Private ownership</td>
<td>Private</td>
<td>1853</td>
<td>166</td>
<td>8.9</td>
</tr>
<tr>
<td>Foreign ownership</td>
<td>Inostr</td>
<td>444</td>
<td>95</td>
<td>21.4</td>
</tr>
<tr>
<td>Food, including beverage and Tabaco</td>
<td>DA</td>
<td>716</td>
<td>75</td>
<td>10.5</td>
</tr>
<tr>
<td>Textile and clothing industry</td>
<td>DB</td>
<td>47</td>
<td>4</td>
<td>8.5</td>
</tr>
<tr>
<td>Leather production, leather products and shoes</td>
<td>DC</td>
<td>7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Timber and wood products</td>
<td>DD</td>
<td>66</td>
<td>9</td>
<td>13.6</td>
</tr>
<tr>
<td>Pulp and paper production; publishing and printing</td>
<td>DE</td>
<td>108</td>
<td>15</td>
<td>13.9</td>
</tr>
<tr>
<td>Coke industry, oil-products and nuclear materials</td>
<td>DF</td>
<td>61</td>
<td>9</td>
<td>14.8</td>
</tr>
<tr>
<td>Chemical industry</td>
<td>DG</td>
<td>238</td>
<td>18</td>
<td>7.6</td>
</tr>
<tr>
<td>Rubber and plastic production</td>
<td>DH</td>
<td>148</td>
<td>17</td>
<td>11.5</td>
</tr>
<tr>
<td>Production of other non-metal mineral products</td>
<td>DI</td>
<td>229</td>
<td>28</td>
<td>12.2</td>
</tr>
<tr>
<td>Metallurgy and manufacture of metallurgic complete products</td>
<td>DJ</td>
<td>321</td>
<td>43</td>
<td>13.4</td>
</tr>
<tr>
<td>Machine and equipment production</td>
<td>DK</td>
<td>253</td>
<td>26</td>
<td>10.4</td>
</tr>
<tr>
<td>Electrical equipment, electronic and optical equipment</td>
<td>DL</td>
<td>257</td>
<td>21</td>
<td>8.2</td>
</tr>
<tr>
<td>Production of vehicles and equipment</td>
<td>DM</td>
<td>195</td>
<td>31</td>
<td>15.9</td>
</tr>
<tr>
<td>Other productions</td>
<td>DN</td>
<td>54</td>
<td>5</td>
<td>9.3</td>
</tr>
</tbody>
</table>

*Resources: SPARK-Interfax, filled by the authors.*

### Table 3

Instructive and control samples of the frequency of negative net worth of a company

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative net worth of a company</td>
<td></td>
<td>91</td>
<td>87</td>
<td>103</td>
<td>167</td>
<td>161</td>
<td>448</td>
<td>161</td>
<td>357</td>
<td>252</td>
</tr>
<tr>
<td>Number of observations</td>
<td></td>
<td>2427</td>
<td>2499</td>
<td>2612</td>
<td>2610</td>
<td>2603</td>
<td>10148</td>
<td>2603</td>
<td>7721</td>
<td>5030</td>
</tr>
<tr>
<td>Event frequency, %</td>
<td></td>
<td>3.8</td>
<td>3.5</td>
<td>3.9</td>
<td>6.4</td>
<td>6.2</td>
<td>4.4</td>
<td>6.2</td>
<td>4.6</td>
<td>5.0</td>
</tr>
</tbody>
</table>

*Resources: SPARK-Interfax, filled by the authors.*

*Sample No. 1 is divided into 80: 20% — according to the observations, and into 75: 25% according to the events. Sample No. 2 is divided into 60: 40% accordingly.*
4. Research methods (empiric design)

We use logistic regression to make prognosis of the probability of negative net worth of a manufacturing company (Ohlson, 1980). At step one we estimate a probability of negative net worth of a company with a number of explanatory variables:

$$P\{NNW_{it+1} = 1\} = \left(1 + \exp(\alpha + \sum_{L=1}^{L} \beta_{1,L} \cdot Finance_{it} + \varepsilon_{1,it+1})\right)^{-1},$$  \hspace{1em} (1)

where $i$ — company index, $t$ — year, $Finance$ — a number of explanatory financial variables.

At step two one by one we include the factors of corporate governance and industry expectations of the companies’ directors:

$$P\{NNW_{it+1} = 1\} = \left(1 + \exp\left(\alpha_2 + \sum_{L=1}^{L} \beta_{2,L} \cdot Finance_{it} + \sum_{M=1}^{M} \gamma_{2,M} \cdot CorpGov_{it} + \varepsilon_{2,it+1}\right)\right)^{-1},$$  \hspace{1em} (2)

where $CorpGov$ — a number of corporate governance factors.

Change of model quality after including additional factors is examined on the basis of comparison the prognostic power of the models’ indexes (AUC and mistakes of type I and II).

Binary choice models are tested with the help of maximum likelihood method (Bluhm et al., 2010). Among the advantages of logit-model we notice a possibility of accounting different factors influencing the negative net worth of the company (or default probability (Merton, 1974)), hierarchical character, simplicity of economic interpretation and further model use. This class of the models is distinguished by possible correlation between the results and a sample (effect of retraining). That is why the final specification of the model was tested for coefficient stability (signs and significance). The essence of the method is the interactive estimate of the coefficients of the final model specifications; at every step (out of 1000) the coefficients are estimated for random creation of instructive and control samples as 75 and 25% correspondingly.

To find multicollinearity we use a coefficient of increasing variance inflation factor’s (VIF) dispersion; its meaning should not exceed 5 to make sure that such a problem is absent (Zuur et al., 2010). Let us note, that dependent variable of the model with one year lag is explained by the financial and corporate parameters. In this statement there is no idea of endogeneity.

Further implications of the model is projected for the new data; that is why the prognostic quality of the model is to be better tested on the control sample for mistakes type I (goal skipping) and type II (false alarm) (Kaminsky, Reinhart, 1999). The the cut-off point is cleared in the process of arithmetic mean minimization of type I and II mistakes. The evident quality of the final model in the work is presented by area under ROC-curve (AUC); the values higher than 0.8 mark the perfect quality of the model (Pomazanov, Petrov, 2008).
5. Economic analysis of the empirical results

According to the above described methodology the basic model of probable negative net worth of the company using the financial variables was tested at the first step (Table 4).

Table 4
Regression results (basic logit-model): explanation of negative net worth of the company probability only through the financial factors

<table>
<thead>
<tr>
<th>No. pp.</th>
<th>Group</th>
<th>Explanatory variables (lag = 1 year before negative net worth of the company in accounting department)</th>
<th>logit-model (dependent variable — NNW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Size of a company</td>
<td>Size_R</td>
<td>−0.21*** (0.07)</td>
</tr>
<tr>
<td>2</td>
<td>Profitability (return on assets)</td>
<td>ROA</td>
<td>−4.24*** (1.01)</td>
</tr>
<tr>
<td>3</td>
<td>Liquidity</td>
<td>Net_working_capital</td>
<td>−6.34*** (0.37)</td>
</tr>
<tr>
<td>4</td>
<td>Business activities</td>
<td>Z_A_m</td>
<td>1.55*** (0.36)</td>
</tr>
<tr>
<td>5</td>
<td>Financial sustainability</td>
<td>Real_value</td>
<td>−4.44*** (0.41)</td>
</tr>
<tr>
<td>6</td>
<td>Debt load</td>
<td>Lt_debt_ratio</td>
<td>6.59*** (0.37)</td>
</tr>
<tr>
<td>7</td>
<td>Dynamics of development</td>
<td>D_ROA</td>
<td>0.18*** (0.05)</td>
</tr>
</tbody>
</table>

Dummy variables for the years
Dummy variables for the industries (DA — basic industry) +
Dummy variables for Federal districts −
Dummy variables for creating the company period −

Constant 0.14 (1.09)

Prognostic variables

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of observations</td>
<td>7721</td>
</tr>
<tr>
<td>Number of events in the sample</td>
<td>357 (4.6%)</td>
</tr>
</tbody>
</table>

Log Likelihood −835.74

Akaike Criterion 1717.48

Area under ROC-curve (AUC) 0.905 0.912

Type II mistake “False alarm” 0.166 0.164

Type I mistake “Goal skipping” 0.171 0.160

Mean mistake 0.168 0.162

Cut-off point* 0.0543 0.0425

*Significance:
* — significance at 10% level;
** — significance at 5% level;
*** — significance at 1% level.
Statistically significant explanatory variables of the basic (underlying) model have the expected signs; all these demonstrate high prognostic quality — parameter AUC equals 0.905 and 0.912 for intra-sample and out-of-sample prognosis correspondingly. Average error of prognosis is about 16.5%, which is considered a good result.

We consider classic the variables in the basic (underlying) model. It is necessary to note, that net accounts payable (creditors’ debt) is likely to be considered as an absolute value (module accuracy): much less than zero value is followed by the operational risks, but a value much greater than zero is followed by late payments. A special parameter of profitability is responsible for the dynamics of company development: a number of years before the report date, when profitability is in the negative zone. It is clear, that in case of losses a company is difficult to find the reserves for the further conduct of business. Let us note in addition, that the estimates for the basic (underlying) model appeared likely for the companies of any age: dummy-variables turned to be insignificant for the period of company foundation. We could not confirm the statistical significance of geographic location of manufacturing enterprises — dummy-variables for the federal districts turned to be insignificant. Nevertheless, dummy-variables were accounted by including dummy-variables for industry (basic industry — food industry) and dummy-variables for years (basic year 2011).

After basic (underlying) model estimate we start testing hypothesis on the influence of corporate management on the financial stability of the companies in manufacturing industries by including the parameters of every one out of five. The empiric results (Table 5) turned to be quite interesting and effective. The entire hypothesis (that found statistical support) significantly improved the prognostic quality of the basic (underlying) model: AUC was higher, and the average prognosis mistake turned to be less.

The combination of executive and control functions, when CEO-owner also takes the position of chief executive officer (CEO) — a characteristic feature of manufacturing enterprises — was confirmed by the statistics with in the first hypothesis with “minus” (positive effect). This fact is likely to characterize deep-rooted specificity of a structure of inner corporate management — that is full combination (overlap), being the consequence of weak institutes, aimed at protecting the ownership rights in 1990s, and providing solution of agency problem. So, if an owner of manufacturing enterprise is also chief executive officer (CEO), then a probability of negative net worth of such a company is lower (Table 5).

Index of entrepreneur confidence, which we used as a proxy-variable for industry expectations, turned to be quite significant and had the expected sign. So, we could confirm the second hypothesis: the CEO could to some extend predict negative market conditions in the industry in concern. Let us note, that the higher the industry expectations (IBC), the lower probability to get negative net worth of the companies in the industries in concern.
Table 5
Hypothesis test: corporate expectations and corporate management influence on the probability of negative net worth of the company

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>H1 CEO_owner: 1 — если генеральный директор является совладельцем компании, 0 — otherwise</td>
<td>-1.24*** (0.28)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H2 IPU_i: IBC (half a year)</td>
<td></td>
<td>-0.19*** (0.04)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H3 Number_coowners: number of major company owners</td>
<td></td>
<td></td>
<td></td>
<td>-0.11** (0.05)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H4 (I) Ownership_concentration: maximum share among shareholders</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.68** (0.27)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H4 (II) Low_concentration: 1 — if maximum share among shareholders is ≤ 25%. 0 — otherwise</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.11 (0.33)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H4 (III) Medium_concentration: 1 — if maximum share among shareholders is within 25–50%. 0 — otherwise</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.53* (0.27)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H4 (IV) High_concentration: 1 — if maximum share among shareholders is ≥ 50%. 0 — otherwise</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.39* (0.22)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H4 (V) High_concentration_2: 1 — maximum share among shareholders ≥ 50% and major owner ≥ 25%. 0 — otherwise</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.04 (0.20)</td>
<td></td>
</tr>
<tr>
<td>H5 (I) Private: 1 — private ownership. 0 — otherwise</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.59*** (0.15)</td>
</tr>
<tr>
<td>-----------------------------------</td>
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<td>---------</td>
</tr>
<tr>
<td>H5 (II)</td>
<td>Inst_control</td>
<td>1 — if legal entities with shareholding are &gt; 50%.</td>
<td>0 — otherwise</td>
<td>0.21 (0.14)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H5 (III)</td>
<td>Inst_control</td>
<td>1 — joint-stock company.</td>
<td>0 — otherwise</td>
<td>–0.35** (0.14)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic model (financial parameters)</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Constant</td>
<td>0.88 (1.08)</td>
<td>0.04 (1.07)</td>
<td>0.23 (1.07)</td>
<td>–0.48 (1.08)</td>
<td>0.04 (1.06)</td>
<td>0.12 (1.07)</td>
<td>–0.28 (1.08)</td>
<td>0.06 (1.07)</td>
<td>0.92 (1.08)</td>
<td>0.18 (1.07)</td>
<td>–0.19 (1.06)</td>
</tr>
<tr>
<td>Dummy-variables for industry (DA — basic industry)</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Number of observations</td>
<td>5030</td>
<td>5030</td>
<td>5030</td>
<td>5030</td>
<td>5030</td>
<td>5030</td>
<td>5030</td>
<td>5030</td>
<td>5030</td>
<td>5030</td>
<td>5030</td>
</tr>
<tr>
<td>Number of events in a sample</td>
<td>252 (5.0%)</td>
<td>252 (5.0%)</td>
<td>252 (5.0%)</td>
<td>252 (5.0%)</td>
<td>252 (5.0%)</td>
<td>252 (5.0%)</td>
<td>252 (5.0%)</td>
<td>252 (5.0%)</td>
<td>252 (5.0%)</td>
<td>252 (5.0%)</td>
<td>252 (5.0%)</td>
</tr>
<tr>
<td>Akaike Criterion</td>
<td>1710.44</td>
<td>1734.90</td>
<td>1729.60</td>
<td>1730.54</td>
<td>1736.78</td>
<td>1732.83</td>
<td>1733.42</td>
<td>1736.85</td>
<td>1720.95</td>
<td>1734.61</td>
<td>1730.58</td>
</tr>
<tr>
<td>AUC (area under ROC-curve)</td>
<td>0.943</td>
<td>0.942</td>
<td>0.942</td>
<td>0.942</td>
<td>0.910</td>
<td>0.943</td>
<td>0.942</td>
<td>0.911</td>
<td>0.941</td>
<td>0.907</td>
<td>0.942</td>
</tr>
<tr>
<td>Type I mistake «Goal skipping»</td>
<td>0.157</td>
<td>0.109</td>
<td>0.114</td>
<td>0.104</td>
<td>0.149</td>
<td>0.103</td>
<td>0.104</td>
<td>0.150</td>
<td>0.142</td>
<td>0.160</td>
<td>0.095</td>
</tr>
<tr>
<td>Type II mistake «False alarm»</td>
<td>0.099</td>
<td>0.143</td>
<td>0.135</td>
<td>0.151</td>
<td>0.173</td>
<td>0.142</td>
<td>0.142</td>
<td>0.173</td>
<td>0.123</td>
<td>0.181</td>
<td>0.151</td>
</tr>
<tr>
<td>Average mistake</td>
<td>0.128</td>
<td>0.126</td>
<td>0.124</td>
<td>0.128</td>
<td>0.161</td>
<td>0.123</td>
<td>0.123</td>
<td>0.161</td>
<td>0.133</td>
<td>0.171</td>
<td>0.123</td>
</tr>
<tr>
<td>Cut-off point*</td>
<td>0.0838</td>
<td>0.1194</td>
<td>0.1159</td>
<td>0.1266</td>
<td>0.1201</td>
<td>0.1256</td>
<td>0.1257</td>
<td>0.1203</td>
<td>0.0943</td>
<td>0.1183</td>
<td>0.1378</td>
</tr>
</tbody>
</table>

*Resource: Filled by the authors.

**Note.** «*» — significance at 10% level; «**» — significance at 5% level; «***» — significance at 1% level; in the round brackets are the robust standard mistakes; dependent variable — NNW.
The results of testing the third hypothesis on the significance of a number of co-owners give the ability to state: the specific features of inside corporate control of the company are effective for proving its stable development within market economy. So, in 2012–2014 the following fact was confirmed: the more there are major co-owners; the lower is the probability of financial instability of such a company in manufacturing industry.

The results of testing the fourth hypothesis demonstrate that in 2011–2015 high concentration of the ownership in the manufacturing industries negatively influenced the negative net worth of the companies, the higher is a share of business concentration, and the higher is a probability to get negative net worth of the company. The similar effect was obtained by including the continuous value of ownership concentration (from 0 to 100%), as well as the dummy-variable influencing the high ownership concentration (majority ownership). Nonlinear (or U-shape) correlation between financial stability and level of ownership concentration was not clearly confirmed. Probably, there is an indirect confirmation of this very fact: dummy-variables of high (sign “+”) and average concentration (sign “−”). Though dummy-variables of low concentration turned out to be of low statistical significance, a return to significantly dispersed ownership is hardly possible on our corporate market.

The reason for it is a negative experience of the 1990s, when the dispersed ownership of working collectives after privatization quickly led to diminishing the minorities’ rights. It is quite probable, that the Russian corporate market now understands that high ownership concentration may carry additional risks. And an effective compromise may be here an average level of concentration of the ownership (with the maximum share of the ownership is 25–50%). Let us note in addition that if a form of ownership is CEO-co-owner (with the controlling and blocking share) did not get a significant statistical support for negative net worth of the company.

The fifth hypothesis tested the specific features of ownership, and legal and organization forms. Our calculations showed private business working in the market are better managed, than the public companies. It can be traced in lower probability of negative net worth of the company. Expected negative influence of correlation with the legal entities (controlling share) did not find confirmation in our present research. Let us add that joint-stock companies are more open, more financially stable, than limited liability companies.

Our results were verified on stability with cross validation. To do this one of the possible final specifications were found concerning multicollinearity and simultaneous significance factor of explanatory variables: corporate management and industry expectations’ factors were added. The coefficients were found stable (Table 6). For example, the variable “CEO_owner” was found significant with sign “minis” at every of 1000 steps. In 100% cases the sings at the coefficients of all the explanatory variables remained the same; while their signs were confirmed not less than in 97% of cases.
Our computation show, that the models’ prognostic quality for different samples remains very high: minimum AUC = 0.906, maximum AUC = 0.962.

In that way, we received the confirmation of factor analysis of corporate management and industry expectations using the statistics, when studying the probability of negative net worth of the Russian manufacturing companies.

**Table 6**

Final logit-model specifications (NNW – dependent variable)

<table>
<thead>
<tr>
<th>Explanatory variables (lag = 1 year before negative net worth of the company in financial reporting)</th>
<th>Logit-модель</th>
<th>Marginal effect</th>
<th>VIF (Variance inflation factor)</th>
<th>Sign</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Size_R</strong></td>
<td>0.23*** (0.07)</td>
<td>-0.001</td>
<td>1.17</td>
<td>(-) 1000</td>
<td>999</td>
</tr>
<tr>
<td><strong>ROA</strong></td>
<td>-3.81*** (1.00)</td>
<td>-0.024</td>
<td>1.43</td>
<td>(-) 1000</td>
<td>1000</td>
</tr>
<tr>
<td><strong>Net_working_capital</strong></td>
<td>-6.25*** (0.37)</td>
<td>-0.039</td>
<td>2.51</td>
<td>(-) 1000</td>
<td>1000</td>
</tr>
<tr>
<td><strong>Z_A_m</strong></td>
<td>1.78*** (0.37)</td>
<td>0.011</td>
<td>1.28</td>
<td>(+) 1000</td>
<td>1000</td>
</tr>
<tr>
<td><strong>Real_value</strong></td>
<td>-4.37*** (0.41)</td>
<td>-0.027</td>
<td>2.15</td>
<td>(-) 1000</td>
<td>1000</td>
</tr>
<tr>
<td><strong>Lt_debt_ratio</strong></td>
<td>6.44*** (0.37)</td>
<td>0.040</td>
<td>2.69</td>
<td>(+) 1000</td>
<td>1000</td>
</tr>
<tr>
<td><strong>D_ROA</strong></td>
<td>0.13** (0.05)</td>
<td>0.001</td>
<td>1.55</td>
<td>(+) 1000</td>
<td>971</td>
</tr>
<tr>
<td><strong>IPU_h</strong></td>
<td>-0.20*** (0.04)</td>
<td>-0.001</td>
<td>2.33</td>
<td>(+) 1000</td>
<td>979</td>
</tr>
<tr>
<td><strong>CEO_owner</strong></td>
<td>-1.13*** (0.28)</td>
<td>-0.005</td>
<td>1.05</td>
<td>(+) 1000</td>
<td>1000</td>
</tr>
<tr>
<td><strong>Private</strong></td>
<td>-0.48*** (0.15)</td>
<td>-0.003</td>
<td>1.14</td>
<td>(+) 1000</td>
<td>980</td>
</tr>
<tr>
<td><strong>Константа</strong></td>
<td>1.51 (1.09)</td>
<td>0.009</td>
<td>(+) 901</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td><strong>Dummy-variables for industry</strong> (DA – basic industry)</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td><strong>Dummy-variables for Federal districts</strong></td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td><strong>Dummy-variables for the company foundation period</strong></td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
</tr>
</tbody>
</table>

*Journal NEA, No. 2 (38), 2018, p. 61–82*
6. Conclusion

One of the major steps to the effective market economy is considered to be the introduction of high quality corporate governance at the national companies. These factors are supposed to stabilize the investment climate and invite investment for successive economic growth. The system of corporate governance in Russia is on the march. That is why the efforts of the government and the state are to enhance its development.

In our article we modeled the probability of negative net worth of the company related to the factors of corporate governance and industry expectations of the companies' directors. We used the national and foreign experience of financial stability and structural effects of corporates’ governance studies to design the models. We proposed new hypothesis give a possibility to test the influence of the variables in question on the probability of negative net worth of the company. In particular, we formulated hypothesis 1 – about CEO-co-owner, hypothesis 2 – about industry expectations, hypothesis 3 – about number of co-owners, hypothesis 4 – about high ownership concentration, hypothesis 5 – about financial stability and joint-stock company. To test every hypothesis we proposed the variables, which we tested in the logistic regressions, along with the classical financial parameters.
We created a sample with medium and big companies in the Russian manufacturing industries for 2011–2015 for our research.

The results of our research show that corporate governance has additional value in explaining the financial stability of the companies. We confirmed the robust qualities of the resulting estimates (signs and values of the logistic regression coefficients).

The most interesting corporate effects are:

- if one of the owners of a company was at the same time CEO, then probability of negative net worth of the company was lower (elasticity –1.24);
- the higher the index of entrepreneurs’ (business) confidence in the industry, the lower a probability of negative net worth of the companies (elasticity –0.19);
- the more the number of co-owners, the lower a probability of negative net worth of the companies (elasticity –0.50);
- the higher ownership concentration, the higher a probability of negative net worth of the companies;
- if a company has an average level of ownership concentration, the lower a probability of negative net worth of the companies;
- if a company is a private ownership or a joint-stock company, the lower a probability of negative net worth of the companies.

One of the directions of the further analysis of negative net worth of the companies (similar to the banking sector) should be the analysis and prognostics of their value, including the case when negative net worth of the companies is concealed in fraudulent financial reporting. This new task will make us understand, which factors influence not only the expected risks of counterparty’s losses, but also the value of potential losses. Another interesting task is a study of specificities of negative net worth of the companies in the disaggregated industry profile (through the manufacturing industries).

REFERENCES


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**Fiscal Multipliers in Russia**

**Abstract.** This paper covers theoretical and practical issues related to the estimation of fiscal multipliers for the Russian economy that measure response of output to discretionary change in fiscal indicators. The analysis of the main determinants affecting the size of multipliers suggests relatively low values of fiscal multipliers in Russia. By means of a Structural Bayesian Vector Autoregressive Model (structural BVAR), we obtain a multiplier for the overall government revenue and spending equal to −0.75 and 0.28 respectively, i.e.: an increase in government revenue (or spending) by 1 percent of GDP leads to a decrease (or increase) in output by 0.75 (0.28) percent. In the case of government spending shock, maximum effect on output takes place in the subsequent quarter after the shock, while in the case of revenue shock, the effect builds up quarter by quarter and reaches its peak in the eighth quarter. The obtained results are generally in line with expectations as well as with the results available for emerging market economies. Recent plans of fiscal consolidation, scheduled for the medium-term, are expected to have negative impact on output growth. However, since it is intended to be carried out mainly at the expense of the expenditure part of the budget, this should be less harmful for economic growth and could promote the efficiency of public spending.

**Keywords:** fiscal multipliers, general government revenue, general government spending, Russia, structural BVAR.

JEL classification: E62, H20, H50, O47.

DOI: 10.31737/2221-2264-2018-38-2-5

1. Introduction

Fiscal multipliers show the impact of discretionary changes of the main budgetary indicators (revenue / expenditure ΔFI) during period t in response to GDP change (ΔY) on the horizon i. They allow making a comparison of various measures of the budgetary policies as they are also an important constituent of macroeconomic forecasting:

\[
Fiscal\ multiplier\ on\ the\ horizon\ i = \frac{\Delta Y(t+i)}{\Delta FI(t)}.
\]

Fiscal multipliers play especially significant role during the periods of recession when corrective measures to manage budget revenue and spending are necessary to provide for better stimuli for the economy in downfall or to implement budgetary consolidation to minimize painful effects of higher taxes or diminished spending because of the downward economic trend. The assessment of fiscal multiplier poses a heightened interest for the Russian economy because of the recent decade of consecutive weakening of fiscal policy which, since 2017, has been largely replaced by budgetary consolidation that targeted stabilization of budget deficit.

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1 The views expressed in this paper are those of the authors and do not necessarily reflect the official position of the Bank of Russia.

2 Special case with \( i = 0 \) indicates instantaneous fiscal multiplier for fiscal multiplier definitions see (Batini et al., 2014)
This study is dedicated to exploration of the theoretical aspects of fiscal multipliers for the Russian economy and their assessment with regards to the revenue and spending parts of the budget. The obtained estimates indicated that expenditure multiplier is significantly lower than the revenue one. The conclusive results posit that even though budgetary consolidation has to affect the GDP negatively, through implementing spending cuts, this negative impact might remain relatively small with respect to overall GDP growth.

This article is structured in a following way. Section 2 presents a brief literature overview of research on fiscal multipliers and their determinants for the Russian economy. Section 3 provides computations of Russian economy fiscal multipliers using structural BVAR model for budget revenue and expenditures. The conclusion sums up main findings.

2. Literature overview and multipliers’ determinants in Russia

Recent decade has seen multiple studies of fiscal multipliers and their computations all around the world. These studies concluded that fiscal multipliers span a wide array of estimates and the absence of their convergence on a single reference. Such conclusion can be attributed to either objective or subjective factors affecting estimates in question. Subjective factors might comprise divergent methods of estimation, assumptions made, and also the length and frequency of panel data. In S. Gechert and H. Will (Gechert, Will, 2012) the authors of 89 studies used meta regression analysis and pointed out that results largely depend on model classes and selected method of estimation of fiscal multipliers as well as the length and frequency of the used panels of data.

There are two main empirical methods of fiscal multiplier estimation in research literature: vector autoregressive models (VAR) or dynamic stochastic general equilibrium models (DSGE). Structural vector autoregressive (SVAR) models are also widely used. One of the most renowned papers in this vein by O. Blanchard and R. Perotti (Blanchard, Perotti, 2002) presents the theory of structural shocks and their impact on GDP growth. In A. Mountford and H. Uhlig (Mountford, Uhlig, 2009) the method of sign restrictions was adapted to identify impulse response of GDP to fiscal shocks. In later research diverse identifications of SVAR models have been actively applied to take into account exogenous nature of fiscal shocks (Favero, Giavazzi, 2012; Mertens, Ravn, 2014), or to generalize commonalities and highlight differences in different countries, or, further, to reveal non-linear conduct of fiscal multipliers during different phases of business cycles (Auerbach, Gorodnichenko, 2012; Baum et al., 2012). VAR models have demonstrated median GDP response to fiscal policy shocks, and multipliers obtained with these models are used, as a rule, in situations when the economy is close to its normal state (the output gap is small, key interest rate is positive, etc.) When the economy is much farther from its normal state, estimates, obtained with the aid of DSGE models, appear to be
more effective because they better capture current economic characteristics. DSGE-models’ overview is provided in G. Coenen et al. (Coenen et al., 2012)\(^3\). Besides, there are quite a few countries that lack sufficient number of observations for qualitative analysis that prompted the International Monetary Fund (IMF) to come up with a simplified method of aggregate fiscal multiplier calculation, based on a set of determinants of its value (Batini et al., 2014).

Long and comparable set of data on many indicators are mostly absent in Russia which can be explained by the differences in standards used in the Soviet statistics and worldwide and also by the ongoing transition of Russian official institutions in charge to embrace new methodology of estimation and, oftentimes, without re-evaluation of pre-existing data. We construe SVAR model here using Bayesian approach which allows working with short-term and volatile time series (see point 3.2).

Objective factors, behind a wide array of fiscal multipliers estimates for various countries and various periods of time, are determinants of their value stemming from country specific traits, implemented policies, and the state of the economy overall. We point out the following major determinants:

- **labor market rigidity** — the firmer are labor contracts setting work time and work pay and the lower the bargaining power of the employers, then the stronger is GDP response to demand shocks (Gorodnichenko et al., 2012). Russian labor market is characterized by relatively lower bargaining power of the employees (Gimpelson, Kapelushnikov, 2015);

- **propensity to import** — for smaller and more closed economies a smaller part of fiscal stimuli would flow overseas (Ilzetzki et al., 2013). Russia is a large and open economy;

- **efficiency of budget expenditures and tax administration/enforcement** — the higher is efficiency of budget measures the stronger is their effect on the output. In Russia, even though the GDP can have positive rates of growth; this efficiency is relatively low\(^4\). This fact can be accounted for by a high share of the “shadow economy” (according to RosStat estimate it accounts for about 16% of GDP), and also supposedly a high sensitivity to heightened tax burden\(^5\);

- **financial stability(solvency) of the government** — the lower is the government debt, the higher is agents’ trust in government implemented fiscal policies and the lower is propensity to save part of the economic stimuli package in fear of potential policy tightening (Ilzetzki et al., 2013). Despite a low level of the government debt in

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\(^3\) For a more detailed discussion of main methods to estimate fiscal multipliers, and their respective advantages and drawbacks see (Batini et al., 2012).


\(^5\) According to our estimates, the increase of social contributions rate in 2010–2011 was accompanied by an increase of payroll taxes at a slower pace than the one expected due to the growth of tax base. In 2012 the opposite was true when a decreased tax rate brought about by growth of tax receipts. This points to high dependence between the size of the “shadow economy” and tax burden.
Russia (15.5% of GDP by the end of 2017)\textsuperscript{6}, agents’ trust remained low. This can be explained by the memory of the 1998 default and high dependence of the Russian economy on raw materials markets and economic conditions in trade partner countries\textsuperscript{7};

- **exchange rate regime** — if the regime of exchange rate is less flexible, then monetary/credit policy has more wiggle room to fit with the fiscal one, and the possibility of the stimulus package leakage overseas through manipulated exchange rate is diminished (Corsetti et al., 2012). In 2014 Bank of Russia implemented a transition to a floating exchange rate: before that it has not pursued a regime of fixed rate even though the exchange rate was under Bank’s implicit influence;

- **monetary/credit policy response** — fiscal multipliers will be higher if the monetary authority does not raise key interest rate in response to government budget expenditure expansion that would crowd out investment and consumption (Spilimbergo et al., 2009). Bank of Russia raised key interest rate in 2008 and in 2014, without referring it to budgetary easing;

- **business cycle phases** — during economic downward trend fiscal multipliers are higher than they are during the economic expansion (Auerbach, Gorodnichenko, 2012). One of the possible explanations of this is directing relatively large volumes of budget expenditure (non-Ricardian in nature) to households with high propensity to consume,

There are also theoretical and empirical findings about the relationship between multipliers of government expenditure and revenue and their components:

- **expenditure multiplier exceeds** revenue multiplier because in case of tax reduction households save part of the subsequent pecuniary gain (Padoan, 2009). However, many other studies prove just the opposite (Ilzetzki, 2011);

- in the **area of government spending** the highest multiplier is present in the areas of direct influence on aggregate demand (consumption, investment);

- and in the **area of taxes** — these multipliers are the highest for consumption taxes because they are directly passed into price markups and therefore are hard to dodge (Coenen et al., 2010).

Present research has shown that fiscal multipliers in the developed countries are largely higher than in the emerging market and low income economies, that can be attributed to higher efficiency of budgetary measures mentioned above. Thus, according to estimates in (Guajardo et al., 2014), based on OECD panel data, revenue multiplier during the first year after the shock is close to 1. And A. Mineshima (Mineshima et al., 2014) in the survey of 41 research results have shown that expenditure multiplier during the first year after the shock is 0.75 on the average.

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\textsuperscript{6} Data of the Ministry of Finance of Russia on state and municipal debt and RosStat data on GDP is used here

\textsuperscript{7} Estimates of the Ministry of Finance of Russia puts safe level of the government debt at 25% of GDP. (Reinhart et al., 2003) demonstrated that the debt maximum for a country risking a default is 15% of GDP
Provided that the majority of considered above determinants in Russia are likely to affect negatively the value of fiscal multipliers, it is possible to expect their estimates being low for normal rate of growth. This conclusion largely corresponds to their earlier estimates for the Russian economies. Hence, S. Vlasov and A. Ponomarenko (Vlasov, Ponomarenko, 2010) on the basis of the pre-crisis sample selection, have obtained three-year accumulated multiplier of a factor of 0.6 for government expenditure and a factor of −0.1 for government revenue. Estimates by H. Ivanov and M. Kamenskyh (Ivanov, Kamenskyh, 2011), using data of Russian Treasury (Office of the Exchequer), showed that expenditure multiplier of expanded Russian budget was equal to 0.13, which is almost a doubling of its value during the crisis of 2009–2010 compared to the pre-crisis number. Looking at specific sections of the functional classification of government expenditures, one finds multipliers spanning the range from −0.77 to 0.55. In 2013 D. Kulikov and D. Skrypnik (Kulikov, Skrypnik, 2013) got a weight-averaged value of government expenditure multiplier for the period of crisis on the horizon of one to two years at respectively 0.25 and 0.4, but for the normal growth rate period close to zero. V. Eller (Eller et al., 2016) has demonstrated that discretionary expansionary spending exerts significant influence on GDP growth rates oscillation in Russian regions and can bring about macroeconomic instability as well.

In contrast to above mentioned research for the Russian economy, mostly focused on the impact of government expenditure (as a whole and as specific functional components during various phases of the business cycle) on GDP growth rates, this study addresses both the expenditure and the revenue sides of the budget and contains estimates of respective fiscal multipliers which permits comparison of efficiency of these measures. Furthermore, contrary to the estimates in S. Vlasov and A. Ponomarenko (Vlasov, Ponomarenko, 2010), implemented on the basis of national accounts system (NAS) which lumps transfers with, we use statistical data of government finances of the Russian Treasury (Office of the Exchequer). This statistical data is significantly different from indicators of NAS reported to Statistical Committee of the Community of Independent States (CIS)9, which stipulates fiscal multipliers divergent estimates, drawn from two types of statistical sources. Besides, NAS statistics, contrary to the statistics by the Russian Treasury (Office of the Exchequer of Russia), is not issued regularly and with a substantial lag, and it is not actively used for budget indicators forecasts. The use of NAS statistics would seriously diminish efficiency of using multipliers thus derived compared to the analogous ones based on data from the Treasury (Office of the Exchequer) (for details see characteristics of selected data in point. 3.1 and the limitations of obtained estimates — in point 3.3). Lastly, the horizon of the selected sample is greatly expanded from 9 to 16 in comparison with the study by S. Vlasov and A. Ponomarenko

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8 D. Kulikov and D. Skrypnik presented this research at the Russian Economic Congress in Suzdal (Kulikov, Skrypnik, 2013). The presented report was titled “Estimate of fiscal multipliers for the Russian economy with the use of VAR model with transition dynamics”.

(Vlasov, Ponomarenko, 2010) which has to improve veracity of the obtained estimates.

3. Estimation of fiscal multiplier for Russia

3.1 Data

While selecting data for fiscal multipliers, we were guided by practicality objectives and possibilities to further utilize them. Our main criteria for the selection process were: data should cover budget system as a whole; timeliness of data issue, the ease of obtained estimates for forecasting. These tasks dictated preference for the Treasury (Office of the Exchequer) statistical data. This statistical data is accessible with a minimum lag (contrary to the one issued by NAS which is released with a lag of more than a year) and is used by the Ministry of Finance of Russia while drafting budgets for the proximate budget planned period.

We estimate fiscal multipliers for aggregate revenue and aggregate expenditure of the budget system using quarterly data for 2000–2015. The utilization of Bayesian method for estimation allows for the analysis of relatively short-term panels of data (Canova, 2007).

The following endogenous variables are included in the model besides Russian GDP: nominal interest rate for credits to non-financial organizations for terms greater than three years (monetary policy indicator proxy), GDP deflator (price level proxy) and the EU GDP (the main trade partner of Russia) as well as Urals oil prices in ruble denomination (the indicator of the external sector). Used sources of data are Bank of Russia, Russian Treasury (the Office of the Exchequer), RosStat and Eurostat.

Panel data for government revenue are stripped of one-time receipts to erase oil company “Yukos” debt to the government which took place in 2004–2007. All indicators are converted to real expression with the use of GDP deflators (excluded are nominal interest rate, GDP deflator and ruble-expressed oil price); EU GDP is converted to real value with GDP deflator of the EU, seasonally smoothed by TRAMO/SEATS procedure, and are presented as natural logarithms (with the exception of nominal interest rate). Lags duration in the model is assumed to be one quarter.

3.2. Econometric approach

Fiscal multipliers estimation is carried out using structural BVAR. A reduced form of the VAR model looks as follows:

\[ Y_t = \mu + B(L)Y_{t-1} + u_t, \]

where \( Y_t \) is the vector \( n \) of endogenous variables comprising GDP, government revenue, government spending, EU GDP, ruble-denominated oil price, nominal interest rate, GDP deflator; \( \mu \) is a constant; \( B(L) \) is the lag operator; \( u_t \) indicates non structure shocks with zero averages and covariance matrix \( \Sigma \).

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10 Consolidated budget and budgets of government off-budget founds.

11 Data used is from Economic Expert Group of the Russian Ministry of Finance (see http://www.eeg.ru/pages/186?PHPSESSID=a65a191b2db2940e749e1996d2d1a1a).

12 More detailed discussion of SBVAR models is, for instance, in (Blake, Mumtaz, 2012).
Following Banbura et al., (Banbura et al., 2010) we impose a Normal inverted Wishart conjugate prior with adding dummy observations. We have also taken more typical hyperparameters of a priori distributions (see, for instance, (Blake, Mumtaz, 2012)).

We apply an agnostic identification scheme by introducing zero and sign restrictions to functions of impulse responses using an approach detailed in (Arias et al., 2014).

Furthermore, we identify structural shocks $e_t$ that have economic interpretations in the following way:

$$u_t = A e_t, \quad (3)$$

Thus we construct a model to estimate multipliers for aggregate government revenue and spending. The set of variables includes aggregate revenue and spending as well as the indicators mentioned in 3.1. We consider two types of shocks: those affecting aggregate government revenue and those affecting aggregate government spending.

The impulse response function is calculated on the basis of Gibbs sampling of 30,000 algorithm iterations out of which the last 10,000 are kept. With this, zero and sign restrictions on instantaneous reaction of the impulse response function are applied based on theoretical assumptions about macro-indicators’ reaction to fiscal policy shocks (Table 1). The identification scheme, found in (Mountford, Uhlig, 2009), serves as a basis. Provided assumptions about the influence of government finances on GDP growth hold, we suggest that increased tax burden response (government revenue shock) causes GDP to go down whereas response to increased spending (government expenditure shock) makes GDP go up during the same quarter. In order to isolate considered shocks we presuppose that a) a non-negative response of expenditure by the government to positive revenue shock (in this case GDP decline is not a result of more austere government expenditure policy but rather a product of revenue shock) and b) non-negative response of revenue to positive spending shock — and vice versa. This scheme eliminates the possibility of two shocks’ simultaneous impact (i.e. expenditure reduction and increased revenue at the same time) and permits isolation of their impact on GDP. In addition, we postulate

<table>
<thead>
<tr>
<th>Shock</th>
<th>GDP</th>
<th>Revenue</th>
<th>Expenditure</th>
<th>EU GDP</th>
<th>Oil price (ruble)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue</td>
<td>–</td>
<td>+</td>
<td>$\geq 0$</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Expenditure</td>
<td>+</td>
<td>$\geq 0$</td>
<td>+</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Note. “+” — positive response, “−” — negative response, “$\geq 0$” — non-negative response, “0” — zero restrictions.

13 Reduced form parameters of the model, shocks identification, impulse responses functions and historic decomposition are computed for all saved iterations using Gibbs sampling technique. Figures 1 and 2 show median values of impulse responses functions to fiscal policies shocks as well as their 16- and 84%-quintiles.
that Russian budget policy does not influence indicators of the EU GDP and oil prices denominated in rubles right away thus we impose their zero constraint. Such assumption allows deeming these variables as endogenous at the time of the shock within the model’s framework. All constraints are introduced for the period of the shock only (one quarter) without otherwise constraints for other periods.

3.3 Results

We define the value of fiscal multipliers as a maximum GDP response to the shock of respective fiscal variable (peak multipliers). Impulse response function analysis has shown that GDP tends to increase gradually and reach a peak during a period of eight quarters after the shock in response to government revenue shock (Fig. 1) whereas in case of government expenditure shock the effects on GDP come about during the following quarter after the shock (Fig. 2). GDP impulse response function values at these two points are statistically significant. Such results are in no conflict with other studies where GDP is shown to react faster to increased government transfers and consumption being the biggest part of budget expenditure than to the changes of tax burden (Anderson et al., 2013; Coenen et al., 2012). Other variables reaction in the model is statistically insignificant, ceteris paribus.

We compute fiscal multipliers on the basis of impulse response functions. Fiscal multipliers are given as percentage of GDP, i.e. percent change of GDP in response to fiscal shock of 1% of GDP. In order to convert impulse responses to GDP percentages in absolute terms, we average.
the budget share of either revenue or expenditure in GDP for all of the sample under analysis (the period under consideration is first quarter of 2000 through fourth quarter of 2015). This approach allows us to correct estimates obtained from initial expenditure/revenue shocks and the magnitude of GDP response to said estimates. We obtain aggregate government expenditure/revenue fiscal multipliers equal to –0.75 and 0.28 respectively which means that government revenue/expenditure by 1% of GDP leads to output decrease (increase) by 0.75% (0.28%). Multiplier values for various time horizons are in Table 2.

Table 2
Fiscal multipliers at various time horizons

<table>
<thead>
<tr>
<th>Fiscal multiplier</th>
<th>Number of quarters after the shock</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Revenue</td>
<td>–0.33</td>
</tr>
<tr>
<td>Расходов</td>
<td>0.25</td>
</tr>
</tbody>
</table>

**Note.** Peak multiplier values are in bold-face, statistically insignificant values are in cursive.

**Source:** authors’ computations using Matlab.

Resultant low values of fiscal multipliers for the Russian economy correspond to our theoretical assumptions about the analysis of their determinants provided in section 2 of the present study. The relationship between
the values of government revenue and expenditure multipliers does not contradict theory of low efficiency of budget expenditures in Russia, but rather serves as its evidence.

Our results also agree with fiscal multipliers estimates for transition economies. Thus in E. Ilzetzki (Ilzetzki, 2011) used a sample of 13 emerging market economies and obtained government revenue multipliers in the range from −0.4 to −0.2, and government expenditure ones — from 0.1 to 0.3. In (Jooste et al., 2013) authors indicated government revenue / expenditure multipliers for South Africa equal to −0.7 and 0.3, and in A. Stoian (Stoian, 2012) — respectively −0.9 and 0.5 for Romania.

Our estimates hold even if we change the set of the variables included in the model, like, for instance, include oil price denominated in dollars, or alter the number of iterations or use a smaller sample.

We note, however, that our estimates of fiscal multipliers for the Russian economy are not completely credible. Therefore, they should be used with necessary caution for forecasting implications of budget revenue and expenditure changes on the level of the output. Our computations do not take into consideration possible effects of economic agents’ reaction to discretionary policy announcements but before this policy actual implementation. Here we assume that this possible effect in Russia is likely to be quite small in comparison with other countries. The limitations for using obtained estimates for forecasting purposes stem from the differences of conditions of policy implementation during the period of prognosis versus the period of estimated effects as well as alterations of expenditure and revenue of the budget during the interim period between the two. Nevertheless, we deem the use of obtained results feasible and, more specifically, the revealed relationship between the values of revenue and expenditure multipliers can be instrumental for the analysis of potential fiscal policy impact on output for the proximate years.

Fig. 3 presents historical decomposition of structural shocks impact on real GDP growth in Russia. As a rule, these shocks have played a small role in the aggregate dynamic. Fiscal policy has been moderately contractionary up till mid 2000 under the rule-based fiscal measures, paying off majority of government debt and building up Stabilization Fund14. During the 2000–2006 period budget balance has increased by 5% of GDP. From 2007 and onwards the nature of fiscal policy became expansionary: as a result, the economy was over-heated during the pre-crisis period but also slowed down economic decline in 2009–2010 and propped it up in the following years. Net budget balance during 2007–2016 has come down 11% of GDP.

Historic decomposition has also shown that budget expenditure and revenue impact of GDP growth were generally co-directional. This conclusion is supported by reported data for periods of 2000–2006 and 2007–2016 when slightly more than 2/3 of budget balance changes were produced by changing expenditures and the rest — by changing budget revenue.

14 Main factual data, related to Russian government finances, is in (Vlasov, 2011).
Relaxation of fiscal policy has produced large budget deficit which challenges government long-term financial stability and urges measure for its reduction. According to the draft of the bill “Main trends of the budget, tax and customs policies of the Russian Federation in 2018—2020” the Russian government intends to reduce budget deficit during this period by 3 percent points of GDP. This will heighten expectations of negative implications for the prospects of economic growth. In addition, even though greater tax burden would facilitate budget deficit reduction, the main source of budget consolidation is viewed to be a product of reduced government expenditure as a share of GDP. This conclusion corresponds to our resultant estimates of fiscal multipliers in Russia which have demonstrated that lower government expenditure effectively influences GDP growth to a lesser degree than an analogous increase of tax burden. The coming years can provide government authorities with opportunities to increase efficiency of budget spending.

4. Conclusion

Our analysis of main determinants of fiscal multipliers has demonstrated relatively small effects of government finances on GDP in Russia. Aggregate expenditure / revenue multipliers estimates confirm these expectations. Government expenditure increase of 1% of GDP has generated GDP growth in the shock following quarter of the amount 0.28%, whereas an increase of taxes by 1% of GDP has led to consecutive drop in GDP by 0.75% at its peak during the eighth quarter after the said shock. These finding are in no conflict with earlier estimates of fiscal multipliers obtained for the Russian economy or with analogous computations made by foreign authors for the transition economies in general.

Fig. 3

Contribution of structural shocks on real GDP growth in 2000–2015 (deviation from base scenario\textsuperscript{15}, in logarithms)

Source: authors’ computations using Matlab.

\textsuperscript{15} Baseline scenario — GDP trajectory in the model computed for zero shocks.
As of the last decade, Russian budget policy has had mostly stimulating effect due to the expansionary policy of expenditures and contractionary policy of the revenue. At the same time, the intermediate term period policy would require efforts to reduce budget deficit which, in turn, would negatively affect GDP growth. Expenditure austerity measures to lower their share of GDP as the main instrument of budget consolidation is in agreement with estimates of fiscal multipliers: such measures, in addition, can also contribute to improved efficiency of these expenditures.

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Transaction Costs and Development of the Mineral Base in the Russian Resource Region

Abstract. The article examines the mechanism of cooperation between the state and private investor in the development of mining sector of the region with poor production infrastructure. Within the framework of this mechanism, the government assists the investor in infrastructure development as well as in the implementation of the necessary environmental protection measures. We use the Stackelberg model of transaction costs (TC) affecting the efficacy of this cooperative relationship is natural resource rent dividing up to devise special tools to assess TC impact on this cooperative (government — investor) mechanism. A model test site is constructed to demonstrate the capabilities of the approach. The actual data of the model test-site captures the specificity of the modeled object and makes possible a practical study of the properties of the Stackelberg equilibrium. The methodology is based on analyzing the sensitivity of the solutions of the corresponding bi-level Boolean programming problem to changes in the basic parameters of the model. To raise the societal efficiency of the cooperation mechanism with a rent-seeking investor and fair sharing of rent; this article suggests some steps that can significantly improve state institutions and thus reduce the level of transaction costs both for the state and the private investor.

Keywords: cooperation mechanisms, government — investor, natural-resource rents, rent-sharing, Stackelberg model.

JEL Classification: C6, Q32.

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I. Introduction

The majority of the problems, tied to natural resource development in under-developed territories of the Russian Federation, concerns devising a cooperation mechanism between the government and a private investor. There is a typical situation when an investor cannot implement his project because of absent necessary infrastructure, and the state is not willing to invest into infrastructure development without certainty that this infrastructure is properly exploited. Furthermore, even if the cooperative project is already launched, there are no guarantees that in the end a long term compromise between state and investor interests would be reached, and the investment would be sufficiently profitable and the state would receive possibly the larger part of natural resource rent in the form of tax payments.

For natural resources-rich regions, this cooperation project is at the basis of strategic planning, centered on forming programs of the mineral resource base (MRB) exploitation. Such programs necessitate the choice of appropriate production infrastructure for a territory in question in order to

1 This study was supported by the Russian Science Foundation (project 16–18–00073).
attract investors and to justify respective budget expenditure. It is needed for assisting investors in infrastructure and environment-aware construction while maintaining principles of sustainable development, preserving the natural environment and making sure that the society receives the majority of the natural rent as a value created by nature.

The established practice of forming such programs of mineral resources operates, in general, based on political arguments and rather simplistic estimates of decision-making efficiency, drawn from the state of technology and current raw materials prices. High transaction costs (TC), related to the underdeveloped state institutions that regulate the mineral resource sector, are customarily outside consideration. The authors believe that this aspect of TC is currently under-estimated: the mechanism of interaction between high TC and state-investor's cooperation principles are quite complex. It also requires special tools and consideration (Glazyrina, Lavlinsky, 2017).

How does one forecast expected ratio of rent sharing between investor and the state (the nominal owner of mineral resources) and estimate prospects of safeguarding their respective interests at the initial stage of decision-making? This problem is at the center of this study. Its main objective is to elaborate on and analyze economic and mathematical models of formulating efficient mineral resource base (MRB) development, based on solutions of bi-level Boolean programming. Such approach permits a compromise between economic interests and provides for long-term efficiency for investors as well as the state that seeks to implement strategic management of mineral resource complex (MRC).

2. Cooperation mechanism and rent sharing

What should be the mechanism of state cooperation with private investor at the base of natural resources development in the territory with underdeveloped production infrastructure? Practical examples of such cooperation are few and far from successful. Negative experiences of large infrastructure projects within state-private business partnership (SPP) under the aegis of Investment Fund of the Russian Federation like “Complex Development of Low Angara river region” and the project of “Transport infrastructure development to access mineral resources of the South Western Chita region” are quite instructive.

“State-private business partnership”, labeled thus by the government of Russia, is not considered as such by western literature. According to the adopted methodology, specific projects would be considered as SPP only if a private company finances construction and / or exploitation of mineral deposits sites that belong to the state (Varnavsky, 2009). Russian production and infrastructure complex follows the principle when each economic agent finances solely its own project. In practice this means that the state finances construction of its proprietary sites like roads, bridges, power lines, etc., whereas business builds its own factories, plants, and the like.
Most of the large infrastructure projects, implemented with Investment Fund of the Russian Federation, are carried out following the said principles. The Low Angara River project comprises construction of infrastructure and the Boguchany hydroelectric station (HES) as well as an aluminum plant and a paper mill. State support in this project included co-financing of HES and implementation of environmental protective measures and building infrastructure.

The Transbaikalia project implied state’s construction of the railroad branch “Naryn-Lugokan” (with a prospective natural resource developer co-financing) thus opening access to promising sites of natural resources to be developed by the private investor: in this case a corporation (joint-stock Co.) of “Norilsk Nickel”.

Both projects are under way even though with different rates of progress and rates of success. The Low Angara River project saw completion of the HES construction but the part, financed by private business, to timely launch the factory and the plant, is behind schedule. As a result, the state budget received no promised income, the population relocated from the dam area received no promised benefits, and additional social infrastructure failed to materialize.

In the case of the Transbaikalia project three years after the its launch, the private investor reneged his on intent to comply with the terms of the agreement to the full extent due to the fall of world prices for metals. This decision by investor cast doubt on this company’s overall competence and on the necessity to continue railroad construction fully. Under the circumstances, the state reduced its contract responsibilities and completed only partial railroad construction to “Alexander Factory” station ending up with an investment of 24 bn rubles. “Norilsk Nickel” share of financing amounted to 8 bn. rubles. Thus, the project allowed access to 2 out of 5 planned natural resource sites via new infrastructure: the Bystryno and Bugdain sites².

These examples of state-private investor cooperation have shown that the search of rational mechanism for such partnership in building MRC is making only initial steps in the desired direction. The level of this cooperation in developed economies with efficient and functional institutions is quite farther along, and it will take time to transform the existing mechanism in Russia into a full-fledged model of partnership between the state and the private investor where the latter would be prepared to finance proprietary mineral deposits sites of the former.

As shown by the examples above, if natural resource territory is under-developed, the aid by the state will remove infrastructure constraints and promote environmental protection to offset negative effects of extractive industries. Same examples also highlight an important role of transaction costs (TC) in managing natural resources established in works by Ostrom (Ostrom, 1997, 2009); Williamson (Williamson, 1998), Challen (Challen, 2001).

² The current state of affairs in these two cases proves the absence of efficient and working institutions in MRC: private investor froze project implementation due to world price for metals drop, and the railroad under construction remained without owner and was actively taken apart to sell scrap metal to China. In 2015 the railroad was reconstructed and launched into provisional exploitation.
These authors have expanded the notion of TC from its traditional association with costs associated with making contracts and involving economic agents’ interaction to the area of natural resources use and protection. In this study we will use the definition of TC following established consensus in the ecological economics literature: TC of managing natural resources are overall costs to define, establish and maintain, use and change respective functional institutions (formal and informal here) and organizations as well as costs to identify problems these institutions and organizations are intended to solve (Marshall, 2013, p. 187).

TC for large mineral resources projects in remote regions of Russia can be quite substantial. They can possibly include in part control and monitoring of technological and ecological conditions on behalf of the state and also expenditures to improve public institutions. The investor’s part of TC might include costs of estimation of environmental effects, setting up services to interact with regulatory agencies and so forth. According to Marshall (Marshall, 2013), we will distinguish TC ex ante and TC ex post concerning specific projects. This distinction has to do with the fact that TC of managing natural resources ex ante and ex post is intended to solve substantially different problems (Glazyrina, 2016). Moreover, TC can be distributed in a variety of ways between the state and private investor depending on the institutional environment, thus the model should be able to capture this fact to be functional.

Hence, a generalized case of state-private investor cooperation under the conditions of the underdeveloped territory can be based on state assistance to private business in creating production infrastructure and enforcing necessary environmental protection. The mechanism of such cooperation is likely to be wrought with conflicts that can be modeled as TC.

Under these circumstances, the problem of developing an efficient program of development of mineral resources base (MRB) can be otherwise a problem of the state assistance allocation of resources along two directions, i.e. direct state investments in infrastructure and partial financing of environmental protection to offset negative externalities. The question of engaging public financial resources (otherwise state participation in projects, representing the society) in the projects of private business to address environmental issues remains most debatable. The authors are not prepared to assert that this is acceptable in all cases. However, in cases of underdeveloped regional infrastructure, in general, and communal housing in particular, which are typical for practically all territories of eastern Russia, the arguments in favor of such assistance are quite persuasive.

First, new environment protection facilities for production waste treatment can and should perform a social function. These can include allocation of special sites for waste complement and its treatment. Remote areas of Siberia and Far East have never had any of these facilities in the majority of populated areas. Building such facilities will permit systematic construc-

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3 Authors share a conceptual approach that assumes ecological allocation of natural resource rent, analyzed in-depth by E. B. Ryumina (Ryumina, 2009).
tion of housing with standard amenities and other socially significant amenities, as well as to resolve mounting problems of solid waste that, despite sparse population, have reached catastrophic proportions.

Second, given that such environmental protection measures start from a clean slate they do require massive investments during the initial stages. The scale of this investment can cancel investor’s motivation to develop production in the first place.

Concrete combination of the above-mentioned state influence instruments on the economic terms of the discussed projects, the level of TC and fixed system of project financing determine together the profitability for investors and the share of natural resource rent, received by the state in a form of tax payments.

How can we formalize this problem of strategic planning? The estimation of rent from natural resource sites is at the basis of development programs of natural resources: in each concrete case and keeping external factors fixed one attempts to assess the income over normal rate of return, generated during the process of development of a particular site. These estimates are instrumental for investor’s choice of the most promising mineral deposits sites and forming an efficient program of development of MRB.

General case scenario rent estimate for natural resource site can be given by net present value \( \text{NPV} \) of a project:

\[
\text{NPV} = \sum_{t=1}^{T} \left[ \left( D_t - R_t \right) / (1 + E)^t \right],
\]

where \( D_t \) and \( R_t \) — income from output sale and technology costs of project implementation (capital investment, operational costs, payroll expenses), expressed in adjusted prices of year \( t \); \( E \) — project discount rate; \( T \) — duration of the period of development before exploitation.

Rent estimate of a site \( \text{NPV} \) reflects general efficiency level of the project and corresponds to the discounted cash flow for the pair “state-private investor”, where the state plays a passive role of the owner of resources and a recipient of budget income according to the fixed system of taxation. On the contrary, the state can be an active participant of cooperation with private business using the specific mechanism. Within the framework of this cooperation, state takes part in financing capital investment, building infrastructure, and implementing measures to protect the environment.

If we view the state as a co-investor of the project, we can also ask a question of profitability of such state participation. The answer to this question is determined by the sign analogous to equation (1), net present value of the state from implemented project \( \text{NPV}_{\text{gov}} \), construed in a way that TC are included into overall state expenses \( \text{STC}_t \), and capital expenses \( \text{SR}_t \) (i.e. investments in infrastructure and environmental protection measures), and, finally income tax payments based on projections of the project \( \text{tax}_t \) and future outside-the-project income \( \text{VD}_t \), not associated with the project proper but generated by development of regional infrastructure in the territory in question:

---

4 For example, in the Transbaikalia area the share of good amenities housing in 2016 accounted for a bit more than 50% and it was mostly concentrated in area’s center and a few cities.
\[ NPV_{gov} = \sum_{t=-T_1}^{ST} VD_t - SR_t + tax_t - STC_t. \]  
\[ (2) \]

We assume here that the state incurs TC annually up to the time of the project. If we denote \( T_2 \) as the duration of the period when investor incurs TC before the launch of the project, one can construct \( NPV_{inv} \) analogous to (2), in which tax payments \( tax_t \) are included into overall expenditures along with investor TC \( ITC_t \) and capital expenditures less project ones associated with the state participation:

\[ NPV_{inv} = \sum_{t=-T_2}^{T_2} D_t - (R_t - SR_t) - tax_t - ITC_t. \]  
\[ (3) \]

Investor will have interest in the project of a particular site if \( NPV_{inv} \geq 0 \). The situation is different for the state where the time horizon \( ST \) for calculated \( NPV_{gov} \) is greater and the discount rate is significantly smaller than the one for the investor, and outside the project benefits and income are farther in the future beyond the scope of the particular project. The latter would account for a significant part of \( NPV_{gov} \) due the low discount rate and might make it greater than 0.

Overall MRB program that comprises infrastructure, environment protection and production proper project, is implemented within fixed state-investor cooperation mechanism and becomes a complex project for which net present value determines rent estimate \( NPV_{proj} \) of a number of sites of the said program:

\[ NPV_{proj} = \sum_{t=0}^{T} \frac{D_t - R_t}{(1 + E)^t}, \]  
\[ (4) \]

where \( D_t, R_t \) — sum of general income and expenditures of the program, and \( E \) — discount rate for it.

In the process of program implementation each participant, i.e. the state and the investor generate their flow of income \( DS_t, DI_t \) and expenditures \( RS_t, RI_t \), the structure of which corresponds to (2) and (3). In order to determine the way rent is distributed one needs to analyze these flows and construct net present value of respectively state and investor \( NPV_{gov} \) and \( NPV_{inv} \), assuming the discount rate of the program to be \( E \). The obtained state share of the rent \( \delta \) is estimated using formulae:

\[ NPV_{gov} = \sum_{t=-T_1}^{ST} \frac{DS_t - RS_t}{(1 + E)^t}, \]
\[ NPV_{inv} = \sum_{t=-T_2}^{T_2} \frac{DI_t - RI_t}{(1 + E)^t}, \]
\[ \delta = \frac{NPV_{gov}}{NPV_{proj}} \]  
\[ (5) \]

How should one select the discount rate \( E \) for the program implementation? Figure 1 presents a graph depicting dependence of \( \delta \) on \( E \), built on the basis of the program analysis of program implementation in the Transbaikalia area with the above-mentioned mechanism of state-investor cooperation. As \( E \) approaches the internal program implementation profitability value \( IRR_{proj} \) at the function \( \delta \) discontinuity, it becomes virtually impossible to correctly estimate state share of the rent and thus the quality of the state–investor cooperation mechanism\(^5\). Due to these circumstances,
a range of low discount rates $\bar{E}$ can be recommended for the state as the owner of mineral deposits.

We will follow these principles to select $\bar{E}$ for the offered below program models of designing cooperation mechanism, based on Boolean programming of state rent share as target function (Lavlinsky et al., 2016).

3. Models of cooperation mechanism design

The methodology proposed to develop efficient cooperation mechanisms to insure compromise between the interests of the participants for the underdeveloped regions, can be built based on the Stackelberg model. The state assumes here a leadership role as it launches production infrastructure (roads, power grid etc.) that serves a dual purpose: this state develops the regional economy and it provides private investors with profitable development of mineral deposits. The role of private business is to be led in rational selection of MRB development in response to state initiatives thus eliminating additional investor expenditures to fit projects to a particular territory.

At first glance, such a setup contradicts the established practice of investors being first movers in developing a mineral resource deposit site. In such cases, the state has to undertake ground-laying decisions like the sale of a license and state commitment of financial resources to infrastructure prior to an investor deciding to go ahead with a project, thus one can consider state first mover. Considering these, we input the following data in order to model cooperation mechanism:

- a set of infrastructure projects, implemented by the state, selected based on state estimates of their efficiency from the perspective of the long term development of a particular territory;
- a set of production projects to develop mineral deposit sites by private investors, selected and configured by private investors, depending on the state proposed initiatives in the area of infrastructure build-up;
- a list of ecological projects to ensure offset of negative ecological externalities due to the implementation of production projects; concrete assignment of ecological responsibilities between the state and the private investor at the start of the model is not determined and should be introduced obtained at the finish of the model of planning.

Model output is MRB development program and mechanism of distribution of environment protection costs between the state and private investor.

![Fig. 1](image-url)
Formal description of planning problem can be presented in a following way. Let $NP, NI, NE$ be the number of production, infrastructure and ecology projects, $T$—planning time horizon, $i = 1, \ldots, NP; j = 1, \ldots, NI; k = 1, \ldots, NE$; ordinal year $t = \max(T, T'_{2}), \ldots, T$.

Production project $i$: $\text{CFP}_i$—cash flow; $\text{EPP}_i$—value estimate of ecological negative externalities; $\text{STC}_i, \text{ITC}_i$—TC for the state and investor in the process of the project implementation $i$; $\text{DBP}_i$—state budget revenue from the project.

Infrastructure project $j$: $\text{ZI}_j$—table of costs, $\text{EPI}_j$—value estimate of ecological negative externalities, $\text{VDI}_j$—off-projected budget revenue from project implementation associated with the overall development of the territory in question.

Table of costs $\text{ZE}_k$ characterizes ecological project $k$.

Projects’ interconnection: $v_{ij}$—indicator of technological connectivity of production and infrastructure projects equal to 1, if for production project $i$ it is necessary to have infrastructure project $j$ implemented, and equal to 0 in the opposite case; $v_{ik}$—indicator of connectivity between production and ecological projects, equal to 1 if production project $i$ implementation necessitates realization of the ecological project $k$, or equal to 0 in the opposite case.

Discount rates and budget constraints: $\text{DG}$—state discount rate; $\text{DI}$—investor discount rate; $\text{BudG}_i, \text{BudI}_i$—state and investor budget constraints.

Let us introduce whole number variables:
\[ z_i = 1, \text{ if investor launches a production project } i, z_i = 0 \text{ — if it does not; } \]
\[ x_j = 1, \text{ if the state launches an infrastructure project } j, x_j = 0 \text{ — if it does not; } \]
\[ y_k = 1, \text{ if the state launches an ecological project } k, y_k = 0 \text{ — if it does not; } \]
\[ u_k = 1, \text{ if investor launches an ecological project } k, u_k = 0 \text{ — if it does not; } \]
\[ \overline{y}_k = 1, \text{ if the state declares its readiness to implement ecological project } k, \overline{y}_k = 0 \text{ — if it does not. } \]

3.1. Stackelberg model

Interactive procedure “leader—follower” at the basis of the Stackelberg model is a good enough description of the state-private investor interaction in the underdeveloped territory endowed with natural resources, where the state should play a critical role in such cooperation by making the first move to stimulate entry of potential developers of natural resource deposits. Respective model is formulated as a following bi-level problem of mathematical programming $L_2$.

State problem—maximization of the state rent share:
\[
\sum_{t - T'}^{T} \sum_{i = 1}^{NP} (\text{DBP}_i - \text{STC}_i - \text{EPP}_i)z_i + \sum_{j = 1}^{NI} (\text{VDI}_j - \text{EPI}_j - \text{ZI}_j)x_j - (6)
\]

It is this very parameter and constraint (11) in the model’s setup that fixes the state’s position as the “leader” in Stackelberg game: investor cannot begin project implementation unless the state creates necessary infrastructure.
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\[
-\sum_{k=1}^{NE} ZE_k y_k \] / (1 + DG) \rightarrow \text{max}
\]

Under conditions:
\[
\sum_{j=1}^{NI} ZI_j x_j + \sum_{k=1}^{NE} ZE_k y_k \leq BudG_t, \quad t = 1, \ldots, T,
\]
\[
(y, z, u) \in F(x, \bar{y}),
\]
\[
x_j, \bar{y}_k \in \{0; 1\}, \quad j = 1, \ldots, NI, \quad k = 1, \ldots, NE,
\]
where \( F(x, \bar{y}) \) — a set of optimal solutions of investor problem.

**Investor problem** — maximization of total net present value (NPV):
\[
\sum_{i=1}^{T} \left( \sum_{j=1}^{NI} (CFP_{i,j} - ITC_{i,j})z_i - \sum_{k=1}^{NE} ZE_k u_k \right) / (1 + DI) \rightarrow \text{max}
\]
under the conditions
\[
x_j \geq z_i \mu_j; \quad i = 1, \ldots, NP; \quad j = 1, \ldots, NI,
\]
\[
y_k + u_k \geq z_i \nu_k; \quad i = 1, \ldots, NP; \quad k = 1, \ldots, NE,
\]
\[
y_k + u_k \leq 1, \quad k = 1, \ldots, NE,
\]
\[
y_k \leq \bar{y}_k, \quad k = 1, \ldots, NE,
\]
\[
\sum_{i=1}^{NI} (CFP_{i,j} - ITC_{i,j})z_i \leq BudI_t, \quad t = 1, \ldots, T,
\]
\[
y_k, z_i, u_k \in \{0; 1\}, \quad i = 1, \ldots, NP; \quad k = 1, \ldots, NE.
\]

Thus formulated model implies the investor to maximize \( \text{NPV}_{\text{inv}} \), whereas the state’s main objective is to maximize rent \( \text{NPV}_{\text{gov}} \) taking into the account TC and also value estimates of negative externalities that stem from the chosen program MRB development. Both state and private investor are limited by budget constraints (7) and (16) vis-à-vis potential set of feasible projects. Constraints (11)—(12) fix the interconnection of production, infrastructure and ecology projects. Each ecological project can be launched by only one of the partners (13) and has to be a prerequisite for the implementation of the production project (14). An ecological project can be a firm state commitment only if the state included it in its approved list of projects (15).

The model’s output is an ecological and economic model of cooperation \( \{x_j, y_k, z_i, u_k\} \), that determines the mechanism of costs distribution and overall program of regional MRB development.

**3.2. Model of the informed state**

Certain assumptions about the state competencies and abilities can simplify the initial bi-level problem solution mathematical programing to a single level one. This becomes possible if the state is informed about the technological projects of mineral deposit sites’ development projects and about the details of respective project financing. Hence, the model under-
goes transformation into the following Boolean programing problem \( L_1 \):

\[
\begin{align*}
\sum_{l=1}^{T} \left[ \left( \sum_{j=1}^{NP} (DBP_{ji} - STC_{ji} - EPP_{ji}) z_j + \sum_{j=1}^{NI} (VDI_{ji} - EPI_{ji} - ZI_{ji}) x_j - \right) \right] - \sum_{k=1}^{NE} ZE_{hk} y_k \right] \frac{1}{(1 + DG)^t} \Rightarrow \text{max}
\end{align*}
\]

(18)

Under conditions:

\[
\sum_{j=1}^{NP} ZI_{ji} x_j + \sum_{k=1}^{NE} ZE_{hk} y_k \leq BudG_t, \quad t = 1, \ldots, T,
\]

(19)

\[

\sum_{i=1}^{T} \left[ \sum_{j=1}^{NP} (CFP_{ji} - ITC_{ji}) z_j - \sum_{i=1}^{NE} ZE_{hi} u_i \right] \frac{1 + DI_t}{(1 + DG)^t} \geq 0,
\]

(20)

\[

x_j \geq z_j \mu_j, \quad i = 1, \ldots, NP; \quad j = 1, \ldots, NI,
\]

(22)

\[

y_k + u_k \geq z_k \gamma_k, \quad i = 1, \ldots, NP; \quad k = 1, \ldots, NE,
\]

(23)

\[

y_k + u_k \leq 1, \quad k = 1, \ldots, NE,
\]

(24)

\[

(y_k + u_k) z_k \leq z_j, \quad i = 1, \ldots, NP; \quad k = 1, \ldots, NE,
\]

(25)

\[

x_j, y_k, z_j, u_k \in \{0; 1\}, \quad i = 1, \ldots, NP; \quad j = 1, \ldots, NI; \quad k = 1, \ldots, NE.
\]

(26)

The model provided in (18)—(26) has the same objective function as the state objective in model \( L_2 \), and investor return aspirations are limited by the informed state (see 21), which provides investor with profitability, based on his discount rate and needed to reach a compromise. In this case, the state substantive knowledge of the investor makes the state the primary architect of the cooperation mechanism here.

It is supremely important that both models work with the same information base, and solution of single level problem \( L_1 \) determines the upper boundary of the functional for model \( L_2 \). This property of the said models will be used below for the analysis of TC effects on the mechanism of coming up with MRB development program.

4. Transaction costs and efficiency of cooperation mechanism

In order to feature cooperation mechanism sensitivity to TC, we modeled a test site using as an example the Transbaikalia region mineral resources base. We identified ten polymetallic deposit sites broken into three clusters based on the terrain relief, continental divides and particulars of the existing infrastructure. Five infrastructure projects were devised to service these clusters’ system, parts of which were already under way (like railroads, high voltage lines) whereas other infrastructure installations were
making up for the absent-as-of-today ones but laying foundations for the future ones projected to support mineral deposits development. For each mineral deposit site there was a complex of environmental protection measures, integrated into an overall complex ecological project.

Information base for the models $L_1$, $L_2$ is formed aided by specialized forecasts that permit detailed description of all types of projects implementation with a sufficient degree (Glazyrina, Lavinsky, 2017). As far as infrastructure and environmental protection projects go, their costs $Z_{I_k}$, $ZE_k$ are determined by project documentation.

Projections of mineral deposit sites development use forecasts of market prices and overall output sales. At the same time, forecasts of capital and exploitation costs of all types are provided by technical and economic estimates of the project, which, in turn, constitute all technologically required costs. Investor TC graph $ITC_n$ is given by expert assessment at the onset of the model. This allows forecasting cash flow $CFP_n$ and budget revenue $DBP_n$, which include all kinds of tax payments, technology associated costs (stated in technical and economic estimates of a project) and investor TC.

State TC graph $STC_n$ depends on the characteristics of mineral deposit site and serves as an exogenous model parameter of its development, entered as expert assessment.

Thus, for both the state and investor TC ex post are beyond the scope of immediate production costs. Nevertheless, TC ex ante, according to their nature, are incurred, as stated in their definition, during the period whence other TC are not present. This allows us to state that $ITC_n$ and $STC_n$ within the framework of the model is distinguished from production costs, stemming from project implementation and thus can be indeed treated as transaction costs.

Which transaction costs are at the base of the proposed model?

State TC ex ante comprise expenditures to form and promote environmental protection institutions, and their scientific research and information provision, the issuance of licenses to ensure acceptable environmental standards, various respective agreements and the like. State TC ex post include expenditures of monitoring and controlling ecological negative externalities of functioning enterprises, costs of enforcing ecological standards by court and administrative measures and so long.

Investor TC ex ante comprise research and information provision for project development, documentation preparation, procurement of licenses for acceptable ecological externalities, making preliminary contracts and getting legal retainers, etc. Investor TC ex post includes project management, production monitoring, contracting out as one goes to diminish negative externalities. One can also add to these adaptation costs to account for changing circumstances of project implementation in the areas of technology, ecology and institutions makeup and altering natural climate.

We formalize listed above constituents of the model TCs in a following fashion.

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7 Investor TC is not included into this computation.

8 Tax payments of various types are levied according to the scheme of taxation used, and directly include investor TC.
1. State TC size depends on the project investment value. During period $T_1$ years the state carries TC *ex ante* and during period $T_3$ years $T$ *ex post* equal to a fixed percent share of total capital investment for the project.

2. Investor TC overall amount is also a fixed percent share of total capital investment of a project and their distribution over periods $T_2$ years before and $T_4$ years after the project was launched. As a rule, investor TC are usually increasing during the run-up to the project launch and decrease as the project get under way.

3. Investor TC tends to stay fixed overall and in that part that is passed into the cost of production. According to the authors, this formalization (of the listed above TC) allows to capture in an aggregate fashion the particulars of their dynamics and possibly provide a more detailed look at state private investor interaction at the base of models $L_1$ and $L_2$.

Thus constructed model test site permits analysis of problem solutions stability with respect to TC parameters changes, and to apply obtained results to make practical recommendations for improved mineral resources development and management.

Figure 2 shows computation results when participants’ discount rates varied with TC held at zero. Here and further in the text below sectors A and B describe surfaces that correspond to government target function in statements $L_2$ and $L_1$; i.e. value estimate of the state share of the rent. Surfaces in sectors C and D correspond to $\delta$ representing state share of the rent received in these statements and expressed as a percentage of the rent estimate of project implementation found in the process of solving it. Target investor function values in models $L_2$ and $L_1$ are in sectors E and F.

In both setups, whilst low discount rates are present, the state implements a full range infrastructure program thus opening the possibilities for investors to fully commit to a total complex of developing mineral deposits sites. As the discount rate goes up, the state curtails its infrastructure program, envisaging rent estimate approaching zero and thus lowering the state share $\delta$ of it. The analysis of surfaces in Figure 2 attests to the fact that under low discount rates, faced by the participants, and in the absence of friction (TC equal zero) in cooperation mechanism, rent-driven investor behavior in setup $L_2$ practically leads to the same results as the interaction of the participants in the model of the informed state $L_1$.

What happens when TC are other than zero? Let us assume for the purposes of certainty that discount rates for investor and the state are fixed at 15 and 5% respectively. Fig. 3 presents numerical experiments when TC by the state and investor varied. Our computations demonstrate that in model $L_2$ the state builds infrastructure and assists investor in implementing environmental protection measures when TC for the state remain narrowly defined and investor TC are small. In this case full-fledged infrastructure program is put in place upfront and it is scaled down as investor TC increase. This investor TC increase is accompanied by mounting assistance

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9 In a general case, this parameter depends on the system of taxation.

10 Bi-level program solution programming methods are based on local search and are present in the paper (Lavlinsky et al., 2016).
by the state only up to the certain level after reaching which state assistance is discontinued and so is the infrastructure program.

In model $L_1$ the number of infrastructure projects, implemented by the state, practically shows no dependence on investor TC. When $STC$ stay small, the government build infrastructure to a full extent, but when TC start to grow the state drastically cuts this construction activity. Such altered behavior of the state explains the differences in the nature of surfaces in Figure 3. We observe here maximum sensitivity of both cooperation mechanisms to increasing TC. Investor TC increase exerts a particularly negative effect on efficiency for the model $L_2$ participants: the investor is first to incur losses but so does the state too due to the losses associated with a reduction
The distribution of rent depending on TC by the state and the investor.

of budget revenue flows. For investor model $L_2$ provides for greater resiliency to TC increase (see Fig. 3, E), compared to model $L_1$, when the state keeps track of investor profitability and expediently cut back assistance scale thus lowering investor functional to zero for high TC.

High discount rate for investors entails even more dramatic negative effect for MRB development programs when state TC tends to grow. Figure 4 presents computation results when investor TC were fixed at the average level and the alterations were permitted for investor discount rate and state TC. In this case, within the framework of both models, the state builds infrastructure to a minimal degree even if the state TC is high, under the condition, that investor discount rate is minimal. As a result, the state program to assist investor in implementation of environmental protection
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measure takes a significant blow. Target function values for participants of the said cooperation drastically come down as we leave the zone of low discount rates and small TC.

Increased investor TC has significantly less negative effects with regards to efficiency if state discount rate is low. Resultant computations with fixed at the average level state TC and state and investor discount rates assumed to change in tandem and performed analysis of the likely effects, have demonstrated that model $L_1$ has the government implement a full-fledged infrastructure program, accompanied by significant state assistance to ensure environment protection. Model $L_2$ though has much higher government sensitivity to investor TC and the scope of infrastructure buildup

Fig. 4

*Distribution of rent, depending on state TC and investor discount rate*
is much more limited when \( ITC \) go up. This affects, in the first place, state share of the rent \( \delta \) and accounts for the differences in sectors C and D in Figure 5. Investor functional appears to have lower sensitivity to increased state discount rate and it mostly determined by Investor TC for the most part.

Given that discount rates and the size of TC are not independent variables, the increase of investor TC would entail an increase of his discount rate. However, it is very unlikely to find any further detailed relationship between these two because of potential diversity of cooperation projects. Besides, it is not obvious that one can predict state discount rates if TC starts rising. In a number of cases, when increased TC are associated with institutional transformation to ensure environmental safety and social

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Fig. 5
Rent distribution, depending on investor and state discount rates
wellbeing (and, therefore, to reduce potential social costs to offset negative externalities), the government/society might be prepared to handle lower discount rates.

These above-mentioned considerations justify, to a certain extent, the fact that the model does not provide dependence of TC on discount rates in an obvious fashion. According to the authors, it is more important to feature how, in today’s Russia, the mineral resource complex is affected by overall market conditions and macroeconomic factors like a high inflation rate, oscillating ruble exchange rate, and constantly changing system of taxation. Still though, the possibilities of model instrumentation allow to plot at the program start various versions of functional linkages and to construct model forecasts of cooperation efficacy for different combinations of TC and discount rates. More specifically, we can thus answer the question how lower TC can go along with lower discount rate without sacrificing acceptable level of profitability.

5. Discussion of the obtained results

Modeling results permit assessment of TC effects on efficiency of MRB development programs as generated in models $L_1$ and $L_2$. Even though the state — private investor interaction mechanism in both models is based on government assistance in infrastructure construction and environmental protection installation, the initial assumptions about the level of the government being informed and government powers overall are essentially very different. This is why we find such variety of results and the effects of TC on them. Our computations have shown that the size of TC, their distribution between the government and the private investor can be quite significant and are not obvious before hand, but they have crucial effects on the efficiency of production processes and on achieving a balance of interests for the parties involved. Main conclusions following results of modelling can be formulated as follows.

1. Among all TC, state transaction costs are likely to impose the biggest damage to the indicators of state investor cooperation. Indeed, the level of state TC, comparable to partners’ discount rate, appears to be a major factor of negative effects especially if investor discount rate is high. This implies that if investment conditions are not beneficial (which brings about high discount rate) it is especially important not to allow state TC get out of control. The most obvious way to do so is to raise efficiency of government ecological and economic institutions performance by eliminating redundancies and unsubstantiated expenditures.

Nevertheless, one needs to be aware that intent to lower state TC is desirable only up to a certain level. In order to have coordinated economic and ecological interests of both the society and business effective and efficient institutions have to be present, and they are not to be gratis (Marshall, 2013, p. 185). Thus, a task to minimize state TC can possibly lead to dangerous consequences because in nearly all cases in question ecological inter-

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11 For instance, if one redistributes part of state TC to investor while maintaining acceptable level of profitability.
ests of the society and stability of ecosystems are the first to be sacrificed in almost all situations.

2. It is recommended that the government use the average range of its discount rate in the process of decision-making. If these discount rates were either too high or too small, the government would drastically diminish its share of the rent when investor TC goes up\(^2\). A big part of the government discount rate is generated by state TC and that is why it cannot fall below a fixed level. In addition, a low discount rate is in conflict with the government’s role in state — private investor cooperation as the owner of natural resources and the party that funds development projects at the initial important stage when necessary infrastructure is being built to make sure mineral deposit sites development is launched. If discount rate is too high, the government, which gets engaged in the project before investors, would practically lose outside-of-the-project revenue from a particular territory development\(^3\), and also it would lose from the perspective of NPV in comparison with investors the functional of whom, as we saw, have shown little sensitivity to increasing state discount rate and are mostly determined by TC of investor proper.

3. As far as decision-making institutions are concerned the government should transition from today’s Stackelberg model to the model of informed state. Despite the fact that informed government model adds TC associated with information search at the beginning, single level problem \(L_1\) solution is the upper boundary for the functional of model \(L_2\), which, in turn, determines the directional choice of transformation of decision-making in the process of mineral resource potential development.

What is the information base for decision-making process in Stackelberg model that would adequately enough reflect today’s reality? The government has to have complete information about infrastructure projects for the task at the upper level, expenditure charts for ecological projects, and state budget revenue forecast and population income from project implementation forecast as well for investment projects. This list corresponds largely with the informational data that the state (the main party contacting infrastructure installations) receives from the private investor in a form of technical and economic specifications of mineral deposit sites development proposals where budget revenue and workers’ payments are projected.

Transition to the model of informed state suggests that the government has at its disposal the data about the technological specifications of the mineral deposit sites development, as well as the forecasts of market prices and details of project financing. This transition to the informed state becomes feasible if the decision-making process is supported by state institutions in charge of assessing mineral deposit sites development form the vantage point of the government and the society as a whole. Such institutions, engaged in long-term resource projects in the past, have been largely lost during the Russian economy reform process\(^4\). Today the government as the owner of the mineral resources is becoming increasingly aware that

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\(^{12}\) This range in our example is between 3 and 7% (see figure 5, sector C).

\(^{13}\) This is because revenue of this kind has a tendency to increase with a big lag.

\(^{14}\) A number of institutions of such specialization was privatized and served the interests of the new owner.
their use needs to become more rational. This will not be possible without reinstating an institutional infrastructure to manage MRC: the said infrastructure would permit professional solution for long term challenges associated with sustainable development. Proposed transition from model $L_2$ to $L_1$ would map direction of institutional project-making (Tambovtsev, 2008) to raise efficiency of state–private business partnership.

Hence, cooperation efficiency during the process of MRC development in under-developed territories depends not only on general macroeconomic conditions but also on the quality of state management of environment protection that does not directly relate to the cooperation in question. Hereafter we can propose certain steps to gradually transition to the informed state model based on the improvement state institutions performance and lowering state and private investor TC.

Potential investor needs complex assessment of the mineral resources’ value in a detailed and time specific fashion to ensure economically profitable projects for prospective investment in addition to macroeconomic stability. Such an assessment cannot use prior formed expert estimates of resource base development because with time market conditions are subject to crucial changes as do prices in the domestic economy with high inflation and unstable exchange rate of the ruble.

Under these circumstances, the government should carry out an inventory of main resource sites with current conditions in mind and organize ongoing monitoring of the resultant rent estimates. This way a necessary external informational infrastructure would facilitate investor decision-making and the state would have data to make sure natural resources are utilized in a more rational fashion.

This basis provides for the proper approach to solve the central problem of mineral resource regions, i.e. a development of complex scenario to build a MRB, inclusive of production infrastructure installations, and formulating investment proposal packages, aimed to implement stage-by-stage development of a particular territory. One needs here to safeguard the interests of private business and more so of the society as a whole. The search for various versions of such coordination of interests is not a simple task, but we propose in this work instruments to facilitate that this task be tackled.

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Hot Topic

Round Table:
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D. A. Izotov
Injecting Dynamism in the Russian Far East Economy: Can New Institutions Help?

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Economic Integration in East Asia: Challenges for the Russian Far East
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**Far East Priority: Combinations of Investment and Institutions**

**Abstract.** Trends and possibilities for implementing the state economic policy for the Russian Far East development are discussed. Historical overview is given with the identification of stages of regional development, characterizing by the different sources and scales of economic resources, in particular investments, and the types and degree of localization of specific economic institutions for the regional development. The motivation duality for priority development of the region is shown. On the one hand, it is characterized by non-competitiveness in terms of standard market procedures. On the other hand, it has a high appraisal of utility in terms of national geostrategic and geo-economic goals. A hypothesis is advanced that in this situation; priority economic development is possible only if an effective combination of scales and sources of investment resources is found with an adequate type of institutional regime for this purpose and with an optimal level of localization of institutions.

**Keywords:** Far East, investments, economic development, institutions, integration, priorities.  
JEL Classification: O1, R1.  
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**Introduction**

Since the mid-1990s, the problem of the economic development of the Russian Far East in the context of integration into the APR (Asia-Pacific region) has gradually become one of the priority tasks of economic policy. The threat of the economic and demographic vacuum in the Far Eastern borders (in 1996 the GRP of the region was only 42%, and the population — 76% of the level of 1990) forced the revival in 1996 of a long-term state program for the development of the region, which was approved back in 1987. The deficit of public resources, non-competitiveness of Far Eastern private investment options, and lack of institutional preferences for the economic agents operating in the region (real and potential) did not allow to significantly change the economic and social situation in the region until the early 2000s. In the years 2000–2016, many systemic problems were eliminated or mitigated: the energy deficit was eliminated, the state of the transport infrastructure improved, the growth rate of investments in the fixed assets was almost 350% (235% in the whole of the Russian Federation fixed capital), the value of exports increased almost 5.2 times (2.8 times higher than in the Russian Federation), the growth of incomes of the population started up again (as before the 1990s) to outstrip the average Russian indicators (300% vs. 270%, respectively). Nevertheless, the key question remains: why, given the invariability of the generally recognized positive (the availability of natural resources and the economic and geographical situation) and negative (marginal level of transport and production costs) factors, the economic development of the region is unstable in the sense of alternating periods of relative prosperity and the failure of pace and level of development. The article proposes a hypothesis for explaining this phenomenon, the pace and level of development of the region depending on the combination of different types of investment (exogenous and endogenous; public and private), development resources, and institutional (inclusive and extractive) regimes (Natkhov, Polishchuk, 2017). At the same time, institutional regimes refer to specific institutions designed to target support for the development of the Far East.

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1. The role of investment and institutions in regional development

From the point of view of the determining factors of the regional development, the main difference between the economic development of the region and the scale of national or global systems is that the areas of generation and exploitation of growth in the volume of economic resources do not coincide. Therefore, in the case of the region, economic growth and socio-economic development are not identical. Of course, the economic growth of the region is based on economic and social development. But this growth is not necessarily localized within the given territory. Even though such localization exists, it will not necessarily lead to economic development in this region.

Regional economic development is determined by the nature of the spatial distribution of the generated income used for accumulation and consumption in specific regions, the scale and proportions of financial and material flows between the region and the center, including the conditions and efficiency of the production factors (Minakir, 2013). But the income itself can be generated both in the region and outside it and redistributed to the region in accordance with existing institutions, the quality and direction of which determine the scale of the redistribution of income, as well as the scale and nature of the use of the revenue generated in the region itself.

This means that the economic development of a particular region is determined by two fundamental factors: first, the amount of investment (both generated in the region itself and redistributed in its favor from the interregional system), and secondly, by the nature of the institutions that determine the opportunities for formation of internal and external development resources and their most effective use.

For regions characterized by a high assessment of the geopolitical and geo-economic utility for the country, but a low assessment of the competitiveness of economic agents located and functioning on its territory, the general rule is a chronic shortage of investments generated within the region to ensure unified (or even more — prioritized in relation to the other regions) economic, social and infrastructural development standards and/or the achievement of the national economic or non-economic purposes implemented in this region. This deficit is associated with the limited scope of economic activity, the inability to use the economies of scale due to the narrowness of the domestic market and the limited ability to compensate for the size of the domestic market through interregional exchange of goods and factors of production because of the closing (with regard of labor and capital unit cost) indicators of economic activity (Kardas, Fisher, 2017).

Compensation of the deficit of endogenous investments due to the non-market redistribution of public resources in favor of the region is often completely or partially impossible because of the limitations of those resources in both absolute and relative terms (because of too many national priorities). The amount of state resources, as a rule, is not constant in time — periodically it can be decreased after the change of national priorities of spatial resource redistribution, as well as a result of maintaining the stability of economic growth at the national level, which requires concentrating the accumulated resources in the regions with maximum productivity of the production factors (Isaev, 2014; Kolomak, 2014).

No less important than the amount of resources used to achieve the goals of economic development, has the nature and level of localization of institutions. For the national economies, the institutional regimes are asserted to be the more significant factors of economic development — as compared to the geographical location and richness of resources. And this thesis is considered proven (North, 1990; Rodrik, Subramanian, Trebbi, 2004; Hashim Osman, Alexiou, Tsaliki, 2011; Frolov, 2015). It is also true for the regions. Confirmation of this argument can be found in a number of theoretical and empirical studies on the example of the regions of different countries (Rodríguez-Pose, 2013; Stough, 2001). As factors of regional development, institutions are divided into compensatory and stimulating.

The first institutions (compensating) help to reduce the level of production, transport and transaction costs of economic agents operating in
the region; through government subsidies, they mitigate or eliminate economic barriers to inter-regional redistribution of private resources. In some ways, this kind of institutions performs the role of protection from predators for regions that need support in interregional competition. The term of “predators” refers to the strong regions in terms of interregional competition for resources (Anderson, 2004; Anderson, Bandiera, 2005; Ryzhova, 2013).

The second institutions (stimulating) are designed as local institutional regimes that provide preferential terms for both economic activity in a given region, as well as general development conditions or, as John Stuart Mill pointed out, “improving business ability” (Mill, 1981). In practice, both compensatory and stimulating institutions function together.

Institutions are in general a more significant factor in the economic development of the region than state investment support, since there are possibilities of the situations of almost complete absence of this support, as shown below. Then the economic development of the region on the basis of endogenously generated resources is completely determined by the nature and impact of unified or local institutions.

The success of the region’s economic development for a given amount of endogenous and exogenous investment depends on the nature of the institutional environment, which is determined by the prevalence of inclusive (providing favorable conditions for productive activities and effective application and accumulation of productive resources) and extractive (providing economic or political rent-seeking in favor of economic and political elite) institutions (Natkhov, Polishchuk, 2017).

2. Economic history

The history of development and evolution of the Far East can be divided into several periods. The main difference between them (from the point of view of our analysis) is the peculiarities of the influence of the scale ratio and the preferential type of investments (such as institutes) on the rates of economic development of the region.

2.1. State investments — localized inclusive institutions (1860–1930)

The state carried out direct resource intervention (construction and maintenance of transport infrastructure, military industry and military logistics of the army and navy), as well as indirect subsidization of endogenous economic development through financing the functioning of a special institutional regime for the Far East. This regime included the financing of resettlement programs from European Russia. For this resettlement, in 1861, benefits were introduced to resettled people, as well as incentives for doing business (Krushanov et al., 1977, p. 40; Minakir, Prokapalo, 2010, pp. 35–36). The effect of institutional intervention began to emerge from the end of the 1880s, when state investment and intensive resettlement (in 1861–1995, about 1.5 million people moved into the region) created the basis for the endogenous development of market economy in the region. For the years 1890–1913, the cost of industrial production was increased by 2.5 times (Minakir, Prokapalo, 2010, p. 43), while about 70% of the cost of the entire regional product was created in agriculture.

The effect of an inclusive institutional regime turned out to be greater than the state’s military-political rent-seeking. This statement was manifested in the defeat in the Russo-Japanese War. Another lesson of this War was that the institutional regime alone cannot provide the level of development necessary for extracting political rent even if this institutional regime is very effective, without significant investments of public and private resources in the region’s economic development. And the connection of external private resources requires an addition to the institutional regime by encouraging non-resident economic agents, i.e. delocalization of the institutes’ activities.

This situation was fully revealed in 1922–1930, when direct state financing in the region development practically ceased and the restoration of the regional economy relied almost exclusively on an extraordinary institutional regime bordering the full economic autonomy of the Far East, focused on mobilizing endogenous resources and stimulating the activity of regional economic agents in the operation of domestic and adjacent
foreign markets (Minakir, 2006, pp. 142–152). This allowed us to quickly restore the pre-war level of development in the region, but at the same time excluded support for non-economic goals at the national level.

2.2. State investments — delocalized extractive institutions (1930–1985)

Since 1930, the priority of the Far East has been restored as a recipient of state investments aimed at creating a support base for the protection of military and political interests in the Far East. The experience of the Russo-Japanese War showed that a powerful diversified industrial and economic complex should be created in the Far East. This complex should be based on infrastructural capacities, its own resource base with the necessary social characteristics in order to ensure the functioning of large military groups in a relatively autonomous mode. To create such a complex in the Far East, significant capital resources were redistributed. The share of these resources in total state capital investments during the whole period up until 1990 was maintained at 6.8–7.5% (0.8% in the 1920s) (Minakir, Prokapalo, 2010, pp. 46–51). During this time the population increased more than 5 times. The economic complex was developed in the region, the share of industry reached 82% by the end of the 1930s against less than 30% in the 1920s.

The institutional support of the Far East was significantly increased in order to eliminate the factors responsible for the lack of market competitiveness of the regional economic agents, and to ensure the normal functioning and integration of the regional economic complex into the national economy. So, all the last factors are to support the resettlement of large contingents of the population and labor. The institutional support was done in the form of extractive institutions that stimulate population migration and functioning of economic agents as part of a unified planned country’s complex and enhance the recovery of foreign trade rent (special regimes in pricing, planning, procurement, product sales, special accounting of the population incomes). This institutional regime ensured the transferring of resources and functioning of the subordinate national military-political and geo-economic tasks of the regional economic complex, which had practically no opportunities to develop endogenously. By the end of the 1980s, all this ended up in accumulation of significant systemic problems, both — economic and social.

2.3. Endogenous private investments, unified institutions (1990–2002)

Following the abandonment of the priority of the Far East, a special institutional regime was also dismantled (only equalizing coefficients to wages were preserved), and the state investment support for the region was practically eliminated. The region found itself in a situation of autonomous functioning of the mode of the 1920s. The regional economic complex began to rapidly collapse being able to function only in a special institutional environment and with large-scale investment support. The only exception was the resource-producing industries, whose access to the Asian markets under new conditions was even facilitated. The destruction of a significant part of the military and civilian economy led to an outflow of people employed in industrial and military organizations (Minakir, 2006, pp. 357–378). The resources generated in the region were sufficient to maintain less than 30% of the economic potential created by 1990, while the population decreased only by 24%.

In the early 1990s, an attempt was made to ease the deficit of resources’ development by creating an inclusive institutional regime in the form of free economic zones; however this attempt failed (Russian Far East ..., 2017, pp. 313–317). The attempt to change the situation through the resuscitation of the 1987 state development program and the President’s development program through 2005 as its base were also unsuccessful, as

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2 Resolution of the CPSU (Central Committee of the Communist Party of the Soviet Union), USSR Council of Ministers of 19.08.1987 No. 958 «On the integrated development of the productive forces of the Far East economic region, the Buryat ASSR and the Chita region for the period to 2000».

3 «Presidential Program for the Economic and Social Development of the Far East and Trans-Baikal for 1996–2005» approved by the Decree of the Government of the Russian Federation of April 15, 1996, No. 489. The status of the «presidential» program was assigned to the program by the Decree of the President of Russia No. 601 of April 23, 1996.
the resources still did not exist, especially given the 1998 financial and economic crisis. So, the institutional innovations were blocked by the prevailing conviction, that the institutional discrimination of economic agents was no more admissible.

2.4. State investments — localized extractive institutions

After overcoming the consequences of 1998 financial and economic collapse and the beginning of the restoration of oil export prices, the concept of two-track development, which was interrupted in the 1990s, was resumed: firstly, the comprehensive development of the Far East, and secondly, the integration of the Russian Federation into the Asia-Pacific region (APR).

The priority was to achieve geo-economic goals, which, after 2007, became known as a turn toward the East. This turn implies an attempt to replace the European markets with the East Asian ones. However, the opportunities for an extensive increase in the export rents were almost exhausted and structural or technological possibilities for moving to an intensive strategy of increasing foreign trade rents at the disposal of Russia did not emerge (Minakir, Prokapalo, 2017).

In 2007, the main goal of the refined program for the development of the Far East was formulated as «... the formation of the necessary infrastructure ... taking into account geostrategic interests and ensuring the security of the Russian Federation»¹. Significant state and corporate investment resources were aimed to the development of infrastructure and strengthening of the commodity export base. These resources were invested in creating the main export transport infrastructure (road construction, seaports, pipelines), as well as in the new capacities in resource- and energy-producing industries (oil and gas, coal, oil refining, petrochemical, mining industries).

This investment flow was not accompanied with any serious institutional innovations, which made it incapable of stimulating the economic and social development of the region itself. At the same time, the implementation of the strategic declaration of a turn toward the East is complicated not only by obstacles specific for East Asia (bad history syndrome, high level of non-tariff barriers), but also by the pale economic face of Russia in East Asia. This face is the economy of the Far East — its infrastructure that provides intra- and interregional mobility, comfortable and comparable with East Asian neighbors’ levels of development of medicine, education, cultural environment, communal and social infrastructure (housing, landscaping, ecology), favorable business environment, ability to develop endogenously and generate own sources of income.

These circumstances forced to declare the accelerated development of the Far Eastern region as a national priority of the 21st century⁵. However, the scale of state investments necessary to realize this priority cannot be accumulated. Because the number of critical regions lacking the development is increasing in 2011–2016 the volume of aggregate investments in fixed capital in the region decreased by 35% at the rate of 8% per year (Prokapalo, Isayev, Mazitova, 2017).

In this situation, an attempt was made to introduce new institutions into the institutional environment in the Far East (example — territories of advanced development (TASED), free-zones, several tariff preferences, some measures aimed at increasing the involvement of the population into the work force)⁶. The total set of all these measures was called the «New Eastern Policy».

The listed institutions are not only predominantly localized, but also have a sub-local character — their effect extends only to the limited territories within the region. Consequently, the problem of the «marginal» nature of production costs and transaction costs to some extent is solved only for the residents of local zones. This situation blocks the systemic effect of regional development in the

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³ For more details see (Minakir, 2017, pp. 304—312, 318—327).
absence of mechanisms for translating economic effects beyond these institutional harbors.

The illusion of substitution of scarce public investment and blocked by the lack of effective institutional regimes of private investment by foreign capital is deceptive. Foreign capital comes only into commodity export projects (almost 90% of foreign direct investment — investments in the Sakhalin shelf and related infrastructure projects and processing). State investments in the infrastructure of the region significantly support the export projects in the region and the export potential of other regions.

As a result, the institutional regime has acquired features of a set of extractive institutions, which, combined with a deficit of exogenous development resources, does not allow us to approach the solution of the problem of "double-track development." A change in the situation is possible only if institutional support is addressed to the majority of economic and social agents determining the qualitative state and dynamics of the region's social and economic system.

Conclusion

Until now the task of turning this region into an economic and humanitarian outpost of the country in East Asia is still far from being solved despite the considerable efforts and huge economic and human resources expended for more than one and a half centuries on the development and exploration of the Far East. Two closely interrelated factors hamper this decision: first, the constant shortage of resources, and secondly, the weakness and instability of institutions.

The scarce material and financial resources are associated with the limited possibilities of attracting non-state investments to solve economic and social problems in the region. Private investors are ready to enter and enter only those Far Eastern markets, where economic rent, including foreign trade, is ensured, despite objective increases in the cost of production factors and increased transport costs. These are extractive industries which products are export-oriented. This conclusion is even more relevant to foreign investors. The formation of an effective and economic complex capable of reasonably endogenous development is impossible without the development of other segments of the economic structure and infrastructure. However, diversion of state investments to solve this problem means that it is impossible to provide the necessary (from the point of the main objective) level of social development and the communal environment, the formation of which is possible mainly at the expense of state resources.

The only way out, as shown above, is to create an effective institutional environment that should ensure: 1) stimulation of entrepreneurial and investment activity of the economic agents operating in the region; 2) compensation of factors that are rising in price and services, and a radical decrease in transaction costs for functioning and potential economic agents in the region; 3) unification of institutional regimes in the region and adjacent economies; 4) the state guarantee of maintaining humanitarian, social and communal standards in the region at a level that ensures a quality of life comparable to neighboring countries in the region.

In terms of the scale and sources of investment resources, the best, based on the above review, is the option of large-scale public investment in the development of infrastructure and socio-communal environment — an intensive influx of private exogenous and endogenous investments in the development of the economic structure. This option requires the creation of a stable institutional regime based on inclusive, delocalized institutions.

Currently, in practice, the option “large-scale state investments in the export infrastructure — limited public investment in the economic structure — limited exogenous private investment in export commodity projects — limited public investment in the social environment in the formation of extractive localized institutions.”

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**Injecting Dynamism in the Russian Far East Economy: Can New Institutions Help?**

**Abstract.** The specific institutional features inherent to countries with big shares of natural resource rent and high-risk economies, such as Russia, impose significant constraints on the choice of effective public policy instruments. The attempts to inject dynamism in the Russian Far East economy with the outdated half-a-century old public intervention tools manifest the knowledge problem within the bureaucratic administration, evidenced by very modest outcomes of the measures to hold the regional population and of public investments in the regional infrastructure. Drawing on the experience of countries with the similar structural and institutional specifics, the author makes the case that the regional economic development strategies should not become the means to retain population. It is also shown that improvement in the institutions quality *per se* can boost private investments notwithstanding the quality of public-financed infrastructure, while setting up of special economic zones (SEZ) can generate risks related to non-Pareto optimality situation.

**Keywords:** investments, infrastructure, development program, special economic zones, holding population, institutions, natural resource rent, Russian Far East.

**JEL classification:** H54, O43, Q30, R11, R58.

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The Russian economy has encountered the long-term development constraints of structural origin. The structural deformations are caused by heavy dependence on the natural resource (oil and gas) rent, weak institutions and the resulting high investments risks (The Oxford Handbook..., 2013). Economic projects in such countries are implemented predominantly through the natural resource rent allocation mechanisms within the context of public policy (Ross, 2012; Van Eeghen et al., 2014).

In recent time the Russian Federation (RF) top leadership was actively engaged in solving the social and economic problems of the Russian Far East (RFE). The new federal authority and administrative bodies already established for the Far Eastern region are implementing a range of strategic decisions to create institutional conditions, enabling, as it was declared, to speed up the economic growth, to improve the social and demographic situation, attract and keep the population in the region, upgrade the regional infrastructure and thus to improve the investment climate there.

On the one hand, the RFE economy offers good opportunities for the development on the base of its abundant natural resources and the proximity to the fastest growing (*tigers*) economies of the Asia-Pacific region (APR). So the development prospects of the Far Eastern region are considered as related to creating and supporting favorable conditions and opportunities to fully take advantage of its potential. On the other hand, the structural problems impose major limitations and negatively affect the economic development of the Russian Far East — these include the narrow home market, the dependence on external demand conditions, and the patterns of relationships with the central federal authorities and state-owned corporations.

The RFE ranks the top national positions in the share of the resource mining sector in its economy. Yet, despite this advantage there is the long-term lagging in the development of the regional economy compared to the national economy. In about the past 25 years the national economy had grown by 11.0%, while the RFE economy had reduced by 2.4% in the same period\(^1\). In the first half of 2010s the economic growth increment of the RFE was lower than that of the national economy. In 1992–2015 the Russian Far East experienced the 1.5 million population loss due to outmigration, with this loss equals nearly to the

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\(^1\) Gross regional product (GRP) of the RFE in 2015 as compared to GRP in 1992, in 2015 prices.
quarter of its current population. Moreover, the RFE ranks the second across the country, just after the North Caucasus, by the share of unrequited receipts in its regional budget income, which reflects the role of inter-budget transfers and points out that the region is heavily dependent on the federal budget in meeting its expenses.

So, the new public policies, aimed at supporting the accelerated autonomous economic growth, improving social and demographic situation, boosting infrastructure development and improving the investment climate may seem perfectly reasonable. However, there are solid grounds to suggest, that the new strategic decisions for the RFE currently implemented by the federal authorities do actually copy the widely known special public policies earlier implemented in some countries similar to Russian structural and institutional patterns, and at some point given up by more successful national economies.

1. Increasing public (budget) investments in the infrastructure

The budget investments in the Russian Far East are currently expanding according to several comprehensive development programs, mainly the federal target program “Socio-economic development of the Far East and the Baikal region (up to 2018 and 2025). Given the high oil prices, the federal authorities decided to boost public investments in the region. The Program designers have built it on the assumption that the pressing infrastructure challenges, especially those of transport infrastructure, are getting in the same way as the balanced economic growth of the region. This idea is also evidenced in the officially published documents pertaining to the Program. So it was concluded that the public investing in the regional infrastructure facilities were essential to mitigating risks.

As the foreign experiences show, providing the proper infrastructure that would bring in the entrepreneurs, willing to start businesses, is indeed one of the key challenges confronting the economies with the high share of natural resource rent. With all the functional differences of infrastructure facilities, this line of arguments, as evidenced by the foreign experiences, highlights three core aspects. First, infrastructure investments are rather the results, than the cause of an economic system development: countries with plenty of business companies usually have good infrastructure and government authorities are willing to provide it, given that it is needed for further growth of businesses (Making Public Investment..., 2015). Second, strong institutions substantially reduce general risks of economic activities, and so are the keys to efficient use of infrastructure in the economies with high resource rent (Bhattacharyya, Collier, 2014). Third, the increase of public expenditures would have a significant positive impact on the economies with the predominantly low per capita incomes (Gupta et al., 2014). Or, to put it another way, apart from the institutions, a country’s development level does matter, when the demand for infrastructure on part of business as a result of economic growth significantly exceeds the supply.

While Russia generally falls far behind the leading world economies in terms of infrastructure quality, the Russian economy is characterized by high risks and the average level of per capita income. From this perspective infrastructure projects, publicly funded (through one or another way) from the resource rent redistribution, can have only the limited impact on the economic development. The weaker the general belief that the government is determined to protect investors’ and entrepreneurs’ interests and to impose uniform understandable and executable playing rules, the poorer the private investment flows would be, no matter how high the infrastructure quality is (Van Eeghen et al., 2014).

As the analysis evidenced, in recent years the government has actually increased investments in the RFE from the budget funds. So the diminishing growth rate of the regional economy may seem quite counterintuitive against this background, suggesting that investments in the image-building infrastructure (such as the infrastructure to facilitate the hosting of Asia-Pacific Economic Cooperation (APEC) Summit) have failed to generate the multiplicative effect (i.e. the GRP growth in the Russian Far East has exactly matched the growth in infrastructure investments). Indeed, in 2010–2015 the real average per capita investments
Into the RFE economy nearly doubled the national average figure, and yet the efficiency of investments remained remarkably low. On the average, each RUB1.00 invested in the fixed assets generated only RUB0.06 in GRP increase — about a half as much compared to the national economy as a whole. Massive public investments failed either to substantially reduce risks of investing in the regional economy or to boost its development. Given the high risks the clear-cut investment intentions are seen mainly on the part of the state-owned and public sector affiliated corporations, which gain budget support in the form of benefits and transform regional joint-stock companies into their subsidiaries through acquisitions, often followed by the transfer of assets out of the regional jurisdiction. So, the regional businesses are being replaced with large federal business owners, thus driving further market monopolization. So, the efforts to create proper regional infrastructure aimed at attracting new entrepreneurs motivated to start businesses, have produced more than modest outcomes.

2. Instituting Special Economic Zones (SEZ)

As is decided by the Ministry for the Development of the Russian Far East, favorable conditions for business and investments are to be created for the local residents on the premises of tax benefits and various preferences within the special economic zones (SEZ) (called Priority Development Areas (PDA) and the Free port of Vladivostok) already created in the region. The foreign experience demonstrates, how wide multifunctional SEZs can be interpreted, when applied as the tool of government intervention in economic development.

Numerous studies have addressed the general and specific features, their classification and the resulting impacts of SEZs. By now more than 4,000 SEZs exist in the world with only a few of them proved to be successful (Political priority..., 2015). Instituting SEZ implies heavy capital investments and intense purposeful efforts of government officials, aimed to further support and develop them. Yet SEZ instituting is far from serving a uniform tool when it comes to accelerated development of a national economy in general and a regional one in particular, as this tool is highly specific. Stimulation is one of its primary challenges, since in the context of weak institutions SEZs may lead only to impractical resource allocation and adverse consequences of government officials’ rent-seeking behavior. There are many examples, when SEZs resulted in failures. And these facts are especially true of the economies with weak institutions and high share of resource rent, such as in Russia (Special Economic Zones..., 2008; Farole, Akinci, 2011).

The long-time practice of SEZs helps to identify four distinct purposes for instituting SEZ (Special Economic Zones..., 2008): (1) to attract foreign direct investments (FDI); (2) to remedy high level of unemployment; (3) to support a nation-wide large-scale economic reform; (4) to experiment and field-test cutting edge strategies and approaches towards economic development. However it seems that neither the PDAs, nor the “Free port of Vladivostok” concept were aimed at achieving any of the above goals in any explicit way.

Countries with high political centralization usually encounter the problem of complete information (information problem) (Hayek, 1945), which can be described as follows: government officials vested with sufficient authority and subordination mechanisms to set up SEZs, lack sufficient knowledge on market and society behaviors. And as a result, their decisions on SEZs are usually ill-planed and irrelevant, while the decrease of tax burden within such a SEZ can lead to nothing but inefficient spatial allocation of economic activities thus causing non-Pareto optimality situation. Hence the necessity to delegate decisions on spatial location and specialization of SEZs to private businesses or to elaborate some uniform approach to the matter under political decentralization conditions (Moberg, 2015). Despite the evidence that the private SEZs have proved to be the best practice, SEZs in the Russian Far East are all state.

2 The investment risk index for the Russian Far East (issued by the Russian rating agency “Expert-RA”) is still higher than the national average. It is known, that the risks for the national economy are exceptionally high as compared to some other countries.
The experiences of resource rent-based economies with sustainable institutions show, that such a tool, as SEZ, is applied only in individual cases or is not applied altogether, since the investment climate is favorable on its own. Some resource rent-based economies manage to mitigate investment risks through embedding more advanced institutions, such as those in the developed countries, in their economic practices. However, in the current Russian realities this approach is so far impracticable.

Foreign experiences evidenced, that import tariff cuts enable SEZs to contribute to a country’s exports only if SEZs are integrated in the global value chain through production of intermediate parts and components, which is usually the case for countries with initially available or brought-in cheap and abundant workforce (Siroën, Yücer, 2014). SEZs can also be established in more protectionist and high-risk economies, where such zones are open to foreign firms as a way to overcome high import and institutional barriers. SEZ will give: gain access to the assets and penetrate into the national market. The former case is exemplified by the Chinese SEZs in Africa — these are established and run by the Chinese capital in African resource-abundant economies with excess working population (Farole, Akinci, 2011) (example — Zambia, Ethiopia, Nigeria, Mauritania, Algeria). As a rule, such SEZs are based on the access to mineral deposits followed by raw material exports oriented to the Chinese market. The second case is exemplified by the Russian SEZs in the western part of the country (Göler, Levchenkov, 2010). If SEZs are to involve enormous public investments in infrastructure projects, the patterns requiring huge amounts of resources will almost certainly lead to substantial over-expenditure thereof.

Weak institutions may turn things even worse. Indeed the countries with weak institutions coupled with resource rent-based high-risk economies (Tsagaach, 2016; Woolfrey, 2013) have failed to establish successfully performing SEZs. Too often these SEZs amount to disastrous projects, involving huge public investment in infrastructure facilities, which are unfeasible for further use owing to ill-planned programs, poor management, high costs, long-distance from the markets, lack of institutional coordinations etc. Weak institutions and the substantial role of resource rent in the national economy provide a powerful temptation for the officials to further back SEZs from the budget funds and so to indirectly capture the resource rent (Moberg, 2015). Business firms benefit from investing in SEZs until their additional profits gained due to the special status of a SEZ exceed the expenses on overcoming the administrative barriers.

The idea of overcoming high national and regional business risks is per se understandable, but there arise certain practical challenges. In the Russian Far East the SEZs tend to attract domestic (regional) companies, the later lack better alternative opportunities offered by the national and regional markets, rather than foreign companies, which avoid investing in SEZs given the definitely high economic risks. Each subject of the Far Eastern Federal District started establishing SEZs of its own. There are even cases of redistribution of funds within the RFE’s market segments. It is quite conceivable that without any changes in institutional conditions and visible progress in mitigating risks operation of the Far-Eastern SEZs — along with the above mentioned challenges — may prove to be just another episode of overcoming import barriers in the regional market or otherwise, add to the examples of failed import substitution.

3. Efforts to attract and keep the population

Given the sheer differences in the socio-economic development of the RF regions and attempts to attract small numbers of foreign migrants, the ongoing internal migrations motivate the government to initiate various kinds of programs aimed at attracting and keeping the population. The urge to create and expand local labor markets as well as to attract and keep the population in the Russian Far East is inevitably mentioned in almost each official document concerning the RFE development. Generally this urge is based on creating subsidized workplaces and giving out free one-hectare land plots (the so-called Far Eastern hectare).
To date the countries with sustainable institutions have gained considerable experience in giving out free land to anyone willing to get it for any economic activity. In Canada, for example, with the ongoing population decline, some municipal authorities use to initially prescribe the specific range of economic activities to people applying for free land, such as housing or rigidly defined set of businesses (Nine Canadian towns..., 2015). Note that in Canada the practice of offering up land for free takes place at the level of local authorities’ and is restricted to small territories, rather than being initiated by national and regional profile ministries and authorities.

Foreign experiences (Special Economic Zones..., 2007) also point to the fact that creating and expanding local labor markets with the subsidized enterprises has its distinctive limits. Since the subsidized enterprises usually compete with those unsubsidized, the overall labor market tends to change very little. Economic development strategies, initiated in such countries to prevent economic decline in the regions, should not become the means to retain and keep the local population (Polèse, Shearmur, 2006). Canada’s experience clearly shows that the economic lag of certain regions is likely to become more obvious in the countries, where the national economic geography tends to reflect the prevailing historical relations between the Center and the Periphery. Consequently, the primary goal is dual, and on the one hand, it implies to facilitate transition to the more fitted to the low regional population density economy, and on the other hand — and it is quite obvious — to develop the regional economy so as to raise real per capita incomes and make them comparable to those in more thriving regions of a country and in the other countries as well. Such a strategy will rest upon solidarity and collaboration within the local communities involved.

Yet the relatively high average per capita budget expenditure in the RFE, whereas being twice as high as the national average, cannot prevent population outflow from the region. There is loose correlation between the level of the regional economic development (per capita GRP) and the RFE residents’ real per capita income, and as the latter is lower compared to per capita incomes in some other RF regions, it powerfully inclines the population to move away. The Russian Far East, as well as Russia, entered the final stage of demographic transition. It is likely that the outflow of population from the Eastern, and its turn to the Western part of Russia can be explained by the impartial (for the initial model of economic performance) pursuit to concentrate economic activities in the central agglomeration (Head, Mayer, 2004), as the place where resource rent revenues are distributed.

The structure and institutional specifics of countries with resource rent-based and high-risk economies, such as Russia, put substantial constraints on the efficiency of decisions in the public policy sphere and can be considered as imperative attempts to create new institutions. Therefore the government’s attempts to create the environment-friendly managed businesses in the RFE through the instituting SEZs in the real world can produce new sources of risks, related to non-Pareto optimality situation as a result of implicit subsidizing some market agents at the expense of other market agents. Moreover, the weaker the institutions the poorer the flow of private investments, irrespective of the quality of infrastructure facilities, constructed with public funds.

Foreign countries’ experiences have proved that the regional economic development strategies should not become the means to retain and keep the regional population. Therefore their primary task is, on the one hand, to facilitate transition to the economic model, adjusted to the low population density, and on the other hand, to speed up economic development of the region so as to boost real per capita income and thus to encourage more people to settle in the region. Migration processes in that respect should be treated as one of the indicators of a region’s economic development (as well as that of the national system as a whole), rather than a target figure in policy documents issued for the executive authorities.

The very attempts to speed up the RFE economy with the public intervention tools, borrowed from a half-a-century old practices and the most part already rejected as ineffective, confirm that the bureaucratic administrators have encoun-
tered the information problem, which, in turn, generates adverse development incentives, restrictions and the tendency for the isolation of the region.

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Introduction

Trends in the economic development of the Far East in the 21st century, including the implementation of the largest infrastructure projects for the APEC summit 2012 in Vladivostok, confirm the impossibility of a significant change in the pattern of the region’s development, even on the basis of attracting private investment, without removing historically formed barriers. The latter are weak infrastructure development, high outmigration, paucity and low density of population, high energy tariffs, lack of tax preferences and so on. However, the objective of accelerated and sustained economic growth in the Far Eastern regions is declared foreground and is associated with the independent and effective development of the region capable of generating impulses for the prosperity and growth of Russia’s power in general.

According to the state Program “Strategy of socio-economic development of the Far East and the Baikal region until 2025”, one of the main stimuli for the accelerated growth of the Far Eastern economy is investment accumulation. The program provides estimate of forecast indicators differentiated by some recipients, but it provides no data on the future values of the key economic

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1 See the materials from the Russia’s President official site — http://www.kremlin.ru/events/president/news/16990

indicators of the Federal district, secured by the corresponding investment. However, only future dynamics of the Far Eastern economy will indicate the presence of acceleration (or inertia) in the region development.

The article examines the relationship between capital investment and economic growth in the Far East. Also on the base of investment function, an estimate of the prospective scale of investment sufficient for the accelerated growth of the region is obtained.

**Are investments the key driver of long-term economic growth in the Far East?**

In studies of regional growth and convergence problems, the laws of interregional capital flows are based on the well-known postulates of the neoclassical theory: a) the capital is perfectly mobile across regions and is equally accessible in any of them, b) geographical price differentials of the units of capital goods are only due to transportation costs, c) capital seeks industries and regions with the highest possible rate of return.

In reality, perfect capital mobility and regional equality of unit prices of capital goods are too strong assumptions which is due to a number of factors, among which (Gertler, 1984): 1) ratio of enterprises of different sizes, localized in a certain territory, 2) the shift in investment flows from regions with a potentially high rate of return towards more traditional poles of growth, 3) industrial inertia, linking investment to the already created industrial facilities and retarding the mobility of capital. The criterion for choosing the direction of capital movement is only the rate of return. And that is a strong assumption. When studying the regional distribution of capital it is necessary to take into account the significant impact of such non-economic criteria as geopolitical, geo-economic and social priorities. These criteria are prevailed in the case of the Far East.

An interesting feature of investment in the economy of the Far East, both private and public, is the redistribution of national financial resources in favor of the region. The share of total investment in the economy of the Far East in the 2000s steadily exceeds the share of the region’s contribution to the formation of a national product.

In 2005–2016, the share of the gross added value created in the region averaged 4.7% of the national overall, whereas the share of public investments — 8% (private — 7.6%) (in 2016 capital investments in the Far Eastern Federal District amounted to 903 billion rubles). The dynamics of capital investments in the Far Eastern Federal District in 2005–2016 was positive (an increase of 25.4%), but two different periods can be clearly distinguished. Before 2011 the investments grew at high rates (195% in 2005–2011), but after 2011 there was a sharp decline in investment activity (64% in 2016 against the level of 2011). The main reason was the completion of large infrastructure projects: the construction of the East Siberia – Pacific Ocean oil pipeline, as well as the APEC Summit 2012 infrastructure in Vladivostok.

By the end of the first decade of 21st century the Far East significantly strengthened its specialization in raw materials, which it had in the Soviet Era. Capital investments were made mainly into the mining sector and infrastructure. In 2011 investments in Mining accounted for 20.5%, and in the Transportation and Communications for 47.6% of the total in the region. However, by 2016 the situation had significantly changed. Capital investments in the Transportation and Communications sector in 2011–2016 decreased by 65.8% and accounted for 25.3% of the regional total, while investments in mining increased by 23.3%, with their share increasing up to 39.3%. In the other capital-intensive industries, like manufacturing and the production and distribution of electricity, gas and water, a reduction in investment is observed by 28.6% after 2013 (in 2012 — by 59%).

A dramatic decline in investment after 2011 was accompanied by a stagnation of general economic dynamics. If the growth rate of the total GRP for the Far-Eastern Federal District was

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3 Public investments from the Federal budget in the Far East peaked in 2011, and accounted for 12.3% of the national total.

4 The scale of public investment can be shown by the share of Primorsky Krai in capital investments of the DFO: in 2011 it was 31%, exceeding the level of investment in the Sakhalin Oblast.
135.9% during 2005–2011, it became less than 101% during 2011–2015. Relative stagnation was explained mainly by the catastrophic decline of the value added in the regional construction (by 47.6%), which was not compensated even by an increase in the value added in most of the capital-intensive activities\(^5\) (105.8% in mining, 104.4% in Transportation and Communications, and 104.1% in manufacturing).

The general answer to the headline question can be formulated as follows: regional economic dynamics during the period in concern was largely determined by the capital investment dynamics. This influence can be traced through the following effects: increased investment in mining and infrastructure followed by the growth in construction and increase in the total GRP of the region in the short run (Minakir, 2017b, p. 53). In other words, the major investment had an effect in the short run, while the construction of public goods and mining and transportation infrastructure was under way. On the other hand, investments in sectors with long-term multiplier effects on economic growth (like manufacturing) had little effect on the overall dynamics of total GRP in the region. Thereby, the current industrial structure of investment imposes a restriction on the long-run multiplier effect.

Let us consider how this structural feature is reflected in the quantitative relationship between investment and the GRP production for the Far East.

**Theory and Empirical Estimation**

For the analysis of investment behavior in the Far East we will use well-known flexible accelerator model. Let the desired capital stock \(K^*\) of the firm be proportional to the expected output level \(Y\):

\[
K^* = \alpha Y, \quad (1)
\]

where \(\alpha\) — proportionality coefficient with an assumption of the constant optimal \(K/Y\) in time.

Achieving the desired level of capital stock during one production period is the exception rather than the rule. It is only possible to approach it at a certain speed \(\gamma\). Then investment \(I\) is determined (assuming no depreciation) as:

\[
I_t = \sum_y (K^*_{t-y} - K_{t-y}) = \alpha \sum_y (\Delta Y_{t-y}), \quad (2)
\]

where \(\Delta Y\) is the output change. Equation (2) can be interpreted as the influence of lagged output on the current investment. The actual level of investment leaves the gap to the desired level of capital stock.

D. Jorgenson (Jorgenson, 1967) proposed a neoclassical investment model in which the firm maximizes the present value of its future revenue flow. The optimal investment behavior for the profit-maximizing firm will be the adjustment of the capital stock in each period, which remains on the optimal trajectory of capital services, even when the rate of return on capital changes. Jorgenson also demonstrated that the model of a flexible accelerator is a special case of the neoclassical model of investment (Ghali, Renaud, 1971).

Gross regional product (GRP), presented as a function of the lagged investment, can give estimates of the investment multiplier. The magnitude of multiplicative effects provides not only information about the scale of the impact of investment on economic growth, but also on the duration of such an impact (taking into account the inevitable presence of a lag between the inflows of investments and obtaining the desired result in terms of expected output). The estimation of the investment multiplier assumes the use of a distributed lag model:

\[
y_t = a + b_0 x_t + b_1 x_{t-1} + b_2 x_{t-2} + …, \quad (3)
\]

where \(y\) is GRP, \(x_t\) — investment in the period \(t\), \(a\) and \(b\) are estimated coefficients.

This model is based on the assumption that the influence of the factor variables \(x\) on \(y\) is not limited in time (the time lag does not have prescribed limits, \(t \to \infty\)). The value of the short-term multiplier \(b_0\) shows the change in the average GRP with a unit increment in the current (non-lagged) investment. The sum \(\sum_{i=0}^{\infty} b_i\) is a long-term multiplier showing the change in GRP with a unit increment of all the investment at each point of the interval in concern.

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\(^5\) Wholesale and retail trade sector which has a significant share in the total GRP of the Far Eastern Federal District (11% in 2015), but showed low investment capacity, and even slowed down during 2011–2015.
The estimates of the short-term and long-term multipliers are obtained by Koyck transformation of the equation (3), with the assumption that the impact of investment on GRP is decreasing in geometric progression for lagged values of the former:

$$b_i = b_0 \lambda^i, \quad i = 0, \ldots, \infty,$$

(4)

where $0 < \lambda < 1$ is the rate of reduction of investment influence on GRP as the time lag increases. Substituting $b_i$ into (3), we obtain:

$$y_t = a + b_0 x_t + b_0 \lambda x_{t-1} + b_0 \lambda^2 x_{t-2} + \ldots.$$  

(5)

Multiplying (5) for $y_{t-1}$ (all variables lagged for one period) with $\lambda$ and subtracting from the above equation yields autoregression model:

$$y_t = a (1-\lambda) + b_0 x_t + \lambda y_{t-1}.$$  

(6)

The coefficients of (6) are estimated on the basis of the generalized least squares (Zaretskaya, Osinevich, 2010) ($b_0 = 0.46$, $a = 1770522$, $\lambda = 0.76$), which allowed to calculate the coefficients of (3).

Application of the Koyck transformation to model (3) allowed obtaining the following expression using comparable data on the Far Eastern Federal District for 2000–2015 (with 2015 as base year):

$$y_t = 1770522 + 0.46 x_t + 0.35 x_{t-1} + 0.26 x_{t-2} + 0.20 x_{t-3} + 0.15 x_{t-4} + 0.12 x_{t-5} + 0.09 x_{t-6} + 0.07 x_{t-7} + 0.05 x_{t-8} + 0.03 x_{t-9} + 0.02 x_{t-10} + 0.01 x_{t-11}.$$  

(7)

The value of the long-term multiplier is defined as

$$\sum b_i = b_0 + b_0 \lambda + b_0 \lambda^2 + \ldots = \frac{b_0}{1-\lambda}.$$  

(8)

The short-term multiplier, which equals to 0.46, shows that each ruble invested in the current year provides an increase in GRP of the region by 0.46 rubles in the same year. The long-term multiplier (1.91) shows that each ruble invested in the current year will ultimately provide growth of the region’s GRP by 1.91 rubles in the long run. In terms of growth rates, 1% increase of investment in the current year will provide GRP growth by 0.09% in the same year and 0.35% in the long run.

Long-term and short-term multipliers make it possible to obtain estimates of the parameters $k_i$ characterizing the scale of the influence of investments on the GRP dynamics:

$$k_i = \frac{b_i}{\sum b_i}.$$  

(9)

According to (9) for the Far Eastern region only 18.2% of long-term impact of current investment is obtained, 13.8% in the following year, 10.5% in the third year and so on (Fig. 1). Thus, more than 50% of the long-term investment impact is obtained within the first five years.

As we see from the figure the effect of the multiplier decays annually at a high speed. This means that investment reduction initially results in a stagnation of economic growth (as it does after 2011), and inevitably threatens to reduce the production of GRP in the middle run.

The prolongation of the 2013–2016 investment dynamics, namely the preservation of the average annual rate of investment decline at the level of 4%, will lead to the GRP level of 79.4% by 2025 as compared to 2013 (instead of 180% as is assumed by the region’s development plans).

Investment multipliers allow estimating the amount of investment resources necessary to fulfill the intentions of the state Program «Strategy of socio-economic development of the Far East and the Baikal region until 2025».

According to the Program, in order to create conditions for accelerated development of the Far East, it is required that the average annual growth rate of the aggregate GRP of the Far East exceed the national by 1.5%. In other words, based on the national «Forecast-2030», the average annual growth rate in the region should be 105–107%.

Calculations show that, in order to maintain mentioned growth rates, it will require maintaining the investment/GRP ratio at a level of at least 40% by 2020 and about 48% by 2025. Over the period 2005–2015 in the Far East, a similar rate of capital accumulation was observed only in 2011 (41.9%), which was the peak year of infrastructure
investments. After that the investment-output ratio was steadily declining and in 2014–2015 it was only 25%. Such a ratio is typical for many developed countries with high efficiency of capital use and completely different economic structure, and it is insufficient for accelerated growth of the developing economy. The prospects of both changing the structure of the regional economy and increasing the efficiency of its capital use are unobvious. Indeed, in 2005–2013 investments in machines and equipment in the Far East increased by 65%, but in 2014–2015 they experienced decline by 18%, and their share in the total investment does not exceed 40%. Considering that a significant part of these sums to the capital replacement, the prospects of radical technological renewal and increasing the efficiency are very remote.

**Conclusion**

After 2011 the inflow of investments into the Far East declined considerably and the rates of economic growth slowed down, despite the positive dynamics in some capital-intensive sectors. Such a picture is weakly linked to the objective of accelerated growth of the region in the medium and long run. The long-term investment multiplier estimated by the authors indicates that for current structure of the regional economy, its accelerated growth require intensive and annually-increasing investment inflow, not typical even for the period of accelerated industrialization of the 1930s. Accordingly the region again needs redistribution of national resources in favor of the Far East. Reducing the rate of investment (or at least maintaining it at the level of recent years) will inevitably lead not only to the economic stagnation, but to decrease of the output produced by the region in the medium run.

Of course these arguments are valid provided the current structure of investment is preserved, which is objectively conditioned by the economic specialization of the Far East. To increase the long-term return on investment (or, equivalently, to increase the long-term investment multiplier), not only quantitative but also qualitative changes in the investment structure are required. Not just an increase of the investment share in manufacturing and creation of the new industries, but new launching mechanisms for local generation of production chains and incomes. Not just infrastructural investment, but producing the public goods which improve the quality of life. But this process is also associated with a large-scale reallocation of national resources in favor of the region.

Up to now the model of accelerated economic growth of the Far East had to fill up the region with budget resources, which was obviously impossible for a long period, especially after the 2009 and 2014 financial crises that worsened the macroeconomic situation and significantly reduced the revenue of the Federal budget. Besides, large-scale system-integrating infrastructure projects are required for massive public investments. Such projects are currently being implemented in the other regions of the country and require redistribution of national financial resources not in favor of the Far East.

Estimates of necessary investment growth rates for the accelerated growth of the Far East economy made in the present paper, of course use the existing industrial structure of investment, and therefore the high share of state participation. However it is obvious that to improve the efficiency of the region’s economy, — its structural transformation is needed. But the region’s specialization and prevailing demand structure (primarily extra-regional) are the main limitations. The latter cannot be withdrawn simply by locating the new production enterprises. Here a lot of factors takes place, most of which are hardly manageable or uncontrollable at all (for example, the place of the Russian Far East in the current system of labor division and trade flows in Northeast Asia).

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6 Estimates by Melnikova (Melnikova 2010) demonstrate that during the period 2001–2007 the average investment-output ratio in the Far Eastern Federal District was the highest among all the Federal districts (50.6%).

7 As well as the level of development of the region’s public goods and business environment (Minakir, 2017a).

8 Recognition of the above mentioned problems led to a change of focus points in the Far East development policy after 2013. While keeping the trend of export infrastructure development, an institutional innovation was introduced (in the form of Territories of Advanced Development, the Free Port Vladivostok), designed to motivate the inflow of private capital (both foreign and domestic) and labor force into the region (Minakir, 2017a).
Without fulfilling all these conditions, the objective of accelerating the development of the Far East will be reduced to a permanent increase of national financial resources in the region. The launch of endogenous growth mechanisms (which is equivalent to increasing the long-term effects of regional investments) is a structural transformation of the economy that will allow the region to become part of the institutional and economic cooperation in Northeast Asia, thus acquiring a competitive advantage in the national economy.

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Social Development in the Far East: Patronizing or Survival

Abstract. The national concept of accelerated development of the Far East declares the consolidation of population and the growth of human capital through the provision of attractive conditions and high living standards in the region. Together with the state investment into large pretentious projects in social sphere, the decrease of state support to public utilities sector in the region continues. Based on the comparative analysis of state and population expenses on public utilities, the author shows real consequences of changing the parameters of “communal patronizing” for the Far Eastern households’ budgets. The author concludes that decreasing the level of state patronizing of the public utilities sector forms a negative vector of migration mobility. At the same time ignoring the results of unified communal policy, which leads to the destruction of system of state patronizing the social sphere in the region, and contradicts the spatially oriented socio-economic policy in the Russian East.

Keywords: housing and utilities, expenses on public utilities, household budgets, budgets of Russian Federal subjects, state patronizing, Far East.

JEL Classification: D1, G18, H53, H76.

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Foreword

The task of consolidating the population has been considered a special part of the general national concept of “accelerated development of the Far East” for the past twenty years. It’s related to the concerns of the regional and federal authorities on dramatic decrease of population in the region (it has decreased from 8.1 million to 6.2 million people at present compared in the beginning of 1992). The reason for this is mass migration of population caused by de-industrialization, virtual elimination of priority status of the region, decrease in comparative level of income and
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Essential restructuring of political environment (Minakir, 2006).

These processes have caused the concerns about the “demographic vacuum” in the Far East with unpredictable geopolitical consequences back in the mid-1990s. In 2000s the migration outflow has significantly decreased but still it continues. This is why many programs and declarations repeatedly mention the task of consolidating the population and changing the direction of migration mobility.

The formation of population in the Far East during the Soviet period relied mostly on external sources (interregional migration) which efficiency was low (9 people leaving the region per 10 people entering) but constantly positive. After 1992 the interregional migration has steadily become negative. The income and quality of life aren’t the only factors that define migration processes but they have significant impact.

The present article studies one of the most sensitive segments of the households — comparative level of expenses on public utilities. This sphere always had a system of state patronizing, which means the state financed the major part of expenses on maintaining of housing and public utilities (from the federal and regional budgets). The reform of housing and public utilities from 1997 to the present day has significantly modified the ratio of these obligations for both the state and the households. The main part of expenses is de facto the households’ responsibility. The results of such modification are differentiated by region, which significantly changes the comparative level of disposable income in the regions.

The declared priority of Far Eastern development as an entity and solving the task of population consolidation and attraction of should be theoretically reflected in the described sphere as an increased level of state patronizing over Far Eastern population. The author studies the real consequences of changing the parameters of “public patronizing” the Far Easterners’ budgets.

1. Regional social development: the role of patronizing

Provision of priority social environment in the region, especially in the region with marginal living and economic conditions, is possible thanks to state supporting the social standards in key components of the level and quality of life. Such standards are the “measure of worthiness” of social sphere functioning (Rubinshtein, 2009); they support certain parameters (norms) of the level and quality of life, optimal conditions for reproduction and comfortable living in the region.

Social standards did not take root in Russian political, financial, and economic sphere as a universal institution that regulates social development because they are “…extremely difficult to measure and still harder to tie to the mechanism of responsibility for their accomplishment” (Rubinshtein, 2009; Musgrave, 1959). Eventually these social standards have transformed into quasi-guarantees. At the same time, there was no noticeable regional differentiation of these quasi-guarantees while the unified policy of “optimization”, which manifested as a transfer of state resources to the large (federal and regional) objects of social significance, led to actual violations of social guarantees in certain regions. Such violations affected the Far East where low-capacity kindergartens, schools, and hospitals were eliminated en masse, libraries, culture and sport facilities were left to fend for themselves, especially in the small and removed settlements. As a result, the Far Easterners lost traditionally higher (compared to the country’s average) levels of accommodation of social infrastructure objects. Together with the loss of high income advantage — all these


2 The higher levels of accommodation were caused by low population density, objective remoteness of the settlements, less developed road structure and low transport availability and relatively higher population employment in mining industries with harmful or difficult working conditions. That is why the considerable part of population live in Extreme (Far) North and similar regions with extreme natural and climatic conditions.
objects have considerably lowered the attraction of the region and amplified the outflow of population into more auspicious Southern and Central parts of the country. The remaining population entered the survival period (Motrich, Naiden, 2015).

During the last ten years thanks to the declaration of priority of economic and social development of the Far East the state investment into large social projects in the region was increasing. However, this increase was not accompanied by the resurrection of standards of diversified social infrastructure development and of increase in its availability in the conditions of low population density. At the same time, the increasing deficit of state resources explains the problem of substituting the lack of investments with the lack of means to running the social objects. In these conditions, the most popular way to avoid the “deficiency trap” is mass introduction of tools for “transfer” of financing the social objects and systems to the regions themselves and households as their main consumers.

The prolonged and complex experiments of social sphere, while overcoming crises temporarily, could not significantly change the situation and became a strategy of survival. These experiments called for refusal of direct state management and financing of housing and public utilities through denationalization of property, demonopolization of public sphere, transfer of managing functions to the municipal level, allowing enterprises be self-sufficient thanks to full compensation of services by the population together with social protection of low-income groups.

General issues described above are characteristic to such an important subsystem of regional social sphere as public utilities. This takes into account the high capital intensity and high share of expenses on its functioning in the volume of financial and economic expenses in the social sphere. The ratio of state patronizing and consumers’ expenses defines the reliability of this subsystem functioning and the quality of services it provides, which is connected to the quality of life in the region, but also the level of financial burden on the consumers’ budgets, i.e. the comparative level disposable income.

2. Public utilities: is patronizing real?

A certain level of state support of population expenses on the public utilities is explained by the fact that not only are they the “standard” public goods (Samuelson, 1954), but also the products of local natural monopolies that generate external effects and information asymmetry for the consumer (Fomin, Khanin, 2009). At the same time, they have high social utility, “true” (socially useful) needs that differ from individual preferences (Naiden, 2011). High level of social usefulness of public utilities results in not only creation of quality environment that attracts population but also positively affects the entrepreneurial development, and in growth of economic potential of the region. The collective interest requires social patronizing of the state to create conditions to direct the consumers and providers’ behavior to rational choice.

At the same time, high deterioration of fixed assets, continuous growth of expenses and high capital intensity make housing and public utilities an unattractive sphere to attract private investment. State investments are limited by the budgets. After constant savings on capital investments, the provision of public utilities entered a real system crisis (Fomin, 2015). Still, it remains attractive enough to receive increased rent thanks to the imperfect system of tariff regulation and lack of relation between tariffs and the quality of services provided (Aizinova, 2014; Semikashev, Voronina, Nekrasov, 2012).

For the last twenty years the tariffs on housing and public utilities in Russia have increased 80 times (the prices on consumer goods and services increased 20 times), in the Far East this number is 56 times (18 times — for consumer goods and services). The real income of the population increased only 3.2 times. The growth of real income cannot compensate the growing tariffs on housing and public utilities.

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3 For example, education complex — Far Eastern Federal University in the Russky Island (Vladivostok, Primorsky Krai), Perinatal center and Federal center for cardiovascular surgery (Khabarovsk, Khabarovsk Krai), sport complex — “Erophei” arena (Khabarovsk, Khabarovsk Krai).
Since 1997, the norm of “maximum permissible share of citizens’ personal expenses on the housing and public utilities” has created\(^4\), and the population expenses increased two times on average in the Far East, their share in households’ expenses is now 12.5%, the largest among all federal districts. The primary goal of the public reform – the distribution of the housing and public utilities financial burden from the regional budgets to the households’ budgets – has been accomplished. In 1997–2016 the share of expenses on maintaining and developing the public sector of economy from the consolidated budgets of Russian federal subjects in total budget expenses has decreased from 25.7 to 9%, in the Far East – from 23.6 to 14.8%. This was reflected in the level of public patronizing.

In 1997 the ratio of state and population expenses on housing and public utilities in Russia was 58.7% and 41.3% respectively. In 2016 this ratio was 19.3% and 80.7% respectively (Fig. 1).

In the Far East the decrease of state patronizing happened slower. The parity of state and population contributions was achieved in 2001 in Russia and in 2003 in the Far East. The ratio of state and population expenses changed from 59.9 and 40.1% in 1997 to 35.9 and 64.1% in 2016 (Fig. 2). Thus the case of state support in the region appears to be more favorable than in Russia as a whole. But on closer examination this advantage is devalued.

In 2016 the share of population expenses on housing and public utilities in southern\(^5\) subjects of the Far East comprised 83.4%, while in the northern regions\(^6\), which have to maintain higher level of state patronizing due to higher tariffs and high price of fixed assets of housing and utilities,— 44.9%.

Higher level of budget patronizing in the Far East compared to the country’s average (35.9% in the region against 19.3% in Russia) is devalued by higher share of population expenses in the

\[\text{Fig. 1} \]

*The share of population and state expenses on housing and public utilities in Russia, %*

*Source: author’s calculations on Rosstat data.*

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\(^4\) On the reform of housing and public utilities in the Russian Federation: Decree of the President of Russia of 28 April 1997 No. 425.

\(^5\) The southern subjects considered here are Primorsky and Khabarovsk Krai, Amur Oblast, Jewish Autonomous Oblast.

\(^6\) The northern subjects considered here are Sakha Republic, Kamchatka Krai, Magadan Oblast, Sakhalin Oblast, Chukotka Autonomous Okrug.
south (83.4 against 80.7% respectively). The south of the Far East concentrates the main part of population (68.3%), which means the comparative level of income and expenses — one of the factors of migration mobility — is formed over there. The well-meaning intentions to create a potential of population attraction thanks to lowering the level of alternative income of the Far Easterners remain the intentions at least in the public utilities sector of the households.

Apart from creating the difference of potentials in household income to change the direction of migration to the Far East, one of the main elements of priority regional economic development policy is building up the contributions to human capital (The Synthesis, 2011). This way the “accomplishments” of the public utilities reform, which called for the minimization of state patronizing, contradicts the general policy of regional development.

According to theory, the act of spending budget means is the state making market transaction of tax income on social utilities, providing the necessary vector of social and economic progress. In that case, the break-even for the public sector of economy is achieved when the producers’ expenses are covered by individual payments of the consumers and budget assignations (Rubinshtein, 2015). The latter are seen “not as donations of a patron, but as social investment into human capital” (Rubinshtein, 2008, p. 49–52). The urge to decrease the level of budget patronizing as much as possible is seen from that point of view it as an intention to avoid contributing to human capital, which contradicts the declared priority of economic and demographic regional development.

The Far East has developed in conditions of massive state patronizing for decades. The general conditions of economic and social system of the region have not changed by this day. The Far East still requires state patronizing in financial, economic, and social spheres. The accepted and implemented policy of priority development of this region that pursues not only regional but strategic geopolitical and geo-economic goals of the country will not be successful without maintaining a certain level of such patronizing in the future.

From this point of view the social development, this is not limited to migration issues, but includes them as an essential component. It is the most important sphere that requires maintaining and perfecting the mechanisms and forms of state

![Fig. 2](image)

*Fig. 2*

The share of population and state expenses on housing and public utilities in the Far East, %

*Source: calculations made by the author using Rosstat data*
guardianship. The attempts to ignore the results of the unified public policy that leads to elimination of state patronizing in the social sphere contradict the spatially oriented and socially economic policy in the East of the country.

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**Economic Integration in East Asia: Challenges for the Russian Far East**

**Abstract.** With its territorial proximity to Asia-Pacific region in general and particularly to East Asia the Russian Far East has historically oriented its foreign economic relations towards the regional countries. These countries currently enjoy high GDP growth rates as well as the increasing trade and investment flows proving to be one of the modern world politics centers. Also the economic integration processes are currently on a vibrant track in the region. Meanwhile the Russian Far East can develop the economic cooperation with its regional partners only on the subnational level, since deciding on free trade area agreements and other forms of economic integration is obviously the federal government’s prerogative. However the declared pivot to the East in Russia’s foreign economic policy has not yet happened. And thus Russia’s long-term presence in the region has yielded quite modest outcomes, limited to joining the Asia-Pacific Economic Cooperation (APEC) and free trade agreement between the Eurasian Economic Union (EAEU) and Vietnam. As for Russia’s role in the integration processes, it is worth noting that seeking for more FTAs should not be considered as the end in itself, since until Russian business companies are integrated in the global production networks, and straightforward elimination of customs duties can boost trade flows albeit reinforce the current role of the RF and its Far East as the regional natural resources supplier.

**Keywords:** international economic integration, free trade area (FTA), Asia-Pacific region (APR), East Asia, Northeast Asia (NEA), Russia, Russian Far East (RFE).

**JEL Classification:** F 53, F55, F63.

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1. **Introduction**

The Russian Far East (RFE) comprises nine subjects¹ of the Russian Federation and accounts for 36.0% of the national territory (approx. 2.4 million square miles)². However the RFE resident population amounts to only 4.2% of the Russian Federation (RF) population³ (6.2 million⁴). The low population density coupled with poorly developed territory take their toll on the economic role of the region — it will suffice to say, that in 2016 the Russian Far East accounted for only 6.5% of the national exports and 3.2% of the imports⁵.

Due to its territorial proximity to Asia-Pacific region in general and East Asia⁶ in particular, the RFE is conditioned to orient its external economic links towards the neighbor regional countries. Those countries currently enjoy high GDP growth rates as well as the increasing trade and investment flows and prove to be one of the contemporary world politics centers. Also the international economic integration (IEI) processes are currently on a vibrant track in the region.

Meanwhile the Far Eastern region can develop the economic cooperation with its regional partners only on the subnational level, as deciding on free trade zone agreements (FTA) and the other forms of economic integration is obviously the federal government’s prerogative. However the declared pivot to the East in Russia’s foreign economic policy has not yet occurred, and thus

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¹ Namely, Sakha (Yakutia) Republic, Kamchatka Krai, Primorsky Krai, Khabarovsk Krai, Amur Oblast, Magadan Oblast, Sakhalin Oblast, Jewish Autonomous Oblast and Chukotka Autonomous District.
² According to the FSGS RF (Federal State Statistics Service) data.
³ According to the FSGS RF data.
⁴ As of 01.01.2016.
⁵ As estimated based on the FSGS RF data.
⁶ For the purpose of the paper East Asia is meant to embrace ASEAN+3 countries (namely, Japan, the Republic of Korea, China, Indonesia, the Philippines, Thailand, Brunei (Darussalam), Singapore, Vietnam, Lao PDR, Myanmar, Malaysia and Cambodia).
Russia’s long-term presence in the region has yielded quite modest outcomes, limited to joining the APEC\(^7\) and FTA agreement between EAEU\(^8\) and Vietnam (Dyomina, 2017). Moreover, Russia as a whole and the Russian Far East in particular still face several challenges (integrational and geo-strategic; resource-related, infrastructure-related, motivational and competitive)\(^9\), emerged as a result of 25 years-long cooperative game.

2. Economic integration in East Asia: copying the European experience, the “noodle bowl” phenomenon and the political discord

The East Asian countries in contrast to Russia are actively involved in the multilateral economic cooperation, arranged in various formats (ASEAN, ASEAN+1\(^10\), Trans-Pacific Partnership (TPP), APEC). As elsewhere in the world the said formats have undergone some transformation: integration blocks have grown both in scale and in depth (Lee, Shin, 2005; Crawford, Fiorentino, 2005; Kawai, Wignaraja, 2009; Baldwin, Jaimovich, 2010; Kostyunina, 2011; Tselishev, 2012; Dyomina, 2017).

The researchers and the society as a unity use to consider the international economic integration as a positive development, although the drawbacks of international economic integration (IEI) were highlighted as early as in the papers of the founders of the regional economic integration theory (Viner, 1950; Meade, 1955; Lipsey, 1957; Balassa, 1961). The effects, obtained through union creation, can never get distributed evenly neither among all the IEI participants, nor across all its stages.

Moreover, one should also keep an eye on how an economic integration process impacts the countries of an integration group in terms of economic growth and the convergence (or divergence) in their economic development levels. With that, some studies (Venables, 2003; Kawai, Wignaraja, 2009; Ushkalova, Golovnin, 2011; Kostyunina, 2011; Gurova, 2014) suggest that associations of the “South – South”-type (between the developing countries) do not contribute to the economic growth; as opposed to the “North – North”-type associations (between the developed countries), which can enhance economic growth, although the examples thereof are scarce. And the associations of the “North – South”-type (between developed and developing economies) usually induce economic growth of the southern partners. It is also noted that when developed countries embark on economic integration, their economic development levels (per capita incomes) tend to converge, while the similar associations of developing countries produce differing outcomes, although a divergence in their economic development levels tends to be a more frequent result, than a convergence.

On the other hand, when growing in scale, the integration associations tend to gradually divide into the northern- and southern-type participants. The explanation may be as following: the scale of integration associations usually grow through bringing in the countries with inferior levels of socio-economic development, than those of the initial member economies. ASEAN, for instance, had only five states\(^11\) by the date of its creation (1967, August 8\(^{th}\)), while by now its membership has expanded to 10 states\(^12\), which can be divided into ASEAN-6 and ASEAN-4 (Shopina, 2008; Dyomina, 2015). The European Union has also become differentiated by the level of economic development into EU-15 and EU-13.

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\(^{7}\) At present APEC is a forum, comprising 21 countries, or the most economies of the Pacific Rim, including: Japan, Indonesia, the Republic of Korea, the Philippines, Thailand, Taiwan, Hong Kong, China, Papua New Guinea, Russia, Australia, Chile, Peru, USA, Brunei (Darussalam), New Zealand, Singapore, Vietnam, Malaysia, Canada and Mexico.

\(^{8}\) At present the Eurasian Economic Union includes Russia, Kazakhstan, Belarus, Armenia and Kyrgyzstan.

\(^{9}\) For more detail see (Economic Cooperation..., 2007).

\(^{10}\) Comprehensive Economic Partnership agreements are established between ASEAN and China, ASEAN and Japan and ASEAN and the Republic of Korea.

\(^{11}\) Indonesia, Malaysia, the Philippines, Singapore and Thailand.

\(^{12}\) Brunei (Darussalam) joined ASEAN in 1984, Vietnam — in 1995; Lao PDR and Myanmar — in 1997 and Cambodia — in 1999. The latter four ASEAN members are the less developed as compared to the other six member countries.
Among all the existent regional blocks ASEAN has proven itself to be the association with the deepest possible degree of integration\(^\text{13}\). However it seems that the goal to create the single market for ASEAN-6\(^\text{14}\) by 2016, January, 1, has not yet been achieved, although the leaders of member countries had officially reported on fulfilling all their plans. On top of all this the shares of intra-regional trade and foreign direct investments (FDI) within ASEAN member states still do not exceed 25\%\(^\text{15}\), pointing to the relatively weak interdependence of their economies.

As the ASEAN Charter states, integration would evolve along the lines similar to IEI within the European Union. However the very notion to directly implement the relevant European experience seems quite questionable. East Asian countries, to begin with, are too heterogeneous in terms of their economies’ sizes, levels of economic development, democratic practices, living standards etc., to fit with the European integration model (that is, the linear model with consecutive and gradual changes) (Berkofsky, 2005). Second, the contemporary economic and political realities differ profoundly from those existent in 1950s (Plummer, 2006; Kostyunina, 2015).

Moreover, along with customs duties elimination the current FTA encompass also a wide range of issues, such as elimination of non-tariff barriers, promotion of investments, service trade, environmental protection, security matters, intellectual property issues, cross-border movement of labor force, to mention but a few. So most present blocks are not inclined to transfer from FTA to further IEI stages.

Along with in scope and in-depth growth of integration associations, the active engagement of East Asian countries in economic integration processes is featured by negotiation of numerous overlapping FTAs, for the most part, bilateral ones. This phenomenon is well known in the economic literature as the “noodle bowl”\(^\text{16}\). Japan, for example, had signed seven bilateral agreements with associate members\(^\text{17}\) at earlier dates, but after Japan signed the Comprehensive Economic Partnership agreement with ASEAN, those agreements still remained in effect.

While there is no uniform trade or investment agreement between all of the 13 regional countries, they develop integration based on ASEAN+1 pattern. The economic, political and cultural differences and especially discords between the Big Three states (the Republic of Korea, China and Japan) have been the major obstacle to negotiating the uniform agreement. Negotiations on three-party FTA started in 2013, but still prove to be unsuccessful\(^\text{18}\). On the other hand, the agreement on regulations and protection of mutual investments, which was signed by the Big Three and came into effect in 2014, allows for some positive expectations (Lukin, 2016).

In general, a multilateral agreement on free trade of goods and services or on cross-border movement of capital and labor force involving all the regional countries is still considered to be only a long-term goal. Yet, Russia should play a role in elaborating integration game rules and patterns in order to prevent marginalizing itself from the regional multilateral economic cooperation. By now Russia in fact does not participate in any format of the regional economic integration remaining solely a foreign trade and investment partner for ASEAN and North-East Asian countries. The only FTA is signed with Vietnam, which is not the

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\(^{13}\) The decision to deepen economic integration among ASEAN member states was adopted in 2003. In 2007 the ASEAN Charter was signed, stipulating to further develop ASEAN as the three communities – political, economic and socio-cultural communities. Within the joint economic community four freedoms are to be achieved, namely, the freedoms of goods, services, capital and labor movement.

\(^{14}\) Indonesia, Malaysia, the Philippines, Brunei (Darussalam), Singapore and Thailand.


\(^{16}\) See, for example, (Kawai, Wignaraja, 2009).

\(^{17}\) According to WTO Regional Trade Agreements Database (See http://rtais.wto.org/UI/PublicSearchByMemberResult.aspx?MemberCode=392&lang=1&redirect=1).

\(^{18}\) So far ten rounds of negotiations have been conducted and the issues addressed include streamlining of customs procedures, sanitary standards, intellectual property rights and e-commerce.
key trade partner for the RF in general and the Russian Far East in particular, meaning that the resulting customs duties elimination would lead to the positive, albeit minor effect (Kheifets, 2016; Izotov, 2013).

Russia can get more substantial effects (in terms of trade and overall prosperity) through increasing the number of its partners. There are estimates, for example (Izotov, 2016), that through the full mutual elimination of import duties with the Trans-Pacific Partnership (TPP), the Regional Comprehensive Economic Partnership (RCEP) 19 and the APEC countries Russia can exert the trade-creation effect exceeding that of trade diversion, which demonstrates the potential effectiveness of signing FTA agreements. Due to foreign trade liberalization with these blocks Russia will get the prosperity effect amounting to $3.43 billion in case of FTA with the APEC countries; and $2.82 billion in case of FTA with TPP; and $1.83 — with RCEP countries (Izotov, 2016).

### 3. The regional stance of the Russian Far East: desired and actual terms

The APR countries in general and those of East Asia in particular, play a significant but not the key role for Russia (Klein, 2014; Dyomina, 2017). However, as mentioned above, due to its geographical position the RFE has historically oriented its foreign economic links towards the neighbor regional countries. So NEA countries have traditionally been the key foreign economic partners for the Far Eastern Federal District (FEFD) (China, Japan and the Republic of Korea playing the leading role, while Mongolia and DPRK play quite insignificant roles as the partners).

In 2013–2016 five NEA countries accounted on the average for 79.1% of FEFD’s aggregate exports and 67.0% of its aggregate imports 20. The monetary value of RFE’s foreign trade with NEA countries has reduced as a result of dramatic devaluation of ruble exchange rate (Table).

<table>
<thead>
<tr>
<th>Foreign trade flows</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exports</td>
<td>82.3</td>
<td>80.9</td>
<td>80.3</td>
<td>72.7</td>
</tr>
<tr>
<td>Imports</td>
<td>73.3</td>
<td>72.6</td>
<td>64.2</td>
<td>57.8</td>
</tr>
</tbody>
</table>

Source: the author’s calculations based on the RF Federal Customs Service data.

NEA countries as the foreign investors in the RFE economy play less significant role as compared to their role in the foreign trade of the region. In 1995–2002 the sub-regional countries on the average accounted for 20.4% of aggregate foreign investments in the economy of the RFE 21. In the following years the share of NEA countries grew due to the “Sakhalin-1” and “Sakhalin-2” projects (with Japan as the investor).

With the economic and geographical position of the Russian Far East, one can hardly conceive its future development without enhancing trade and investment relations with the APR countries in general and NEA countries in particular. Several federal programs and strategies (for example, “Strategy of Socio-Economic Development of the Far East and the Baikal Region to 2025”) are also supposed to boost the socio-economic growth of the FEFD based on the use of its natural resources and throughways in exchange for financial resources and technologies of the partnering countries. With that such programs and some scientific studies (Usoltsev, 2011) usually involve wishful, but unrealistic goals.

Establishing the standard East to West route through leveraging the performance potential of the Far Eastern regional transport complex is undoubtedly the noble goal, which promises lots of economic and political benefits for both the RFE and Russia at large. However, the current condition of the regional transport infrastructure is far beyond the program expectations and is in the acute need of massive investments. With that

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19 RCEP is still under negotiation and is planned to include 16 states (10 ASEAN members plus Japan, China, the Republic of Korea, India, Australia and the New Zealand).

20 As calculated by the author based on the RF Federal Customs Service data.

21 Calculated by the author based on (Devaeva, 2004).
federal authorities tend to suppose, that foreign companies or Russia’s transnational corporations would be willing to become such investors. One should also take into account that China is actively pushing on with The Belt and Road Initiative, given that it runs counter to the Russian authorities’ plans.

The tourist infrastructure of the FEFD is also undeveloped and needs to be heavily invested in. The international tourism (predominantly from China) has grown significantly after 2014, while not as a result of the increased attractiveness of the regional recreation resources to the foreign tourists, but rather owing to the steep devaluation of the ruble exchange rate. Furthermore, the Russian operators can get from regional tourism nearly next to nothing, because tours to the Far East are operated mainly by foreign tourist companies.

It is also unlikely, that the idea to establish a stock exchange in the Russian Far East can yield the desired results. Foreign investors can be at best interested in the stocks of a few resource-extraction companies, with the rest of local issuers being too small and insignificant even by the Russian standards let alone the international ones. And more, it is unreasonable to expect any considerable demand for foreign companies’ securities on the part of the regional investors.

It seems hardly possible to substantially reduce the share of natural resources in the RFE’s exports both in short and medium term prospects since this very category of exports is of particular interest to foreign trade and investment partners. The prospects for expanding high-technology product exports are restricted due to very few regional high-tech companies and the increasingly acute skilled workforce deficit as a result of continuous population outflow from the region.

In 1990s the Russian Far East has lost about 25% of its population and 90% of its heavy industry. And in the latter half of the 2000s the development of Far Eastern region was promoted as the primary nationwide priority. However the region had not gotten any substantial investments beyond those made in the construction of facilities for the 2012 APEC Summit and a few capital objects to spruce up Vladivostok; with that, these investments had not yielded the expected results. So to date the Far Eastern region is far from being the desired platform for Russia’s integration in APR and particularly in East Asia, but rather is an Achilles heel of the country (Klein, 2014).

4. Conclusion

The regional authorities, as mentioned above, lack the power to develop economic integration with APR and NEA neighbor countries, while the federal center has not yet achieved any significant results in the field: Russia still remains an onlooker rather than an active participant in the regional integration processes, with the potential prospect only to isolate itself in the future.

It is worth noting that FTAs are not to be considered the single and the most important goal of Russia’s participation in the ongoing APR integration game. In the eyes of its APR partners the said FTAs would be just another portion to the already existing “noodle bowl”. Through the bare elimination of customs duties not coupled with the efforts to integrate Russian companies into the global and regional production networks, located in East Asian countries and in APR at large, Russia can enhance its trade flows, but not force any changes in its trade pattern. However, there are some additional positive effects in terms of the RFE further economic development.

The Russian Far East can benefit from foreign trade liberalization with its NEA and APR partners due to the trade expansion effect, exports and imports growth and also due to the prosperity effect, because elimination of import duties on consumables would make them more available to the local population, while the correspondent losses would be borne by the federal budget, rather than the regional budgets.

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