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CAPITAL EXPENDITURES FINANCING IN RUSSIA

Working paper WP/01/30

This project was financially supported by the New Economic School (NES) Research Center, sponsored by the World Bank, National Training Foundation and Ford Foundation. Additional financial support was provided by the Center for Economic and Financial Research (CEFIR). Stanislav Anatolyev gratefully acknowledges the fellowship from the Economics Education and Research Consortium, with funds provided by the Government of Sweden through the Eurasia Foundation. The opinions expressed in this paper are those of the authors and do not necessarily reflect the views of the Government of Sweden, the Eurasia Foundation, or any other member of the Economics Education and Research Consortium.

We thank Ray Ball, Owen Lamont, Tobias Moskowitz, Luigi Zingales, Ekaterina Zhuravskaya, Oleg Zamulin, and the participants of the X[th] NES Research Conference for helpful discussions. We also thank Natalia Volchkova, Konstantin Kozlov, Sergey Golovan, and other people at NES and CEFIR for help with data and for valuable comments. We are grateful to Denis Agentov, Andrei Shumilov, and Dmitriy Spryskov for excellent research assistance. All errors are ours.

Moscow
2001

Anatolyev S.A., Ovtcharova G.E. Capital expenditures financing in Russia. Working paper # WP 2001/030.- Moscow, New Economic School, 2001.- 43 p.(Engl.)

For a sample of Russian firms in 1996-1999, we show that if there is a large mismatch between an industry's demand for financing and its *de facto* dependence on external financing, this industry tends to have a larger mismatch between its demand for investment and its actual investment. Because different degrees of mismatch in different industries are likely to cause an unbalanced development of the economy, industries with the highest degrees of mismatch deserve special attention from Russian policymakers. These industries include machinery, transport equipment, and industrial chemicals, i.e., the most technologically advanced sectors. Consequently, a lack of attention to the financing needs of these industries may contribute to the country becoming even more delayed in its technological development.

Outside investors tend to provide just enough financing to ensure that even the most creditworthy firms do not become significantly financially dependent. It is very disappointing because it results in a tendency of outside financing not reaching those firms whose development is dramatically impeded without such financing, i.e., the firms with the highest need for financing their capital expenditures. Because private investors are not likely to change their attitude in the near future, the government should address this problem. Currently, for political reasons, the government tends to financially support inefficient firms with low creditworthiness. Instead, policymakers should consider optimal weighting of political and economic reasons in their decisions about favorable treatment of industries that are at greater risk of being heavily underfinanced relative to their demand for external financing.

Анатольев С.А., Овчарова Г.Э. Финансирование капитальных вложений в Россию. Преринт # WP/2001/030. - М.: Российская экономическая школа, 2001. -43 с.(Англ.)

Для выборки из российских предприятий за 1996-1999 гг. мы показываем, что если существует большое несоответствие между спросом на финансирование в отрасли и её де-факто зависимостью от внешнего финансирования, эта отрасль имеет более значительное несоответствие между её спросом на инвестиции и действительным уровнем инвестиций. Поскольку различные степени такого несоответствия в различных отраслях ведут к несбалансированному развитию экономики, отрасли с высокими уровнями несоответствия заслуживают особого внимания со стороны российских властей. Эти отрасли включают в себя машиностроение, производство транспортных средств и промышленных химикатов, то есть наиболее технологически продвинутые сектора. Следовательно, недостаток внимания к нуждам финансирования в этих отраслях может внести дополнительный вклад в отставание страны в её технологическом развитии.

Внешние инвесторы склонны предоставлять финансирование ровно настолько, чтобы даже наиболее кредитоспособные предприятия не становились финансово зависимы. Эта тенденция разочаровывает, поскольку вследствие неё внешнее финансирование иногда не достигает тех предприятий, чьё развитие сильно тормозится без подобного финансирования, то есть предприятий, испытывающих наибольшую нужду в финансировании капитальных вложений. Так как вряд ли частные инвесторы готовы изменить своё поведение в ближайшем будущем, этой проблемой должно заняться правительство. В настоящий момент по политическим причинам правительство склонно финансово поддерживать неэффективные предприятия с низкой кредитоспособностью. Вместо этого властям следует оптимально взвешивать политические и экономические мотивы при принятии решений о поддержке отраслей, которые более рискуют быть сильно недофинансированными по сравнению с их спросом на внешнее финансирование.

1. INTRODUCTION

It is a well-known fact that competitiveness in any market – domestic or international – crucially depends on continuous investment in capital assets. Taking into account all the problems of Russian enterprises, it is extremely important to assess their ability to make this kind of investment and to obtain necessary financing for this purpose.

The fact that investment intensity in Russia is rather low is well known (see e.g. Batiaeva (1999)). Quite naturally, this problem is largely attributable to the overall scarcity of financing resources available to Russian firms. However, it's not clear whether this scarcity just slows down all the industries proportionally, or whether it aggravates the problem of unbalanced development of different industries, and as a result – of the economy as a whole. We address this question in the present paper.

As a basis for our study, we use recent results in international corporate finance obtained by Rajan and Zingales (1998, 1999a, 1999b). These researchers show that industrial sectors that are relatively more in need of external finance grow faster in countries with more developed financial markets. They also provide a discussion of two types of financial systems – the market-intensive "arms length" system and the institution-heavy "relationship-based" system. The relationship-based system is optimal in environments where laws are poorly drafted and contracts not enforced. In this sense, this system would seem to be more appropriate for the current situation in Russia. On the other hand, this system has comparative advantage in financing physical asset-intensive industries rather than industries with significant intangible assets – high technology and R&D based industries that, due to certain Russian specifics, have significantly higher engineering (but not financial) potential in Russia than in most other developing countries. Consequently, a hybrid of the two financial systems (like venture capital, which is very popular in the US now) would probably be the best choice for Russia.

Up to this point, Western-type academic research on capital expenditures in Russia has been primarily centered on the comparison of investment intensities in financial-industrial groups (FIGs) and non-group firms (see, e.g., Perotti and Gelfer (1998) and Volchkova (2000). However, these papers did not properly control for industry differences that are likely to translate into different demand for investment and external financing.

In this study, we:

First, identify Russian industries that most actively use external sources to finance their capital expenditures, as well as industries that confront significant lack of external financing. For this purpose, we compute financial dependence and investment intensity for various Russian industries. We then compare the results obtained to the relevant results for US industries (Rajan and Zingales (hereinafter "RZ"), 1998). Because US capital markets are characterized by a virtually elastic supply of funds at a properly risk-adjusted rate, the US numbers are likely to represent the (ideal) demand of different industries for investment and financing. On the contrary, similarly computed variables for Russian industries would instead represent a (rationed) supply of funds. Due to this fact, comparison of US and Russian numbers allows us to identify the most severe mismatches between the supply of funds and the demand for them. We find that the mismatch in ranking of Russian and US industries by financial dependence is highly correlated with the mismatch in industry ranking by investment intensity. Industries with especially serious financing and investment problems include machinery, transport equipment, and industrial chemicals, i.e., the most technologically advanced sectors.

Next, we build and estimate econometric models of financial dependence and investment intensity. This helps us to analyze how Russian companies finance their investment, and what determines investment intensity in those companies. We find that, after controlling for industry effect, investment intensity tends to be higher in large firms with new assets, higher credit ratings, higher utilization of capacity, and in faster growing industries. Also, non-manufacturing Moscow firms tend to invest in fixed assets more actively than firms located outside of Moscow. In addition, government support is likely to increase investment intensity. For financially dependent firms, financial dependence tends to be higher in smaller firms with lower credit ratings, registered in Moscow. Also, financial dependence is likely to be lower in FIG firms. Among financially independent firms, large firms with higher credit ratings and higher government support are likely to utilize relatively more of their cash flow for capital expenditures.

The rest of the paper is organized as follows. Section 2 describes the methodology and the rationale for its choice. Section 3 discusses the data. Section 4 presents the results. It first shows that the mismatch in industry ranking by financial dependence is highly correlated with the mismatch in ranking by investment intensity. Then it presents and discusses estimation results for econometric models of investment intensity and financial dependence. Section 5 concludes.

2. METHODOLOGY

2.1. Choice of industries and industry classification systems

Russian industries are classified in accordance with the Russian OKONH system, which is different from US and international classification systems. The major difference is that the OKONH system is product and raw material oriented, while, e.g., ISIC2 is more activity-oriented. As a result, e.g., most of mining and quarrying is classified as manufacturing in OKONH, while it is separated from manufacturing in ISIC2.

For the purpose of comparing investment intensity and financial dependence in Russia and the US, we have compiled a correspondence table between the Russian OKONH and the UN ISIC2 industry classifications. There are two reasons why we have chosen to use the correspondence to ISIC2 rather than to the US SIC. First, we would like to compare our results to those in RZ 1998, and these authors used the ISIC2 classification in their analysis of US manufacturing industries. Second, ISIC2 is used in the UNIDO Industrial Statistics Database that we have utilized in our regression analysis.

In order to allow comparison to a benchmark, we use the same industry classification as that in RZ 1998. RZ use ISIC sectors from the Yearbook of Industrial Statistics. Not all of these sectors are mutually exclusive in their tables. For example, drugs (3522) is a subsector of other chemicals (352). In cases like this, the values for the broader sectors are net of the values for the subsectors that are separately reported. We follow this convention.

Unlike RZ who consider only manufacturing industries, we have chosen to analyze non-manufacturing industries as well, because we believe that comparing manufacturing to other sectors provides deeper insight into characteristics of both.

For the purpose of regression analysis, we have chosen to classify industries in accordance with the OKONH system. In view of the fact that the major purpose of industry classification in our regressions is controlling for industry effects, we believe that the OKONH classification is likely to introduce less noise in this process than ISIC2 classification would, because, despite all our efforts, the ISIC2-OKONH correspondence is not perfect.

2.2. Why compare Russian industries to the US industries a decade ago?

Why have we decided to compare the end of the 1990s in Russia to the 1980s in the USA? The main reason for that is technical: we wanted to use the results in RZ 1998. However, this technical reason does not contradict common sense: the development of industries in Russia during our sample period could hardly match in time the development of corresponding US industries, and we believe that the lag in development of about a decade is not too far from reality.

2.3. Econometric modeling

In this section, we build linear econometric models for investment intensity and financial dependence of Russian companies.

The available data cover a time period of 4 years, some firms having observations for only two or three years. This unpleasant feature of the data imposes certain restrictions on our modeling strategy.

First, we have to include realizations of certain variables instead of the random variables themselves, which we would do if a longer panel were available. Second, we have chosen to utilize Ordinary Least Squares (OLS) with robust calculation of standard errors rather than Generalized Least Squares (GLS) when there are individual random effects in the regression error. We have made this choice, first, because OLS has proven to be more robust in regressions that utilize financial data (Cochrane 2000), and second, because our panel is very unbalanced.

Fama and MacBeth (1973) recognized that the cross-sectional correlation in the errors can invalidate conventional inference by OLS in pooled time-series and cross-sectional regressions. Under our modeling strategy, the cross-sectional correlations are captured by time dummies and are treated as fixed effects. However, we have time-series correlation in the regression errors because of the presence of individual firm or industry effects, which we do take into account. Below we suggest a way to deal with this problem in our setting, as well as describe the way we have chosen to deal with possible structural changes in our econometric model.

2.3.1. Modeling strategy

Suppose that we have a panel of firms with T points in time, and T is very small (in our case, $T=4$). The dependent variables y's (in our case, investment intensity and financial dependence) in that panel are driven both by a set x of observable individual firm characteristics, and one unobservable (and unidentifiable) common factor z. (The model can be easily generalized to include several unobservable common factors).

We show that it is infeasible to model the common factor shocks as random effects given our data restrictions (very small *T*), and then present our alternative modeling and estimation strategy.

A simple version of a desirable structure of a regression is

$$y_{itk} = \alpha + x_{itk}'\beta + f(z_t) + \varepsilon_i + u_{tk}, \qquad (2.3.1)$$

where *i* denotes industry index, *t* stands for year, *k* is a firm index, y_{itk} is a value of the dependent variable for firm *k* within industry *i* in year *t*, x_{itk} is a vector of right-hand side variable values for firm *k* within industry *i* in year *t*, β is a vector of coefficients, and $f(z_t)$ is the common factor. The ε_i-component is an industry fixed effect. As for the u_{tk} idiosyncratic component, we let it have the following structure:

$$u_{tk} = v_{tk} + w_k, \qquad (2.3.2)$$

where v_{tk} are IID idiosyncratic shocks, and w_k are firm-specific random effects.

The model (2.3.1)- (2.3.2) can be rewritten as

$$y_{itk} = \tilde{x}_{itk}'\tilde{\beta} + \tilde{e}_{tk}, \qquad (2.3.3)$$

where $\tilde{x}_{itk}$ is a vector of regressors appended by aforementioned industry dummies, $\tilde{\beta}$ is a corresponding parameter vector, and the error term is

$$\tilde{e}_{tk} = v_{tk} + w_k + (f(z_t) - Ef(z_t)).$$

Note that de-meaning of $f(z_t)$ creates an additional time effect $Ef(z_t)$ which is swallowed by the time fixed effect that is already included in the regression.

Denote $\Omega \equiv E[\tilde{e}\tilde{e}']$, where $\tilde{e}$ is a vector of stacked errors of regression (2.3.3) and let the equations be arranged first by firm and then time period. Then we have

$$\Omega = \sigma_v^2 I_{4K} + \sigma_w^2 I_K \otimes (i_4 i_4') + (i_K i_K') \otimes \Omega_f,$$

where i_4 is a $4{\times}1$ vector of ones, i_K is a $K{\times}1$ vector of ones, and the 4×4 matrix Ω_f is filled with $Var(f(z_t))$ on the main diagonal and $Cov(f(z_t),f(z_s))$ off the main diagonal, $t,s=1,2,3,4$.

To estimate Ω (or, more precisely, $X'\Omega X$ to take care of conditional heteroskedasticity as well), we need to implicitly estimate the following parameters: σ_v^2, which is consistently estimable because we have many firms within few time periods; σ_w^2, which is consistently estimable because we have many firms; and the entries of the matrix Ω_f, which are *not* estimable consistently. The reason is that we have only one observation for the random shock $f(z_t)-E[f(z_t)]$, because it is *common* to all firms. Even if we impose an implausible in our context assumption of stationarity (i.e. that the variance and covariances depend only on the lag difference), which may be done by modeling $f(z_t)$ as, say, a stationary autoregressive process, then we would still have trouble estimating variance and covariances because of a very short time span of the data.

The bottom line is: due to a very short span of the data, we are *forced* to look at realizations of the common factor shocks, instead of looking at them as random variables, i.e., we have to use fixed time effects. The regression thus becomes

$$y_{itk} = \alpha + x_{itk}'\beta + \varepsilon_i + e_t + \eta_{it} + v_{tk} + w_k, \qquad (2.3.4)$$

where the notation is the same, and in addition, the e_t-component is a time fixed effect, the η_{it}-component is the industry-time fixed effect to allow the reaction to the common factor shock to differ across industries. The model can be rewritten in the form we previously mentioned:

$$y_{itk} = \tilde{x}_{itk}'\tilde{\beta} + \tilde{e}_{tk}, \qquad (2.3.5)$$

where $\tilde{x}_{itk}$ is a vector of regressors appended by all the aforementioned dummies (time effect, industry effect, industry-time effect, with elimination of redundant dummies to get rid of multicollinearity), $\tilde{\beta}$ is a corresponding parameter vector, and the error term is $\tilde{e}_{tk} = v_{tk} + w_k$.

Denote $\Omega \equiv E[\tilde{e}\tilde{e}']$, where $\tilde{e}$ is a vector of stacked errors of regression (2.3.5) and let the equations be arranged first by firm and then time period. Then we have

$$\Omega = \sigma_v^2 I_{4K} + \sigma_w^2 I_K \otimes (i_4 i_4').$$

To get standard errors robust to conditional heteroskedasticity, we estimate the conditional variance of OLS estimates $(X'X)^{-1}X'\Omega X(X'X)^{-1}$ by

$$(X'X)^{-1} \cdot \sum_{k=1}^{K} \left(\sum_{t \in T_k} \tilde{x}_{itk} \hat{\tilde{e}}_{kt} \right) \left(\sum_{t \in T_k} \tilde{x}_{itk} \hat{\tilde{e}}_{kt} \right)' \cdot (X'X)^{-1},$$

where $\hat{\tilde{e}}_{kt}$ is the residual from the OLS regression, and T_k is the set of time periods for which the data on firm k are available.[1]

2.3.2. Structural changes

In order to see how stable the regression coefficients are across years and for our own interest, we also perform OLS estimation separately year by year. The resulting estimates may provide useful, albeit informal, information on whether the relationship is the same for all years. The model is similar to (2.3.5):

$$y_{itk} = \tilde{x}_{itk}'\tilde{\beta} + \tilde{e}_{tk}, \qquad (2.3.6)$$

[1] In STATA this can be easily done by using clustering by firm (the command “regress … , robust cluster(…)”).

except that now $\tilde{x}_{itk}$ does not include time and industry-time effects, and the structure of the error term is simply $\tilde{e}_{tk} = v_{tk}$. Due to a simple structure of the error, matrix Ω is diagonal and hence standard errors robust to conditional heteroskedasticity can be computed from the estimate of the conditional variance of OLS estimates $(X'X)^{-1}X'\Omega X(X'X)^{-1}$ by[2]

$$(X'X)^{-1} \cdot \sum_{k=1}^{K} \tilde{x}_{itk}\tilde{x}_{itk}'\hat{\tilde{e}}_{kt}^{2} \cdot (X'X)^{-1}.$$

3. DATA

3.1. Data sources

We have utilized yearly financial statements and disclosure information from the FCSM (Russian Federal Commission for the Securities Market) database, "GNOZIS" database, and "ALBA" database for the years 1996 – 1999. A small amount of data was obtained from the GosKomStat (Russian State Committee of Statistics) publications and other sources. The variable definitions and a brief explanation of the dataset construction can be found below.

3.2. Choosing among alternative data sources

Unfortunately, our dataset has a notable number of missing observations for many variables. Also, there is a problem of duplicate observations, e.g., observations for the same firm and year, but from different sources. For a number

[2] Implemented in STATA by the command "regress … , robust".

of pairs or triples of duplicate observations the variables' values are different from one source to another. The empirical procedure described above cannot treat duplicate observations, so we had to drop extra observations so that there would be no duplicates.

Dropping was performed for each regression separately. First we dropped observations with missing regressors, as they are not used in the regression anyway. If, after this stage, duplicate observations were still left, we dropped duplicates randomly.

3.3. Variable definitions

All the variables that are measured in rubles, were inflation[3]- and denomination[4]-adjusted, where possible[5].

3.3.1. The Left-hand Side Variables

3.3.1.1. Capital Expenditures

Capital expenditures have been measured as a sum of "fixed assets introduced during the current year" and "change in incomplete construction". Specifically,

[3] Adjustment for inflation has been performed using the Producer Price Index (PPI) provided by the GosKomStat yearly publication. (We have used the same deflator for all observations for a given year.) Using this PPI, 1999 rubles were divided by 2.589, 1998's – by 1.547, and 1997's – by 1.256. As a result, all the variables measured in rubles have been expressed in the 1996 prices.

[4] Adjustment for denomination has been performed by multiplying 1999 and 1998 ruble amounts by 1000.

[5] Unfortunately, the measurement units of data were missing for some observations. For these observations nominal variables (e.g., firm size) were regarded as missing.

```
capex1 = s5370_4 + (s1130_4 - s1130_3)
```
[6]

We have regarded as missing any observation for the capital expenditures variable for which this sum was non-positive, or the "change in goodwill" variable defined as `(s5340_6 - s5340_3)` was non-zero. To explain why this has been done, we should turn to a formal definition of capital expenditures[7]. Capital expenditures are defined as "funds used for additions to a company's tangible fixed assets (property, plant and equipment (PPE))."

Capital expenditures include:

- expenditures for capital leases;
- increase in funds for construction;
- reclassification of inventories/stocks to fixed assets.

Capital expenditures exclude:

- capital expenditures of discontinued operations;
- changes in fixed assets due to foreign currency fluctuations;
- decreases in funds for construction;
- fixed assets of an acquired company.

This definition implies that capital expenditures cannot be negative. Also, if a company has acquired another company during the year, which usually implies a change in the firm's goodwill, capital expenditures cannot be calculated from a standard Russian accounting report. Consequently, when the computed value of `capex1` was negative, or the change in goodwill was non-zero, the capital expenditures variable has been regarded as missing. For a few observations with

[6] Here and below sABCD_E means "column E, row BCD of form A from the standard Russian financial statements (revision adopted in 1997)".

[7] The source of the definition is the Compustat manual, Standard and Poor's Compustat Services, Inc., 1990.

capital expenditures equal to zero, the capital expenditures variable has also been regarded as missing for technical reasons[8].

An alternative way to define capital expenditures is to use a variable, which is a sum of "objects of incomplete construction put into operation during the current year" and "change in incomplete construction":

```
capex2 = s5440_5 + (s1130_4 - s1130_3)
```

Ideally, both measures of capital expenditures defined above should be equal, because any newly introduced fixed assets should first be put into operation as a part of completed construction[9]. However, this is not always the case. The actual difference between the two capital expenditures measures calls for choosing between them. We have compared the two variables, and have found that the difference is relatively small. For this reason and because of a smaller number of missing observations for the first variable, we have decided to use capex1 as a measure of capital expenditures.

3.3.1.2. Denominator for the Investment Intensity Formula

To compute investment intensity, RZ (1998) divide capital expenditures by firm size measured as the book value of fixed assets (NPPE - net property, plant, and equipment). Because a book value of firm assets may have been distorted due to a high inflation and imperfect revaluation, we have considered two alternative

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[8] For example, for such observations financial dependence and the logarithm of investment intensity could not be defined.

[9] According to Russian accounting rules, separately acquired fixed assets first appear in `s5440_4` as an addition to incomplete construction and then in `s5440_5` as completed construction.

measures of size to be used as the denominator for the investment intensity formula: the firm's NPPE and its sales.

A firm's sales are defined as "sales during the previous year excluding VAT and other obligatory payments":

```
sales = s2010_4,
```

and NPPE is computed as a sum of "fixed assets at the beginning of the current year" and "incomplete construction at the beginning of the current year"

```
nppe = s1120_3 + s1130_3.
```

3.3.1.3. Investment Intensity

Following the above discussion about the denominator for investment intensity, we have tried two alternative measures of investment intensity: one with sales in the denominator, and another with a book value of fixed assets in the denominator. Having compared the two resulting variables, we have decided to use the book-value-defined investment intensity. It seems to be a better measure of actual investment intensity as it produces more sensible and robust results in regressions, and also significantly raises explanatory power of all regressions in comparison with the sales-defined investment intensity. The resulting investment intensity formula is:

```
invint = capex1 / nppe.
```

In order to exclude the scale effect, in our regressions we have used the log of investment intensity:

$$\text{linvint} = \log_{10}(\text{capex} / \text{nppe}).$$

3.3.1.4. *Cash Flow*

To calculate financial dependence we need to compute a firm's operating cash flow. Operating cash flow is given by "net profit from operations" – "increase in inventories" + "decrease in receivables" + "increase in payables" + "depreciation expense this year" – "tax on profit" – "payments to the budget from profit" + "increase in debt to the government budget":

```
cashfl3 = s2050_3 - (s1210_4 –
 s1210_3) + (s1240_3 – s1240_4) + (s1620_4 –
 s1620_3) + (s5411_4 + s5412_4) - s2150_3 -
 s2160_3 + (s1626_4 - s1626_3)
```

3.3.1.5. *Financial Dependence*

Financial dependence would then be defined as

```
findep = ( capex1-cashfl3 )/capex1 = 1 –
 (cashfl3 /capex1).
```

Having constructed this variable, we found that it takes both positive and negative values rather often. Firms with positive financial dependence are those that use external financing. Firms with negative financial dependence are those that use only their own funds to finance capital expenditures. We believe that the two groups of firms are different from the economic point of view, thus we build and estimate two separate groups of models for financial dependence. The first group of models will use

$$\texttt{lfindep1} = \log_{10}(\texttt{findep}).$$

It is defined only for financially dependent firms.

3.3.1.6. Cash Flow Underutilization

For financially independent firms, we have introduced a different measure of cash flow usage in capital expenditures financing – cash flow underutilization for capital expenditures:

```
lunderutCF = ( cashfl3-capex1 ) / cashfl3 = 1 – (capex1/cashfl3 ).
```

In a certain sense, the cash flow underutilization measure is opposite to the financial dependence measure: the former shows how much extra free operating cash flow the company has after capital expenditures, while the latter shows how much free operating cash flow the company lacks in order to finance its capital expenditures.

3.3.2. The Right-hand Side Variables

3.3.2.1. Firm Size

To measure a firm size we use two alternative variables:

lsize_p = $\log_{10}$(nppe);

lsize_s = $\log_{10}$(sales).

The latter will be used in investment intensity regressions, and the former in financial dependence regressions. This is done to exclude the situation when the same variable is used as a regressor and subtracted when constructing one of regressors at the same time[10].

3.3.2.2. Credit Rating

Another important right-hand side variable is a firm's credit rating, which is a simplified version of the rating formula used by Russian banks to assess their potential borrowers. The rating variable takes values between zero and five. It is a weighted sum of various indicators of the firm's performance, each of them also taking values between zero and five, five being the best and zero the worst. Specifically,

```
rating = 3/9*(firm's debt overdue indicator) +
         2/9*(firm's profitability indicator) +
         1/9*(property measure indicator) +
         1/9*(liquidity indicator) +
         1/9*(dependence on external financing
         indicator) +
         1/9*(accounts receivable overdue
         indicator).
```

The procedure of obtaining these indicators is described in Shumilov and Spryskov (2001). The first two indicators are given a higher weight because they are most important for a bank. When constructing the rating variable, we faced a problem of

[10] Under correct specification, the presence of such regressors is innocuous. However, if the true model is even slightly nonlinear, and this variable is used as a regressor, it may capture a significant portion of variation in the dependent variable and appear to be significant even when it is not.

missing data for one or several indicators. Because of the missing data, the rating variable was available for only about a half of the observations in the dataset. We tried to increase this number by simplifying the rating formula: if any of the four indicators with weight 1/9 were missing, the rating formula was recalculated without missing indicators. The weights were then recalculated so that in the numerator the missing indicators were omitted, and the denominator was changed to $(5+n)$, where $0 \le n \le 4$ equals the number of available "less important" indicators. This correction has substantially increased the number of available non-missing rating observations.

3.3.2.3. Industry and Year Dummies

In accordance with our modeling strategy, industry and year dummies were introduced. These dummies can also be useful to understand the effect of special government policies and other special conditions. For the purpose of constructing industry dummies, industries were grouped by OKONH codes.

Other special policy variables include the financial-industrial group membership status dummy and the government support variable.

3.3.2.4. Financial-Industrial Group Dummy

The FIG variable equals one if a firm belongs to a financial-industrial group from the list of financial-industrial groups compiled by Volchkova (2000).

3.3.2.5. Government Support

To compute the government support variable, we take the sum of the amounts contributed during the current year towards investment[11] from the government budget and non-budgetary funds, and divide this sum by the previous year's net sales:

```
govsup1 = (s5424_4 + s5425_4)/s2010_4.
```

In order to exclude the scale effect, we use the log of this variable in regressions:

$$\texttt{lgovsup1} = \log_{10}(1 + \texttt{govsup1}).$$[12]

Adding unity to the government support measure allows to construct the government support variable in logs for all firms for which the government support information was available. In particular, this allowed us to have the government support variable for companies that were not supported by the government. For these companies, lgovsup variable was equal to zero.

3.3.2.6. Territory dummies

We introduced a Moscow dummy that is equal to one when the company is registered in Moscow.

[11] Note, unlike Orlov and Zhuravskaya (2000), who used the total government subsidies in their analysis, we have chosen to use only those intended to support investment.

[12] In fact, there are several observations (less than ten) for which the government support variable was negative. Such observations were treated as mistakes, with the government support variables being regarded as missing.

3.3.2.7. Average Age of Depreciable Assets

As a proxy for the quality of a firm's equipment, we introduced an "average age of depreciable assets" variable, which was computed as a ratio of "accumulated depreciation by the beginning of the current year" to "depreciation expense for the previous year". In logs:

$$laada = \log_{10}(s5392\_3 / s5640\_4).$$

3.3.2.8. Industry Growth Variables

As a proxy for investment opportunities in Russia, we have introduced the industry growth variable equal to the industry growth in Russia during the previous year. We obtained the industry growth data from the GosKomStat yearly publication[13]. The growth variable was constructed for all industries except communications and transport, for which the growth data were not supplied.

Another growth variable is a proxy for development of an industry outside of Russia, and equals the growth rate of the industry in the US. This variable is only available for manufacturing industries[14].

3.3.2.9. Capacity utilization

The source available at the time of this study[13] contained the capacity utilization data for only a small number of industries. However, we have decided

[13] Госкомстат России, «Российский статистический ежегодник», М., 2000
[14] Source: "Industrial statistics database", United Nations Industrial Development Organization, 2001.

to use this variable in regressions anyway, because it is very likely to be closely related to investment in fixed assets.

3.3.3. Constructing the Dataset

The resulting dataset was constructed using the observations from the FSCM, ALBA, and GNOZIS databases for those firms and years for which the capital expenditures variable was not missing. Observations for other variables were included where possible.

Each observation includes the above-described variables for firm *k* in year *t*. The dataset is comprised of 8,836 observations[15] (including duplicates). The summary statistics for the variables are shown in Table 1.

4. RESULTS

First, we compare the ranking of industries in Russia and the US by investment intensity and financial dependence. Next, we present regression results.

4.1. Industry ranking by investment intensity

Table 2.A shows the ranking of Russian industries by investment intensity. Also reported are the investment intensity values for Russian and US industries

[15] The number of observations for capex1 in Table 1.A is smaller, because the statistics for capital expenditures in this table are reported only for observations, for which the unit of measurement variable was not missing, while in Table 1.C we report the number of observations with non-missing capex1 irrespective of whether the unit of measurement variable is missing.

(the latter are from RZ (1998)), and the ranks of the relevant industries in the US. The most technologically advanced industries, such as machinery, transport equipment, and industrial chemicals, have relatively low investment intensity in our sample.

There is practically no correlation (-6.6%) of investment intensity for Russian industries with that for US ones in RZ (1998).

4.2. Industry ranking by financial dependence

Table 2.B shows industry ranking by financial dependence. The correlation of financial dependences for Russian and US industries in RZ (1998) is about 27%.

Correlation of investment intensity and financial dependence in Russia is 16.7%, which is significantly smaller than that for the US industries in RZ (1998) (81%).

4.3. Statistics for the mismatch between the ranking of Russian and US industries

In this section, we first explain how we have determined whether relative distortions in external financing for a given industry are related to relative distortions in investment intensity, and then show that this relation is positive and strong.

Due to the fact that during the sample period both investment and external financing were dramatically low in Russia, the comparison of *absolute numbers* for investment intensity and financial dependence in Russia and the US during this period is meaningless. Consequently, we have chosen to compare *rankings* of industries by financial dependence and investment intensity. We have separately ranked 36 US and Russian ISIC2 industries analyzed in RZ 1998. Each industry in each country $\boldsymbol{i}$ ($\boldsymbol{i} = \boldsymbol{R}$ (Russia), $\boldsymbol{A}$ (USA)) has been assigned a rank number $\boldsymbol{n_i}$ (see Table 2). In order to assess the degree of relative distortion in the above-introduced ranking of industries, we have computed the "**mismatch**" variable as the difference between $\boldsymbol{n_R}$ and $\boldsymbol{n_A}$. The resulting values of the mismatch for both financial dependence and investment intensity are shown in Table 3. The striking result is that, while the correlation between investment intensity and financial dependence is only about 16.7%[16], the correlation between the mismatch in investment intensity and the mismatch in financial dependence is much higher - about 62.5%! This means that if an industry in Russia is ranked by financial dependence much lower than the same industry in the US, it is highly likely that this industry in Russia will be ranked much lower by investment intensity as well. Also note that for all the industries that are better represented in the sample (with the number of observations above 90), and hence, the ranking results for which are more reliable, the signs of the mismatch in the two rankings coincide.

Industries at the top of the Table 3 should be investing not just more, but significantly more than they actually invest. Because these industries are among the most financially dependent ones in the US, in other countries, including Russia, they are likely to strongly depend on availability of external financing for their investment as well. However, most of these industries do not display any dependence on external finance during the sample period. This fact may explain their relatively low ranking in terms of their investment intensity.

[16] For Russian industries corresponding to the US ones from RZ (1998).

Industries with especially serious financing and investment problems include machinery[17], transport equipment, and industrial chemicals, i.e. the most technologically advanced sectors. In this list electric machinery (ISIC2 383) probably deserves special attention. Though the mismatch in ranking by financial dependence is not very big for this industry, the mismatch in ranking by investment intensity is much bigger for it. This suggests that electric machinery is likely to be affected by the lack of external financing to a much greater extent than other industries. This problem is not obvious if we do not compare the ranking of this industry to the ranking of the same industry in the US. In particular, the absolute level of investment intensity in electric machinery is close to the median across other Russian manufacturing industries, and its lack of financial dependence is small relative to other industries. These facts might erroneously lead to the conclusion that the situation with investment is not that bad in this industry relative to other Russian industries. However, because this industry is among the highest-ranked investment intensive industries in the US, its median investment intensity in Russia is far too low even relative to other Russian industries. Also, because the high ranking of electric machinery in terms of its financial dependence in the US suggests that the demand for external financing in this industry is extremely high, we can conclude that its relatively (to other Russian industries) small lack of

[17] An exception is our sample for ISIC 3832 (manufacture of radio, television and communication equipment and apparatus), which has a positive financial dependence. However, the small size of this sample (6 to 11 companies per year) does not allow us to consider it as a representative one. Also, while ISIC 3832 is extremely investment intensive in the US, our sample for this industry turned out to have one of the lowest rankings in terms of investment intensity. This might indicate that even a relatively (to other Russian industries) good situation with external financing in this industry does not provide sufficient funds for keeping the investment ranking of this industry in Russia close to its investment ranking in the US.

financial dependence will not ensure its relatively proportional growth in comparison with other Russian industries.

4.4. Regression results

In this section we present regression results for investment intensity, financial dependence, and cash flow underutilization for investment.

We have used regression methodology outlined in the "Methodology" section (2.3) above. In accordance with this methodology, temporal dependence has first been modeled by year dummies, industry-year interaction dummies, and firms' random effects. In order to see how stable the regression coefficients are across years, we have also performed estimation separately year by year[18]. In our regressions confidence intervals corresponding to different years intersect for all structural coefficients. Consequently, we can draw an informal conclusion that we do not have to introduce structural breaks into our econometric model.

As a first step, we have estimated basic regressions that included a minimum set of right-hand-side variables, and consequently contained a maximum number of observations for each industry. These regressions have been estimated both with industry-year interactions and without these interactions (the latter only with industry and year dummies). While the former version does not allow interpreting industry dummies because of the small number of observations per year for most industries, the latter version allows interpretation of an industry dummy. The estimation results for the basic regressions with industry dummies but without industry-year interactions are reported in Table 4. Tables 5 through 7 report estimation results for regressions with industry-year interactions included along

[18] We do not report these results.

with industry dummies. The first model in each of Tables 5 through 7 uses the same set of explanatory variables that is used in basic regressions in Table 4[19]. In subsequent models, new variables are added at the cost of reducing the sample size. Because in regressions in Tables 5 through 7 the industry-year dummies cannot be interpreted, the estimates of their coefficients are not reported.

After controlling for industry effects in a given year[20], investment intensity tends to be higher in large firms with new assets, higher credit ratings, higher utilization of capacity, and in faster-growing industries. Also, non-manufacturing Moscow firms tend to invest in fixed assets more actively than firms (both manufacturing and non-manufacturing) located outside of Moscow. In addition, government support is likely to increase investment intensity.

For financially dependent firms, financial dependence tends to be higher in smaller firms with lower credit ratings, registered in Moscow. Also, financial dependence is likely to be lower in FIG firms.

Among financially independent firms, large firms with higher credit ratings and higher government support are likely to utilize relatively more of their cash flow for capital expenditures.

4.4.1. Investment intensity regressions

[19] The difference in structural coefficients for the two different types of basic regressions – with and without industry-year interactions – is miniscule. Quite naturally, the most significant difference is that for the year dummies.

[20] Because regressions in Tables 5 through 7 include industry dummies and industry-year interactions, the structural variable coefficients are naturally interpreted as being computed “after controlling for industry effects in a given year”.

Our estimates for industry dummies in the basic regression for investment intensity (in Table 4) are consistent with the industry ranking results above: industries ranked higher in terms of their investment intensity tend to have higher industry dummy coefficients. There is nothing surprising about it.

Among the four years in our sample, the year 1999 was the most investment intensive one (the relevant dummy is only marginally significant in regressions with interactions). This result is consistent with officially reported numbers.

In the majority of investment intensity regressions in Table 5, the firm size (defined via sales) has a significantly positive coefficient, i.e., firms with bigger sales tend to be more investment intensive. One of the possible explanations of this fact may be that an investment project that has the potential of significantly raising a firm's efficiency would be relatively cheaper for bigger firms, as there can be certain economies of scale here.

In all regressions in this section, the rating variable is highly significant and positive, i.e., firms with a higher rating tend to be more investment intensive. There may be two possible explanations. First, firms with a higher rating are more successful, so they have relatively more resources to invest. Second, these firms have a greater chance of receiving external financing (e.g., a bank loan), which would most probably positively affect investment intensity. The second explanation becomes less logical if we look at financial dependence model results below. These results say that for financially dependent firms, the "rating" variable negatively affects dependence on external sources of financing, in other words, firms with higher ratings tend to use less external financing.

Average age of depreciable assets is significantly negative in investment intensity regressions, that is, firms with older equipment invest less relative to their (net) fixed assets. This result is even stronger if we take into account that, for firms with old equipment, the net book value of fixed assets is likely to be rather low due to high accumulated depreciation: with low book asset value, it is easier for a firm to reach higher investment intensity. A possible explanation for the negative relationship between investment intensity and the age of depreciable assets is that there is a relatively high chance that firms with old equipment are dying, and they hardly have resources to invest, while firms with younger equipment are generally more successful, and are able to carry out new investment projects.

Moscow companies tend to invest more than companies outside of Moscow. However, this result vanishes in the sample of manufacturing (in ISIC2 sense) firms (model 5.D). On the other hand, this result is strong for non-manufacturing firms (model 5.DD). So, being in Moscow tends to improve investment intensity only in non-manufacturing firms.

Unlike in Volchkova (2000), our regressions in Table 5 do not indicate that FIG membership is associated with higher investment intensity. We believe that this difference can be explained by the fact that in our regressions we controlled for the fixed industry effect. The evidence in Table 5, model 5.AA (which is essentially model 5.A without industry dummies) substantiates this claim: once industry dummies are removed, the FIG dummy becomes significantly positive. The latter is in full agreement with the result in Volchkova (2000).

Just like the rating variable, the government support variable highly significantly and positively affects investment intensity. Naturally, a firm supported by the government would probably invest more than if it were not supported.

Industry growth during the previous year is positively and strongly related to investment intensity, which is not a surprise. Industries that managed to grow last year have more resources to invest and are subject to increasing interest on the part of investors.

The capacity utilization coefficient is significant and positive in the small sample for which it has been available[21], that is, in the industries that utilize more of their capacity, firms tend to invest relatively more. This result is quite predictable: if a firm utilizes only a small part of its productive capacity, it will most likely avoid purchasing new equipment, because a significant portion of its existing equipment is not engaged in production.

4.4.2. Financial dependence and cash flow utilization regressions

Because financially dependent firms are likely to be different from financially independent ones, we have built a separate series of econometric models for each of the two firm groups.

As reported in Table 4, financial dependence (for financially dependent firms) and cash flow underutilization for investment (for financially independent firms) in our sample were relatively stable during the sample years. However, in other respects the patterns of the relationship between capital expenditures and operating cash flow for the two firm groups appear to be dramatically different. Consequently, we report the relevant results separately for each group.

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[21] While structural coefficients are pretty robust in previous samples, this is not the case for several coefficients in the sample for model 5.E. Because of the very small size of this sample (which is due to the limited number of industries in it), this sample is probably not a representative one.

4.4.2.1. Financially dependent firms

Regression results for the decimal log of financial dependence for financially dependent firms are shown in Table 6.

In most regressions, the size variable has a significantly negative effect on financial dependence. This negative relationship seems rather logical: for bigger firms, there are likely to be certain possibilities of redistribution of funds between divisions, which should reduce the dependence on external financing. Another possible explanation lies on the "supply" side: raising financial dependence for a bigger firm requires more external financing in absolute terms. Because in the current low state of development of financial markets in Russia it is more difficult to get bigger loans (because the default risk is high, and the number of possible suppliers of external financing is rather low, e.g. a firm cannot find many banks or other lenders that would be willing to give it a loan[22]), larger firms can attract smaller amounts of external resources relative to their cash flow. It is also possible that bigger firms have more power to generate additional cash flow by simply not paying suppliers, which would artificially reduce their dependence on external sources of financing.

The rating variable coefficient is always negative and significant in financial dependence regressions for dependent firms, that is, firms that are more likely to

[22] We believe that the number of possible lenders was rather low during the sample period, because throughout most of the period under consideration, it was on average more profitable to play on the GKO market than to invest in the real sector. It is likely that the non-government and non-debt-related suppliers (see the discussion after this footnote) of external funds were mostly made up of "friendly" banks, e.g., banks in the same FIG, or other financial institutions interested in strategic development of a firm. It is obvious that the number of such institutions is likely to be rather limited.

get bank loans actually tend to use less external financing. This result may be explained by the imperfection of Russia's financial system (a supply-related argument). It is known that in Russia, bank loans account for a rather small part of external financing, and for non-bank lenders other factors besides the credit rating may be important: for example, the government may have supported weak firms[23]. Still, the result is rather striking. Yet another explanation is on the "demand" side: firms with higher ratings are more successful and will generate relatively more cash, which makes them less dependent on external financing.

The average age of depreciable assets coefficient is positive in financial dependence regressions. However, its significance is not strong. To think of an explanation for this result, it's useful to recall the following result for our investment intensity regressions: firms with younger depreciable assets are more likely to make capital expenditures. This result has lead us to a conjecture that there might be two clusters of firms: those that use old equipment and are close to dying, and those with new equipment that are more successful and are ready to invest again. It is quite plausible that dying firms with older equipment not only spend fewer resources on investment in fixed assets, but also generate significantly lower cash flows. While it is reasonable to expect that a successful firm is more likely to attract more external financing, a dying firm with relatively smaller (and often even negative) cash flow is more likely to display higher financial dependence than a successful firm with comparable capital expenditures. Depending on which of the mutually offsetting effects – small capital expenditures

[23] We have compared average share of government support in ("capital expenditures" – "cash flow") for financially dependent firms with low ratings and those with high ratings, and the result was that firms with lower ratings are on average more actively supported by the government.

pared with even smaller cash flow in dying firms, or higher ability of successful firms to attract external financing - turns out to be stronger, the relationship between the average age of depreciable assets and financial dependence may be negative, positive or insignificant[24].

While the FIG dummy is not significant in investment intensity regressions, it is significantly negative in the majority of financial dependence regressions for financially dependent firms. This result is quite surprising: it was reasonable to expect that FIG membership would imply a more efficient redistribution of investment funds among participants, but the result has turned out to be the opposite: FIG members tend to receive a relatively smaller amount of external financing. A possible explanation could be that a successful company with relatively high cash flow is more likely to become a FIG member than a losing company.

Companies registered in Moscow tend to display higher financial dependence. This may be due to the fact that the financial sector is better developed in Moscow.

The “government support” variable has a negative (though not always significant) coefficient in financial dependence regressions. At first glance, the result is quite striking, because it is natural to presume that firms supported by the government would be more financially dependent. A possible explanation of this result is that, during the sample period, the government supported firms with very low financial dependence[25]. This is rather natural, as these firms seem to have faced more difficulties in accessing external financing, and if their development

[24] This logic works for financially independent firms as well.
[25] In our sample of financially dependent firms, the average lfindep1 is 0.34 for non-supported firms, and 0.10 for supported ones.

were important for the government[26], it would make sense for the government to support their investment projects. This explanation is consistent with more general[27] results in Orlov and Zhuravskaya (2000) that in 1996-1998 government subsidies were mostly allocated to less productive firms.

4.4.2.2. Financially independent firms

In this section, we present regression results for another group of firms[28] - the ones that have enough cash resources to finance their *actual*[29] investment in fixed assets. We believe that these firms are significantly different from financially dependent firms, and regression results in this section support this view. Naturally, the measure of financial dependence defined as "amount of resources that a firm lacks in order to finance capital expenditures" has a different economic sense depending on whether it is positive or negative. For firms with a positive measure of financial dependence, this measure shows what share of capital expenditures a firm has financed externally. For financially independent firms, it indicates to what extent the resources that could have been spent on investment in fixed assets were

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[26] As Orlov and Zhuravskaya (2000) show, government subsidies went mostly to large firms or firms with higher employment per regional labor force. In addition, supported firms had a relatively larger state-owned stake.

[27] While in this study we have considered only the part of the government support, which was intended to support investment, Orlov and Zhuravskaya (2000) used the total government subsidies in their analysis.

[28] In fact, here by "firm" we mean an observation for a firm in some year. Naturally, a firm may be financially dependent in one year, and not financially dependent in another year. We still assume that if a firm has changed its status from financially dependent to the one that has enough free cash flow to finance its actual capital expenditures, its "financial dependence" variable will be affected by independent variables in another way.

[29] As opposed to their demand for investment.

not utilized for this purpose[30]. Accordingly, as explained in the "Data" section (3.3.1.6), for financially independent firms we have introduced a different measure of cash flow usage in capital expenditures financing – cash flow underutilization for capital expenditures, which is in a certain sense opposite to the financial dependence measure: the former shows how much extra free operating cash flow the company has after capital expenditures, while the latter shows how much free operating cash flow the company lacks to finance its capital expenditures.

Regression results for the decimal log of cash flow underutilization for capital expenditures are shown in Table 7.

Large firms tend to utilize relatively more of their cash flow for capital expenditures. This is consistent with our conjecture regarding investment intensity regressions: an investment project that will increase the efficiency of a firm would be relatively cheaper (and hence more feasible) for bigger firms due to certain economies of scale. Consequently, a large firm is more likely to undertake an investment project, and hence it is more likely to use its cash flow for this purpose.

Credit rating is positively related to cash flow utilization for capital expenditures. This is not surprising, because, given that in the majority of Russian industries, investment intensity is way below the demand for investment, successful firms (that have high credit ratings) are likely to use more of their cash flow for capital expenditures.

The government support coefficient is negative and significant in cash flow underutilization regressions, which means that companies in which capital expenditures are more actively supported by the government tend to utilize

[30] A firm can also use its free cash flow to pay dividends to the shareholders. Free cash flow may also be diverted in various ways, if the agency problem is not properly addressed in the firm.

relatively more of their cash flow for capital expenditures. This is quite natural: if instead these companies distributed most of their cash flow to shareholders, there would have been no point for the government to support them.

The capacity utilization coefficient is negative in model 7.E, which is not surprising: the more of a firm's capacity is utilized, the more likely the firm is to make new capital expenditures and use its free cash flow for this purpose.

5. CONCLUSION

For the sample of Russian firms in 1996-1999, we have shown that, if there is a large mismatch between an industry's demand for financing and its de facto dependence on external financing, the industry tends to have a larger mismatch between its demand for investment and its actual investment. Because different degrees of mismatch in different industries are likely to cause an unbalanced development of an economy (RZ 1998), industries with the highest mismatch degrees deserve the special attention of policymakers. In Russia, industries with especially serious financing and investment problems include machinery, transport equipment, and industrial chemicals, i.e., the most technologically advanced sectors. Consequently, a lack of attention to the financing needs of these industries may contribute to the country becoming even more delayed in its technological development.

Another important conclusion that can be drawn from this study is that outside investors (except for the government) tend to provide just enough financing to ensure that even the most creditworthy firms do not become financially dependent. This may be quite natural in an unstable environment, where even the most trustworthy firms cannot be fully trusted by outside investors. However, it's very disappointing that outside financing tends not to reach those firms whose development is dramatically impeded without such financing, i.e., firms with the highest demand for financing of their capital expenditures.

Because for political reasons the government tends to financially support mostly inefficient firms with low credit ratings, policymakers should think about optimal weighting of political and economic reasons for their decisions about preferable treatment of industries that are at greater risk of being heavily underfinanced relative to their demand for external financing.

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