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Firm behavior under production
uncertainty: Evidence from Russia



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Simo Leppänen*¹, Mikael Linden² and Laura Solanko³

Firm behavior under production uncertainty: Evidence from Russia

Abstract

Enterprises in post-socialist and transition economies often participate in providing infrastructure and social services to the surrounding community. We argue that this bundling of social and infrastructure goods provision with an enterprise's core operations is a fully rational choice in an uncertain environment. Using a stylized model, we show that this activity can be largely related to efforts by firms to increase their operational reliability. Our unique survey data suggest that this manifests itself through provision of more reliable infrastructure, stronger employee attachment to the firm, and better relations with the authorities.

Keywords. Uncertainty, enterprise performance, Russia

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Tiivistelmä

Monissa kehittyvissä talouksissa, erityisesti entisen Neuvostoliiton alueella, yritykset osallistuvat huomattavissa määrin julkisen infrastruktuurin ja sosiaalipalveluiden tuottamiseen. Tässä tutkimuksessa osoitetaan teoreettisen mallin avulla, että julkisen infrastruktuurin ja sosiaalipalveluiden tuottaminen on täysin rationaalinen keino lisätä yrityksen liiketoimintaympäristön varmuutta. Käytetty mikrotason empiirinen aineisto tukee mallin tuloksia. Yritykset hyötyvät infrastruktuurin ja sosiaalipalveluiden tuottamisesta kolmea kautta: suoraan luotettavammin toimivan perusinfrastruktuurin ja työvoiman liikkuvuuden supistumisen kautta sekä epäsuorasti ylläpitämällä parempia suhteita paikalliseen julkisvaltaan.

Asiasanat: epävarmuus, yrityksen tehokkuus, Venäjä

1 Introduction

The World Bank's *World Development Report 2004: Making Services Work for the Poor* views efficient public service delivery as key ingredient in promoting economic growth and eradicating poverty. The incentive for firms to invest, however, is significantly reduced when firms face issues of operational reliability. For example, the availability of basic infrastructure services needs to be sufficient for the intended business purpose. A company that must constantly put up with daily blackouts of the electrical grid or interruptions in its phone and internet access may soon find its profitability overwhelmed. By the same token, firms are averse to entering a business environment where the challenge of maintaining a stable workforce is complicated by inadequate basic public services in such areas as health care or primary education. Poor access to public services translates to increased labor costs and lower productivity. Finally, serious social imbalances can emerge, especially in company towns, when the dominant employer fails to assure members of the broader community of access to daily necessities.

In the Soviet era, large enterprises in Russia were typically expected to participate in provision of local infrastructure such as energy and district heating, as well as the provision of social services such as housing, medical care and day care. With the collapse of the Soviet system, many such social assets were transferred to municipal ownership. Russia experienced a major shift of responsibility for infrastructure (Leksin and Shvetsov, 1998; Commander and Schankerman, 1997.)

Although more than a decade has elapsed since the transfers of assets under the law on divestiture of enterprise social assets should have been completed, many Russian firms continue to support vestiges of the socialist arrangement. It is not uncommon to see large industrial enterprises providing social services or producing and supporting local infrastructure goods. Generally speaking, these supported activities have little, if anything, to do with the core business functions of the enterprise. Indeed, Haaparanta et al. (2003) report enterprise managers readily acknowledge that these supported activities do not contribute directly to their bottom lines. While part of this commitment to upkeep of legacy facilities and institutions can be attributed to tradition, it still raises the larger question of what would motivate a profit-maximizing, privately owned enterprise to keep funding non-profitable cost centers year in and year out.

Based on a simple model of firm utility maximization under uncertainty, we argue that this apparently altruistic provision of social services and infrastructure goods (sometimes portrayed as "corporate social responsibility") can be explained as a rational response by firms to an uncertain

operating environment.¹ Our basic assertion is that firms use these activities to maximize their operational reliability in surroundings where financial markets fail to provide adequate possibilities for hedging against risk or where risk is largely institutional.

Operational reliability can be enhanced through several channels. First, firms can influence the availability of municipal infrastructure by directly participating in its planning, construction, and operation. Second, providing social services to workers in surroundings where public provision is otherwise poor enables firms to better retain workers and thereby avoid production problems caused by loss of trained personnel. Third, the provision of infrastructure and services, under the right circumstances, can enhance relations between the firm and the public sector, and thereby promote a regulatory environment friendly to the firm.

In the following discussion, we present a theoretical model of firm optimization in an environment where the firm can affect its operational reliability through engagement in provision of social services or infrastructure. Based on survey data from Russia, we consider the empirical evidence that supports the theoretical setting.

The rest of the paper is organized as follows. Section 2 discusses the relevant literature and the provision of social and infrastructure goods in the Russian industrial context. Section 3 presents our model of firm optimization in an uncertain environment. Section 4 presents our empirical evidence and Section 5 concludes.

2 Private goods, social goods, and infrastructure in Russia

The Soviet economic system led to a blurring of the division of public and private provision of basic infrastructure and numerous social services. Municipal infrastructure and social services were provided under to the official plan by the city or individual state-owned enterprises. In Russia's *monocities* (single enterprise towns), as well as cities with just a few large enterprises, the citizenry was largely dependent on their local enterprises for services. The demise of the planned economy and subsequent privatization of state assets in the early 1990s has been particularly traumatic for these populations.

Russia adopted laws requiring divestiture of housing and most other social assets in 1992 and 1993. Instead of immediate privatization, however, assets were divested to local authorities,

¹ According to one definition, corporate social responsibility involves “actions on the part of the firm that appear to advance the promotion of some social good beyond the immediate interest of the firm or shareholders and beyond legal requirements.” (McWilliams and Siegel (2001).

who willingly, or otherwise, shouldered the responsibility for providing the community services previously provided by the divesting enterprises. As planned, the transfer in ownership of enterprises social assets was largely implemented on schedule by the end of 1997. Some 80% of housing, kindergartens, medical clinics, sports facilities and children's summer camps, along with 60-70% of recreational facilities shifted to municipal ownership during 1993-1997.

Local authorities, who typically lacked sufficient funds to operate or maintain the divested facilities, were hardly enthusiastic about what they had been stuck with and even less pleased about their lack of say in the divestiture process. During the 1990s, in particular, insufficient funding and ambiguous property rights meant municipalities had little incentive to properly maintain these facilities (Juurikkala and Lazareva, 2006a). The 2003 HSE/CEFIR/BOFIT survey data² indicate firms in Russia routinely experienced problems with availability of basic infrastructure in the early 2000s (see Table 1). This finding was reinforced by the EBRD's low rating for Russian infrastructure quality a year later (EBRD, 2004). The share of municipalized assets ranges widely in Russia, between 15% and 100%.

Table 1 Interruptions in basic infrastructure services in 2002

	<i>% of firms that have experienced interruptions</i>	<i>Of those: % that regard the interruptions as significant</i>	<i>Mean / median length of interruptions, days</i>
Electricity	38.6	48.8	7.3 / 2
Water	30.0	32.0	8.1 / 3
Telephone	30.9	39.1	8.6 / 5
Gas	10.5	39.1	18.1 / 3
Heating	10.2	30.4	12.5 / 7

Source: HSE/CEFIR/BOFIT enterprise survey data. For details, see Haaparanta et al. (2003).

Russia's large enterprises remain critically important for infrastructure provision. For example, an enterprise could well be the sole building-heating provider for its legacy apartment buildings or the surrounding housing district. Three-quarters of Russian industrial firms supply building-heating services, with half of those providing heating to outside users (Solanko, 2006). Besides supplying building-heating and electricity, many firms support other public infrastructure. Almost a quarter of all enterprises help with construction and maintenance of roads outside their plant area. A sizeable

² See Section 4 and Haaparanta et al. (2003) for a survey description.

portion of the enterprises support local heating, electricity, and water networks. (Haaparanta et al., 2003).

Table 2 Support of firms for construction or maintenance of municipal infrastructure

<i>Form of municipal infrastructure</i>	<i>% of firms giving financial support to maintenance or construction of</i>	<i>% of firms giving non-financial support to maintenance or construction of</i>	<i>% of firms giving either form of support</i>	<i>If firm owns necessary facilities, % of firms giving either form of support</i>
Municipal heating	10.9	10.2	16.6	18.0
Municipal electricity	7.7	7.7	11.9	11.1
Railroads not owned by firm	5.5	4.2	7.7	12.2
Local gas network	6.5	4.2	8.4	n.a.
Municipal water system	10.6	9.4	17.3	n.a.
Municipal waste collection	10.9	7.7	15.4	n.a.
Roads outside plant area	19.9	10.4	24.1	n.a.

Source: HSE/CEFIR/BOFIT enterprise survey data. For details, see Haaparanta et al. (2003).

Many large industrial firms provide or finance a wide array of social services (see Table 3). In the case of firms providing housing services, over half provide housing to tenants who are not employees or members of employee families. Virtually every manager interviewed in the HSE/CEFIR/BOFIT survey considered social asset provision to be unprofitable (Haaparanta et al., 2003).

Table 3 Social service provision (according to firm manager responses)

<i>Percentage of firms providing the service</i>	<i>Housing</i>	<i>Medical care</i>	<i>Daycare</i>	<i>Recreation</i>	<i>Other</i>	<i>At least one</i>
In 1990	78.5	76.7	69.8	38.2	84.4	94.6
In 2002 (assets built after 1990)	15.1	n.a.	2.0	4.7	17.6	32.4
Offer or support in 2002	55.7	90.8	26	73.3	76.5	97.8
Offer in full	34.2	67.1	10.4	20.8	76.5	91.8
Support assets transferred to municipality	5.0	4.0	6.7	0.3	n.a.	14.1
Direct financial aid to employees	22.0	42.1	8.9	58.7	n.a.	76.2
Other form of support	11.4	8.2	3.0	4.5	n.a.	22.0
Of those giving support, user base extends beyond employees and their families	55.6	38.7	41.9	29.4	n.a.	62.3

Source: HSE/CEFIR/BOFIT enterprise survey data. For details, see Haaparanta et al. (2003).

What are the possible rationales for continued engagement in the provision of social and infrastructure goods? Certainly, much of the physical capital of Russian firms was inherited from the Soviet

era, when industrial projects were constructed with a comprehensive view to community needs. In the absence of this legacy of non-plant assets and commitments, it is highly unlikely that firms in Russia would today engage in service and infrastructure provision to the extent they do.

More importantly, however, it appears firms engage in these activities to increase their operational reliability in highly insecure environments. By providing social and infrastructure goods, firms tackle three issues: availability and quality of basic infrastructure services, attachment of labor, and assuaging local officials.

Availability and quality of basic infrastructure services. As Table 1 points out, interruptions in basic infrastructure supply continue to be commonplace in Russia. Thus, firms seek to increase the quality and availability of local infrastructure to maximize their own capital input. Firms can assist in the provision of infrastructure services with financial or non-financial support or by producing the infrastructure good themselves.

Attachment of labor. Where public social services are otherwise scarce, workers give high value to such services from the employer. By providing workers with social services, the firm is able to attach its labor force.³

Assuaging local officials. In their analysis Lavrov, Litwack, and Sutherland (2000) argue that regions and localities in Russia favor large incumbent firms capable of providing public goods. Cash-constrained regional and local governments, which have a duty to provide traditional public goods such as education and health care, as well as heating and road upkeep, have an incentive to cooperate with local enterprises with resources to provide statutorily mandated public services. Enterprise-municipality cooperation is a two-way street: the municipality fulfills its mandates and the firm extracts beneficial treatment from municipal authorities. Influential firms may even engage in what Frye and Zhuravskaya (2002) describe as elite exchange: enterprises receive favorable treatment for providing certain benefits to state agents.⁴ On the other hand, in an economy characterized by insecure property rights, rigid rules with wide latitude for interpretation, and a poorly functioning judi-

³ For a thorough discussion, see Juurikkala and Lazareva (2006b).

⁴ For more discussion on relations between various levels of public administration and the private sector in Russia, see Solanko (2006) and Haaparanta and Juurikkala (2007) and the references therein.

ciary, a local bureaucrat may greatly harm or help any business operations. Firms must try to adjust to such conditions in any case.

Here, we assume that firms gain preferential treatment from authorities when they participate in municipal provision of infrastructure and social services (infrasoc provision) and face a threat of sanctions when they dissociate themselves from it. Social assets may also be used to lobby for authorities' help in shielding firms from competition as demonstrated by Juurikkala and Lazareva (2006a).

3 Optimal firm behavior under institutional uncertainty

Röller and Zhang (2005) envisage a transition country framework and examine how an exogenously given requirement for bundling social services with employee compensation may harm efficiency due to soft budget constraints. Here, we examine the case where firms endogenously choose to participate in social service and infrastructure provision, and propose a stylized model of enterprise behavior in an institutionally uncertain business environment.

The ground-breaking papers of Sandmo (1971) and Leland (1972) offer a model in which the firm seeks to maximize its expected utility from profits rather than directly maximize expected profits. The body of literature on firm decision-making under uncertainty that resulted from this insight provides a rich and fairly realistic framework for analysis of risk-laden business environments typical of transition economies like Russia. Moreover, this new approach avoids the standard risk-neutrality assumption of perfect capital markets (rarely the case in transition economies).

We now build on the assumption of a common von Neumann-Morgenstern utility function for the firm's decision-makers. Following Sandmo's (1971) argument, we assume that the preferences of decision-makers in most firms are sufficiently similar to guarantee the existence of a group preference function. This assumption is especially plausible for insider-owned firms, a common form of ownership in Russia (Angelucci et al., 2002).

The uncertainty literature (e.g. Hau, 2004) typically focuses on uncertainties related to demand and price of the firm's production.⁵ To stylize our firm optimization model, we depart from this traditional emphasis in two ways. First, uncertainty in our model lies in the probability distribution. For simplicity, we assume certainty concerning price and demand. Second, the firm in our model is able to influence its probability distribution through spending on infrastructure and social

⁵ A comprehensive survey is provided in Bauer (2005).

goods. We generalize the approach presented in McKenna (1985, Ch. 4.2.) where the firm faces two possible world states, to an insurance-type setting where the firm can affect the probability distribution.⁶

3.1 The model

Assume a price and wage-taking firm with four inputs: labor, capital, a social good, and an infrastructure good. To keep the model as simple as possible, we consider a short-term production function so capital input is fixed, and include only two outcomes: a good (i.e. well-performing) state with positive production and a breakdown (i.e. collapsing) state, where production falls to zero. The firm faces the risk of a production breakdown of probability $1-q$. The novelty of this model is that its probability distribution depends on three variables: a fully exogenous variable B , and goods variables S and I , $q=q(I, S, B)$. The firm can affect the probability of a good state, q , with its two inputs, social good S and infrastructure good I .

An increase in the social good, i.e. social services the firm provides for some or all of the workforce, results in better social services in such areas as health care. Provision of social services, in turn, helps the firm bind workers in a tight labor market or improve the firm's standing with local administrators. This enhances the probability a good state will emerge. Social services provided by the employer are also likely to improve the productivity of the workforce, especially in an environment where public provision is weak. Thus, we assume the social good positively affects both the probability of a good state and the firm's labor efficiency.

The infrastructure good, which includes activities such as repairing the electrical grid, is a non-traditional input in that it only affects the probability of a good state through more reliable infrastructure supply to the firm or through better connections to the locality. As the firm cannot control the probability distribution completely, the probability of good state q also depends on an exogenous variable B , which diminishes the probability of the good state. Unexpected impediments to a good state might include the installation of a corrupt municipal leader or the malfunction of the main pump at the local water utility. Such occurrences increase B , which translates into the lower probability of a good state with a given I and S .

⁶ For a similar insurance-taking individual application, see e.g. Shavell (1987).

Assume firm with certain demand maximizing expected utility from good and bad states by choosing L, I, S so that

$$\underset{(L,I,S)}{\text{MAX}} \{EU(\pi) = q(I, S, B)U(\pi_1) + (1 - q(I, S, B))U(\pi_2)\} , \quad (1)$$

where

$$\pi_1 = Q(\varphi(S)L) - (w + \lambda S)L - \lambda I + R \quad (2)$$

and

$$\pi_2 = -(w + \lambda S)L - \lambda I + R . \quad (3)$$

are the profits in good and bad state ($\pi_1 > \pi_2 > 0$). The probability of good state q is an increasing function of infrastructure and social expenditures, i.e. $q = q(I, S, B)$ with $q_S, q_I > 0$ and $q_{SS}, q_{II} < 0$ and a decreasing function of B . The natural assumption here is that the cross-derivatives q_{SB} and q_{IB} are positive, indicating a stronger marginal effect of I and S to q in the case of an increase in the exogenous risk variable. Finally, we assume the firm is risk averse, so $U'(\pi) > 0$ and $U''(\pi) < 0$. These are the key assumptions of our model. $Q(\varphi(S)L)$ is a typical concave production function, where $\varphi(S)$ is a concave labor input efficiency function with argument of firm's social provision S . Thus, S is measured in monetary terms as to the extent it increases the efficiency of the firm's workers. It can also be directly added to the cost side of the firm's operations as with the given wage level w . Moreover, infrastructure provision, I , can also be measured in monetary terms and added to the firm's costs. I enters the firm's production function indirectly via the expected utility presentation of production uncertainty. In other words, I does not increase the firm's production like S ; it only increases the probability that the firm will perform well. While the costs of social services increase in relation to size of labor force, actions such as fixing a broken power line secures the electricity supply for the firm irrespective of the how much it produces. The exogenous parameter λ represents physical inheritance and takes a value between zero and one. As discussed earlier, much of the capital assets of Russian firms are a legacy from the Soviet era. This inheritance significantly diminishes costs involved in infrastructure and social good participation. Parameter λ is one minus the share of I and S that is inherited, or a value of one if nothing was inherited from the Soviet period.⁷ Finally, we assume that the firm has asset incomes R to cover the losses involved with the bad production state.

⁷ Purely for notational simplicity, we assume λ to be the same for both I and S . We could easily give different inheritance parameters for I and S without affecting the results.

The maximization problem in details is

$$\underset{(L,I,S)}{MAX} \{E[U(\pi)] = q(I, S, B)U[Q(\phi(S)L - (w + \lambda S)L - \lambda I + R)] + (1 - q(I, S, B))U[-(w + \lambda S)L - \lambda I + R]\} \quad (4)$$

The first-order conditions under assumption that interior maximization solution exists are

$$A1) \quad \frac{\partial E(U)}{\partial L} \Big|_{L=L^*} = qU'(\pi_1^*)[Q'\phi(S) - w - \lambda S] + (1 - q)U'(\pi_2^*)[-w - \lambda S] = 0.$$

$$B1) \quad \frac{\partial E(U)}{\partial I} \Big|_{I=I^*} = qI U(\pi_1^*) - qU'(\pi_1^*)\lambda - qI U(\pi_2^*) - (1 - q)\lambda U'(\pi_2^*) = 0.$$

$$C1) \quad \frac{\partial E(U)}{\partial S} \Big|_{S=S^*} = q_S U(\pi_1^*) + qU'(\pi_1^*)(Q'\phi' - \lambda) + q_S U(\pi_2^*) - (1 - q)\lambda U'(\pi_2^*)L = 0.$$

3.2 Implications of the results

We now analyze how changes in uncertainty affect the firm's behavior. Utilizing the implicit function theorem, we derive the following comparative statics (see details in Appendix I):

$$\frac{dL}{dq} = \frac{-[(w + \lambda S)(U'(\pi_2^*) - U'(\pi_1^*)) + U'(\pi_1^*)Q'e]}{qU''(\pi_1^*)(Q'e - w - \lambda S)^2 + qU'(\pi_1^*)Q''e^2 + (1 - q)U''(\pi_2^*)(-w - \lambda S)^2} > 0 \quad (5)$$

The positive sign of (5) follows from the fact that the denominator is negative due to the second derivatives in each term and as the term in brackets in the nominator is positive. In similar fashion, we obtain $dL/dB < 0$ which is identical to (5) with the exception that nominator is multiplied by q_B reversing the sign. Thus, a firm operating in the current setting employs fewer workers in a less certain environment and reacts to an increase in the exogenous "risk shock" B by lowering its labor demand. Note that these results hold irrespective of the rate of risk aversion or the efficiency rate of S .

Concerning infrastructure and social good expenditures, we base our analysis again on total differentiation. From B2) and C2), we get the following relations, whereby $U(\pi_i^*)$ and others are replaced by $U(1)$ etc. to ease notation:

$$\frac{dI}{dB} = \frac{-[q_{IB}(U(1) - U(2)) + q_B \lambda(U'(2) - U'(1))]}{q_{II}(U(1) - U(2)) + 2q_I \lambda(U'(2) - U'(1)) + q \lambda^2(U''(1) - U''(2)) + \lambda^2 U''(2)} \quad (6)$$

and

$$\frac{dS}{dB} = \frac{-[q_{SB}(U(1) - U(2)) + q_B [U'(1)(Q' \phi' - \lambda)L + \lambda U'(2)]L]}{\Omega}, \quad (7)$$

where

$$\begin{aligned} \Omega = & q_{SS}(U(1) - U(2)) + 2q_S((Q' \phi' - \lambda)U'(1) + \lambda U'(2))L + \\ & + q((Q'' \phi'^2 L + Q' \phi'')U'(1) + LU''(1)(Q' \phi' - \lambda))L + (1 - q)U''(2)\lambda^2 L^2 \end{aligned}$$

Unfortunately, the differentials become too complex for an analytical solution. However, we are able to get some insight from the relations by examining the effect of firm's risk aversion. We will do this by solving (6) and (7) with a standard constant absolute risk aversion (CARA) utility function $U(\pi) = 1 - e^{-\gamma\pi}$, where γ measures the level of risk aversion, i.e. an increase in γ means an increase in risk aversion.⁸ This gives results (8) and (9):

$$\frac{dI}{dB} = \frac{-\left[\frac{1}{e^{\gamma\pi_2}} - \frac{1}{e^{\gamma\pi_1}}\right] [(q_{IB} + \gamma \lambda q_B)]}{\frac{1}{e^{\gamma\pi_2}} (q_{II} + 2q_I \lambda \gamma + (q-1)\gamma^2 \lambda^2) - \frac{1}{e^{\gamma\pi_1}} (q_{II} + 2q_I \lambda \gamma + q \gamma^2 \lambda^2)} \quad (8)$$

and

$$\frac{dS}{dB} = \frac{-\left[q_{SB} \left(\frac{1}{e^{\gamma\pi_2}} - \frac{1}{e^{\gamma\pi_1}}\right) + \gamma q_B \lambda L \left(\frac{1}{e^{\gamma\pi_2}} - \frac{1}{e^{\gamma\pi_1}} (1 - Q' \phi')\right)\right]}{\frac{1}{e^{\gamma\pi_2}} (q_{SS} + 2q_S \gamma \lambda L + (q-1)(\gamma \lambda L)^2) - \frac{1}{e^{\gamma\pi_1}} \left(q_{SS} + 2q_S \gamma L (\lambda - Q' \phi') + q \gamma^2 L^2 \left[(Q' \phi' - \lambda)^2 - \frac{(Q'' \phi'^2 + Q' \phi'')}{\gamma} \right] \right)} \quad (9)$$

⁸ Our qualitative results remain with a standard decreasing absolute risk aversion (DARA) function $U(\pi) = \log(\pi)$.

Looking at (8), we see that as risk aversion (γ) grows, the nominator tends toward positive as the first bracket is positive and second tends to negative. For the denominator, we see that it tends toward negative as γ grows. Thus, the outcome $dI/dB < 0$ becomes more probable as firm becomes more risk averse. At first glance, it might seem counter-intuitive that the firm decides to invest less in “insuring” itself when it perceives increased uncertainty in its operating environment (e.g. increase in frequency and duration of electrical power outages). However, there is a major difference between our setting and the setting with standard insurance. With an insurance contract, the insured party secures a certain level of reimbursement in the bad state. Here, our firm does not have that luxury. For the firm in our setting, there is no guaranteed reimbursement for I in the realized world state no matter how much the firm invests in I . The firm only knows that the probability of the good state is higher with higher I .

Why would a firm, especially a highly risk-averse firm, ever invest in I ? Concerning the analysis above, we see that the sign is reversed if $q_{IB} > \gamma \lambda q_B$; i.e. if the marginal effectiveness of I on q becomes sufficiently large after the increased uncertainty shock.⁹ Thereafter, the firm decides to invest more in I even if there is a risk of getting nothing in return. Intuitively, the positive sign of (8) becomes increasingly likely with a higher capital inheritance as the costs of I diminish.

We find similar effect working for S , but the situation is more complex due to the dual effect of S . In (9), the first term in both the nominator and denominator could be roughly interpreted as the risk effect of S , and the second as the efficiency effect. The denominator tends toward negative as the level of risk aversion rises.¹⁰ The nominator tends to positive with increasing γ resulting in $dS/dB < 0$. The efficiency gains contribute to the sign of (9) in two ways. For small marginal efficiency gains, the outcome $dS/dB > 0$ is enhanced; for $Q' \phi' > 1$, the opposite follows.

Concerning risk aversion and inheritance, the firm’s behavior follows the same logic as with infrastructure. Again, it may seem counter-intuitive that larger marginal efficiency gains from S contribute negatively to the firm’s willingness to increase S in an uncertainty shock. However, we are examining the firm at its optimal level of S . Small marginal efficiency gains mean that firm regards S as beneficial and has initially invested considerably in S , leaving only small marginal gains un-utilized. In contrast, large marginal gains refer to a setting where the firm does not consider S as

⁹ This is analogous to shifting to a lower level on the $q(I)$ curve where $q'(I)$ is larger.

¹⁰ This follows from the fact that terms where variables are raised to the second power all contribute to the negativity of the denominator.

beneficial in the first place, meaning the firms is even less likely to do so in the event of a larger uncertainty shock. The findings are summarized in Proposition 1 below.

Proposition 1

- A) The less certain the operating environment, the fewer the number of people employed by the firm.
- B) Raising the level of risk aversion tends to decrease I if the exogenous shock risk increases. We see an increase in I only when the resulting increase in the marginal effect of I is large enough to offset the negative impact of B on q , multiplied by the level of risk aversion. An increase in I becomes more likely as the share of inherited I grows.
- C) Raising the level of risk aversion tends to decrease S if the exogenous shock risk increases. This effect is enhanced by large marginal gains, indicating that the firm does not consider S to be particularly beneficial in the first place. An increase in S is more likely as the share of inherited S grows.

4 Empirical evidence

In this section, we present empirical evidence on firm activity in an uncertain environment. Although direct testing of our model is difficult, we can get a sense on how the data line up with the model features. We start with a firm performance analysis to see how provision of social services and infrastructure goods by the firm is reflected in its performance. We use common explanatory variables from performance literature coupled with our unique survey variables on firms' provision of social services and infrastructure goods. Following the performance analysis, we examine the three channels through which the firm's participation in provision of social services and infrastructure goods enhances the firm's operational reliability.¹¹

The HSE/BOFIT/CEFIR survey data on Russian medium-sized and large industrial enterprises come out of a survey conducted in spring 2003 that covers 404 large and medium-sized industrial enterprises in 40 Russian regions. Apart from energy production and minerals extraction, the sample is representative of industrial distribution (at the 2-digit level) in Russia. The majority of firms in the sample employed between 500 and 5,000 employees. For a thorough discussion of the

¹¹ In what follows, these two are referred to as "infrasoc goods."

survey design and implementation, see Haaparanta et al. (2003).¹² Descriptions and descriptive statistics of main variables used are provided in Appendix II.

4.1 Firm performance and *infrasoc* participation

The literature on firm performance in Russia has paid little attention to the question of social services and infrastructure. Using a measure of regional transport infrastructure quality, Brown and Earle (2000) identify a clear positive effect from better road quality on total factor productivity. Otherwise, the performance literature for Russian has concentrated on effects of ownership, soft budget constraints, or competition as in Carlin et al. (2001) and Djankov and Murrell (2002). Reiniikka and Svensson (2002) address the role of infrastructure on firm performance in other developing countries.

Relying on the survey data, we examine the effects of firm's provision of *infrasoc* goods on firm performance as measured by profit per employee (*eprofit*).¹³ As explanatory variables we have four variables that each depict different aspects of the phenomenon. First, as a variable reflecting firm's own infrastructure production, we have a dummy (*elec_prod*) with value of one if the firm produced its own electricity in 2002 and zero otherwise. Second, we have the variable (*railsup*) to capture firm support for municipal infrastructure provision. The variable is coded as one if the firm provided any financial or non-financial support for the municipal railway system in 2002, and zero if no support was given. Third, to analyze social service provision, we have the dummy variable (*housing2002*) coded as one if firm provided housing or financed housing of its workers in 2002. Finally, we test the effect of problems in infrastructure delivery on performance. This is controlled with a variable depicting the number of day municipal heat delivery to the firm was interrupted in 2002.

Our standard control variables are capital, finance, internationality, geographical location, size of municipality, market power, ownership,¹⁴ and industry. We proxy the level of capital with a dummy variable (*invest*) indicating whether the firm carried out major investments during 2000-2002. Internationality of a firm is measured as the percentage of firm sales exported in 2002. The

¹² Our companion papers relying on the same dataset are Juurikkala et Lazareva (2006a) and (2006b), Haaparanta and Juurikkala (2007) and Solanko (2006).

¹³ Similar results, available on request, were obtained with sales per employee as the dependent variable.

¹⁴ A dummy was constructed for the largest shareholder (insiders, private, state, foreign, other). The category "insiders" includes employers and managers. The category "private" includes both private individuals and private Russian companies. The category "state" includes all three levels of government in Russia. Large Russian firms are typically controlled by a single type of owner.

firm's financing situation is proxied with the interest rate that it would have to pay for a short-term bank loan.

Our results (see Table 4) suggest production and support of infrastructure are positively linked to performance, a finding that conforms with Brown and Earle (2000). The coefficients are positive for railway support and electricity production when regressing on profit per employee in 2002. We also see evidence of a negative effect from infrastructure interruptions (heat) on performance. Social service provision, however, seems to be a burden as the coefficient on housing provision is negative.¹⁵

A potential bias arises in OLS estimates as infrastructure and social good supply and performance are possibly determined simultaneously. We are able to partly alleviate this endogeneity problem by running regressions with the same independent variables with 2003 performance figures. The main results reported in Table 4 remain unchanged.

How do these results coincide with our model implications? First, it seems that the probability gains from firm's infrastructure provision are large enough to translate into an identifiable increase in profits. On the other hand, social good provision seems to be a financial burden; and observation that matches both the opinions of surveyed firm managers and our regression results. So why would firms continue to provide social services? One possibility is that social services are an important part of the compensation package that the firm provides its employees. Alternatively, there may be a danger that reducing social service provision will harm the firm's relations with local authorities. In any case, the results suggest that firms in Russia are unable to act optimally with respect to social goods provision and are locked into a bad equilibrium created by social and institutional conditions specific to Russia.

4.2 Operational reliability: Participation in infrastructure provision

Our model suggests that firms provide the infrastructure good even though this only increases the probability of the good state and therefore increases their expected profits. We showed above that interruptions in municipal infrastructure provision decrease firm profits, while support to local infrastructure increases profits. The unique data further allow us to examine the determinants of infrastructure provision by the firm. Here, we concentrate on the determinants of private support for a municipal district heating system. Supporting municipal district heating system is one of the most widespread ways forms of private support for municipal infrastructure according to the

¹⁵ For a more thorough discussion on these control variables, see the earlier version of this paper (Leppänen et al., 2008).

HSE/CEFIR/BOFIT data. We show that Russian firms react to interruptions in infrastructure delivery by increasing their support for municipal infrastructure provision.

Column three in Table 4 reports our results for a Probit regression of the firm's contribution to municipal heating. The dependent variable (*heatsup*) is coded one if the firm provided financial or non-financial support to municipal heat supply in 2002. The same set of firm control variables as in the performance estimations are used. Our results indicate that heat interruptions motivate firms to get involved in supporting municipal heat provision. (On average, an increase of ten interruption days in heat delivery raises the probability of supporting municipal heat delivery by four percent). With respect to our model, this result could be interpreted as $dI/dB > 0$, whereby the combination of increased marginal probability effect and inheritance is sufficiently large to make participation in *I* rational after weakened infrastructure supply to the firm.

Table 4 Infrascoc variables and performance^a

	OLS		Probit ^b
	eprofit02	eprofit03	Heatsup
Elec_prod	54.75 (2.38)**	73.13 (2.05)**	
Railsup	28.42 (2.16)**	37.91 (2.34)**	
Housing2002	-10.62 (-2.02)**	2.67 (0.26)	
Heat interruption days	-0.55 (-1.89)*	-1.97 (-5.46)***	0.004 (2.22)**
Ln(employment2002)			-0.036 (-0.76)
Ln(employment2003)			0.059 (1.88)*
Invest	0.88 (0.12)	12.56 (1.16)	-0.050 (-0.68)
Municipality size	0.0032 (1.86)*	-0.0013 (-0.54)	-0.0002 (-2.21)**
Share of exports	0.31 (1.75)*	0.43 (1.78)*	0.0001 (0.11)
Constant	33.15 (1.21)	93.34 (2.05)**	
<i>No. of observations</i>	229	229	188
<i>Prob > F / Chi²</i>	0.0002	0.000	0.048
<i>R² / Pseudo R²</i>	0.32	0.30	0.20

a. t- and z-values for OLS and Probit in parentheses, heteroskedasticity robust standard errors used in all regressions. Federal district, industry, ownership and market power dummies included in all regressions but not reported. b. Results concerning the probit regression are reported in average marginal effects on $\text{Prob}(y=1)$ and their z-values. Marginal effects were obtained through Stata's "margeff" module.

***Significant at 1% level, **Significant at 5% level, *Significant at 10% level.

4.3 Operational reliability: Participation in social service provision

Our model assumes that provision of social services positively affect the probability of a good state, i.e. $q_S > 0$. In addition to obvious gains such as better worker health, enterprises may use social service provision as an attachment tool and diminish production risks resulting from departing staff. Juurikkala and Lazareva (2006b) show that firms use social services as non-wage benefits to employees in tight labor markets to increase labor attachment, and thus decrease labor turnover. Improved labor attachment increases productivity and decreases the monetary and time costs of replacing workers that quit. Juurikkala and Lazareva (2006b) further demonstrate that the strongest reductions in turnover concern blue-collar workers and that improved access to local service provision diminishes the share of non-wage benefits. Thus, social goods provision increases the probability of a good state by increasing operational reliability through labor attachment.

4.4 Operational reliability: Relations with the public sector

In the above discussion, we saw that firms use participation in infrastructure and social goods production as a means of increasing operational reliability via more reliable infrastructure delivery and labor attachment. The third channel for increasing operational reliability consists of relations with local authorities. There is evidence that Russian enterprises that provide infrastructure or social goods are able to extract favors from the local government. Juurikkala and Lazareva (2006a) show that enterprises use their social assets as leverage to extract benefits from the local public sector. They find that firms that divested their social assets later received greater financial benefits from the local authorities, especially in poor localities. They also find that firms operating in highly competitive environments divested later than their counterparts, suggesting that social assets may have been used to lobby authorities to help shield firms from competition. Solanko (2006) identifies evidence that firms involved in heat provision were more likely to receive financial benefits from the authorities. These findings support our argument that enterprises may increase their operational reliability, i.e. the probability of the good state through a combination of infrastructure and social good provision and relations with local authorities.

To explicitly test the perceived ability of enterprises to affect official decision-making, we construct a dummy variable with a value of one if the general manager expresses the view that his enterprise has been able to influence local or regional decision-making. A simple Probit regression was used to test for determinants of the ability of firms to influence local or regional public administration. The results reported in the first two columns of Table 5 suggest that participation in infra-

soc provision enhances firms' chances to influence public decision-making. As expected, larger enterprises in smaller jurisdictions have a higher probability of influencing activities by local or regional authorities. The form of ownership, however, does not seem to be decisive. Compared to insider-owned enterprises, only foreign owned-firms differ in having significantly smaller chances of influencing the behavior of authorities. Unremarkably, enterprises supporting municipal district heating systems have a significantly higher probability of influencing local or regional decision-making.

The results indicate that engagement in infrasoc provision helps enterprises maintain good relations with the local administration and extract benefits from it. Moreover, local administrations are not passive, but rather they have strong incentive to ensure continuity of infrasoc provision from firms. The survey data offer us an indirect measure to proxy for the bargaining power of local administrations. We are able to construct dummy variables on the expected consequences after hypothetical infrasoc divestment. Thus, *worse_heat* has an outcome of one if a general manager thinks his firm's relations with the local authorities could worsen and/or the firm's taxes unrelated to heating system might increase if the firm ceases to provide heating. Variable *worse_medic* is constructed similarly for medical facilities divestment. We use these variables as additional explanatory variables to explain firms' infrasoc provision.

Table 5 Infra-social participation and public relations

<i>PROBIT</i> ^a	<i>munic_capture</i>	<i>regio_capture</i>	<i>Heat prov</i>	<i>Medic prov</i>
LNpopulation	-0.048 (-1.67)*	-0.034 (-1.24)	-0.100 (-3.89)***	-0.016 (-0.67)
LNemp02	0.106 (1.70)*	0.065 (1.05)	0.061 (2.11)**	0.024 (0.45)
LNsales02 ^b	0.028 (0.66)	0.044 (1.09)		-0.042 (-1.09)
Invest	-0.072 (-0.82)	-0.051 (-0.62)	0.106 1.39	-0.100 (-1.52)
Owner: Private	-0.023 (-0.33)	0.087 (1.25)	0.120 (1.94)*	-0.003 (-0.04)
Owner: State	-0.130 (-1.21)	0.065 (0.58)	0.132 (1.48)	-0.036 (-0.38)
Owner: Foreign	-0.240 (-2.09)**	-0.030 (-0.23)	-0.175 (-1.76)*	0.117 (1.37)
Owner: Other	0.045 (0.27)	0.130 (0.83)	0.211 (1.77)*	
Heat support	0.164 (1.75)*	0.210 (2.18)**		
Heat_pre90			0.257 (3.44)***	
Worse_heat			0.168 (2.83)***	
Medic_pre90				0.153 (1.56)
Worse_medic				0.201 (4.39)***
Prob > Chi ²	0.04	0.02	0.000	0.01
Pseudo R ²	0.11	0.12	0.34	0.21
No. of observations	237	239	195	175

a. Probit regression results are reported in average marginal effects on Prob(y=1) and with their z-values. Heteroskedasticity robust standard errors used. Federal district, industry and market power dummies are included, but not reported.

b. LNsales02 variable was dropped from the heat provision estimation as it did not have a major effect on the most interesting variables, but it made LNemp02 insignificant most likely due multicollinearity. This was not the case for provision of medical services, so both are included.

For the dependant dummy variables, we use heat and medical provision to outsiders. These are coded one if the firm provides the service outside its own premises and to people who are not its employees. Here, it is natural to use the provision to *outsiders* variable as this is the clearest example of firms covering the responsibilities of the authorities.¹⁶ The results – robust for the control variable selections – appear in columns three and four of Table 5. Our regressions show that if the firm expects authority relations to worsen if it gets out of the heating business, there is a seventeen percent higher probability that the firm will continue to provide heating than a firm that does not

¹⁶ These two outcome variables were selected as they are the most common social services that firms offer to outside users. See Table 3.

perceive such a threat. For medical service provision, the effect is some twenty percent. Thus, the threat of worsening relations with the local administration seems to keep the current system in operation. The authority risk, together with labor market considerations, may indeed be the reason a firm gets locked into a bad equilibrium of producing non-profitable social services. These results are in line with Solanko (2006), who shows that heat provision by Russian enterprises is largely explained by relations with the local public sector and inherited factors. The legacy factor is also addressed in Table 5 through dummy variables coded as one if the firm had a heating plant and medical facilities already in the socialist time (*heat_pre90* and *medic_pre90*). Interestingly, while heat provision is strongly explained by inheritance, the medical provision is not. This certainly reflects the lower capital intensity of providing basic medical services.

5 Conclusions

The Russian practice of firms participating in the provision of infrastructure and social services has its roots in the Soviet economic system. Although the planned economy ended almost twenty years ago, companies, especially those in towns dedicated to a single large industry, continue to support infrastructure and social services to this day. Utilizing a theoretical model and a unique survey data from large Russian enterprises, we analyzed the rationale for such behavior in an ostensibly market-driven economy. Based on earlier related studies and new results, we argue that the complex involvement of Russian firms in infrastructure and social good provision can largely be distilled down to two factors. First, firms participate in the provision of infrastructure and social service to enhance their operational reliability. Second, the Soviet era legacy of physical facilities and institutions continues to linger in the background.

We constructed a simple model of firm behavior under uncertainty to make our argument. As the starting point, we assumed the firms can influence the probability of a good state by engaging in infrastructure and social services provision. The provision of these goods affects the firm's operational reliability through three channels. Firms may contribute to infrastructure provision to improve the availability and quality of basic infrastructure services in order to assure smooth production, they may use social services to attach workers in tight labor markets, and they may use the provision levels as a bargaining tool in dealing with local authorities.

Using data from a large enterprise survey to empirically support the main features of the model, our theoretical and empirical results show that physical inheritance plays a major role in determining the extent to which firms participate in infrastructure and social good provision. This is natural as the costs of participation are considerably lower with inherited capital. Institutional legacies may help explain why some firms provide excess amount of social goods eating up their profits. If genuine corporate social responsibility is present in the Russian case, this, to our mind, is the strongest evidence of its existence.

The practice of firms' participation in infrastructure and social service provision of infrastructure and social goods is likely to continue as long as the public sector is unable to meet its mandates. Russian institutions remain weak, and facilities inherited by firms from the Soviet times are still serviceable. While the mutual benefits of this arrangement between the public and private sector might be rational in the short term, the long-term impacts on growth and efficiency are likely to be negative. On the other hand, despite the long period of economic growth prior to 2008 crisis, the Russian public sector is still unable to provide these services in full. Without the active participation of firms, many citizens would be deprived of daily necessities and services taken for granted in most of the developed world.

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Appendix I

Totally differentiating first order condition A1) with respect to q , B and $L = L^*$ gives:

$$dL[qU''(1)(Q'\varphi - w - \mu S)^2 + qU'(1)Q''\varphi^2 + (1-q)U''(2)(-w - \mu S)^2] + \dots \\ \dots + dB[q_B((w + \mu S)(U'(2) - U'(1) + U'(1)Q'\varphi)] + dB[((w + \mu S)(U'(2) - U'(1) + U'(1)Q'\varphi)] = 0.$$

Rearranging gives equation (5). Totally differentiating first-order condition B1) with respect to B and $I = I^*$ gives:

$$dI[q_{II}(U(1) - U(2)) + 2q_I\mu(U'(2) - U'(1)) + q\mu^2(U''(1) - U''(2)) + \mu^2U'''(2)] + \dots \\ \dots + dB[q_{IB}U(1) - q_BU'(1)\mu - q_{IB}(U(2) + q_BU'(2)\mu)] = 0.$$

Rearranging gives equation (6). Totally differentiating first order condition C1) with respect to B and $S = S^*$

$$dS[q_{SS}U(1) + 2q_SU'(1)(Q'\varphi' - \mu)L + qU'''(1)(Q'\varphi' - \mu)^2L^2 + qLU'(1)(Q''\varphi'^2L + Q'\varphi'') + \dots \\ \dots - q_{SS}U(2) + 2q_SU'(2)\mu L + (1-q)U''(2)L^2\mu^2] + \dots \\ \dots + dB[q_{SB}U(1) + q_BU'(1)(Q'\varphi' - \mu)L - q_{SB}U(2) + q_BU'(2)\mu L] = 0.$$

Rearranging gives equation (7).

Appendix II

Table 6. Description of main variables

Dependent variables^a						
	Description	Obs.	Mean	Std. Dev.	Min	Max
<i>eprofit02</i>	Profit per employee in 2002	359	18.87	47.47	-83.95	274.96
<i>eprofit03</i>	Profit per employee in 2003	359	19.83	65.16	-	490.31
<i>esales02</i>	Sales per employee in 2002	376	318.78	266.85	3.90	1527.80
<i>esales03</i>	Sales per employee in 2003	369	435.59	418.84	15.28	2580.20
<i>munic_capture</i>	Dummy=1 if firm admits to have ability to influence relevant local / regional legislation	375	0.44	0.50	0	1
<i>regio_capture</i>		386	0.36	0.48	0	1
<i>Heat prov</i>	Dummy=1 if firm provides heat to outsiders	404	0.41	0.49	0	1
<i>Heat support</i>	Dummy=1 if firm provided non- or financial support to municipal heating system	403	0.17	0.37	0	1
<i>Medic prov</i>	Dummy=1 if firm has medical facilities in its books	376	0.72	0.45	0	1
Independent variables						
	Description	Obs.	Mean	Std. Dev.	Min	Max
<i>LNemp02</i>	Log of employment in 2002	390	6.82	0.92	1.79	10.50
<i>LNsales02</i>	Log of sales in 2003	375	12.24	1.32	7.90	16.13
<i>Population</i>	Population of firm's municipality in 1000s	401	1239.77	2265.88	15.6	8304.6
<i>Invest</i>	Dummy=1 if firm has had major capital investments in 2000-2002	402	0.82	0.38	0	1
<i>Interest</i>	Estimated annual interest firm would have to pay for a short term bank loan	333	20.19	4.46	0	39
<i>Export02</i>	Share of exports of all sales in 2002, in %	399	11.29	20.73	0	100
<i>Elec_prod</i>	Dummy=1 if firm produces electricity	404	0.04	0.21	0	1
<i>Railsup</i>	Dummy=1 if firm provided non- or financial support to municipal railway system	403	0.08	0.27	0	1
<i>Heat_pre90</i>	Dummy=1 if firm had heating boilers already in Soviet times	403	0.58	0.49	0	1
<i>Heat interr. days</i>	Number of interruption days in municipal heat supply to firm	399	1.16	6.48	0	90
<i>Worse_heat</i>	Dummy=1 if manager believes heat divestment --> worse relations and/or higher taxes	276	0.27	0.44	0	1
<i>House02</i>	Dummy=1 if firm owned or supported staff housing in 2002	404	0.39	0.49	0	1
<i>Medic_pre90</i>	Dummy=1 if firm had medical facilities already in Soviet times	403	0.77	0.42	0	1
<i>Worse_med</i>	Dummy=1 if manager believes medical divestment --> worse relations and/or higher taxes	301	0.19	0.40	0	1

a. Note that heatprov and heatsup are also used as independent variables.

b. We remove one percent of the performance variables' tails to exclude the obvious outliers.

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