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Coping with missing public infrastructure:

An analysis of Russian industrial enterprises

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Laura Solanko

Coping with missing public infrastructure: An analysis of Russian industrial enterprises[1]

Abstract

During the Soviet period industrial firms not only formed the backbone of the economy but also directly provided a wide range of benefits to their municipalities. Firms were in charge of supplying a great variety of social services, such as housing, medical care and day care. The need to divest at least some of these functions was generally accepted already in the early 1990s. Industrial firms' engagement in the provision of infrastructure services, such as heating, electricity and road upkeep has to date received much less attention. Using a unique dataset of 404 large and medium-sized industrial enterprises in 40 regions of Russia, this paper examines public infrastructure provision by Russian industrial enterprises. We find that, first, to a large degree engagement in infrastructure provision – as proxied by district heating production – is a Soviet legacy. Second, firms providing district heating to users outside their plant area are more likely to have close relations with the local public sector along many other dimensions.

Keywords: Russia, infrastructure, firm performance
JEL Codes: P31, P35 (Socialist Institutions and Their Transitions), H54

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Laura Solanko

Coping with missing public infrastructure: An analysis of Russian industrial enterprises

Tiivistelmä

Neuvostojärjestelmässä teollisuusyritykset paitsi muodostivat kansantalouden tukijalan myös tarjosivat lukuisia palveluita sijantipaikkakunnilleen. Yritykset vastasivat useista sosiaalipalveluista, kuten asumisesta ja päivähoidosta, mutta myös monista infrastruktuuripalveluista, kuten lämmityksestä, sähköntuotannosta tai tieverkon ylläpidosta. Huomattava osa sosiaalipalveluista on jo 1990-luvun aikana joko yksityistetty tai siirretty julkisen sektorin hoidettavaksi, mutta tähän asti on tiedetty hämmästyttävän vähän yritysten osuudesta infrastruktuuripalveluiden tuotannossa.

Tässä tutkimuksessa tarkastellaan teollisuusyritysten roolia julkisten infrastruktuuripalveluiden, kuten kaukolämmön, tiestön ja vesihuollon, tuottajana nyky-Venäjällä. Edustavaan yritysaineistoon perustuva empiirinen analyysi osoittaa, että infrastruktuuripalveluiden tuottaminen teollisuusyritysten voimin on edelleen yleistä ja pitkälti neuvostoaikojen perintöä. Infrastruktuuripalveluita tuottavien yritysten suhteet paikalliseen julkisvaltaan ovat tyypillisesti tiiviitä, eivätkä yritykset halua luopua näiden suhteiden ja infrastruktuuripalveluiden tuottamisen perustuvasta järjestelmästä.

1 Introduction

One can attribute Russia's dismal economic performance in the 1990s to many causes, but poor institutions and cumbersome bureaucracy are increasingly mentioned among the main culprits. The transition of the public sector from a Soviet-era producer and regulator to a market-supporting institution clearly has not succeeded – it is even questionable whether this goal was ever seriously targeted during the 1990s. The Russian government – especially at regional and local levels – is often described as a "grabbing hand" a phrase coined by Frye in Shleifer (1997). Many Soviet-era practices continue and politics still have considerable influence on economic activities. Regional politicians and large firms may collude to, e.g., avoid bankruptcies or optimise tax payments. Small and medium-sized enterprises together with foreign-owned companies, in contrast, tend to rate tax administration, government regulations and inspections as their major headaches.

Although there are signs that administrative reform and cutting down bureaucracy are finally on the way, the reforms are far from completed (CEFIR 2005). Businesses continuously need close contacts with regional and local governments to alleviate their regulatory burden. One area of close cooperation between enterprises (especially large and medium-sized ones) and the local public sector is the provision of public infrastructure.

Based on unique data from a firm survey carried out in 2003 covering 404 large and medium-sized enterprises in 40 Russian regions, this paper aims to deepen our knowledge of the relationship between firms and the public sector at the local level (Haaparanta et al 2003). We will concentrate on the causes and consequences of infrastructure provision, as proxied by heat production, for this relationship. It is increasingly acknowledged that well-functioning public infrastructure is important for growth and development in its own right. This is especially true in a country as large and sparsely populated as Russia. We believe that the repair and maintenance of the basic infrastructure networks like roads as well as oil, gas and water pipelines is bound to become a major issue if economic growth is to continue in Russia.

The role of poor infrastructure and deficient public services has, indeed, lately received more attention in the economic literature. This is largely due to increased interest in structural reforms and infrastructure delivery in developing countries. The World Bank, especially, has been active in promoting discussion on infrastructure development and the

role of infrastructure in promoting economic growth and welfare (World Bank 2002, 2004, EBRD 2004). Infrastructure, especially the provision of basic services and access to modern technology, is increasingly seen as an integral part of development. Most studies of cross-county growth do include infrastructure indicators in the analysis and many find them significant (Barro and Sala-i-Martin, 1995). The existing empirical evidence, however, indicates that the effect of public spending and investment on growth is mixed at best. This may be due to difficulties in measurement and identification: more spending does not necessarily turn into more public capital or services of uniform quality. This concern has caused increased interest in micro-level studies that are better equipped to cope with these issues. Reinikka and Svensson (2002) do, in fact, show that poor public infrastructure, as proxied by unreliable and inadequate electricity supply, significantly reduces private investment.

As much of the development literature focuses on countries situated in much milder climatic conditions, heating has not received much, if any, attention in recent literature on infrastructure and development. Heating is, however, a necessary precondition for industrial activities anywhere, especially anywhere north of latitude 50^{o}. Our survey data reveals that in 2002 three quarters of the large and medium-sized Russian enterprises produced their own heating. Of those, over half also provided district heating for users outside their plant area. District heating is, therefore, the area where the engagement of the enterprise sector in infrastructure provision is clearly most widespread. Further, based on the survey results, we know that heat-producing enterprises are, on average, more likely to give support for the maintenance of many other types of public infrastructure like roads, railways and hot steam pipelines. Therefore, we believe that engagement in district heating production can be used as a meaningful proxy of engagement in infrastructure provision at large in Russia.

The data offers us a unique opportunity to examine the relations between heat-producing enterprises and the local public sector along many dimensions. As only less than 40% of the enterprise managers named profit generation as a reason for heat deliveries, it seems natural to enquire more deeply into the determinants first, of heat production and second, of heat delivery. We will analyse here the effects of heat production on firm performance to find an answer to the critically important question of whether engagement in public infrastructure service provision is a burden for the enterprise sector. Two conflicting hypotheses are possible. H1: Enterprises that are, due to historical reasons, forced into op-

erations far beyond their main business suffer in terms of productivity and investments. H2: The enterprises that engage in heat and infrastructure provision do so in exchange for favours from the local government. Our conclusions seem to be much more in line with the latter option.

The rest of the paper is organised as follows: the following section discusses public-private relations in Russia and characterises the general framework of the analysis. Section three describes the data used. Section four presents the empirical results and section five concludes the discussion.

2 Enterprises, district heating and the public sector in Russia

Following Reinikka and Svensson (2002), complementary capital may be defined as capital that provides support services necessary for the operation of productive private capital. Especially in low- and medium-income countries, complementary capital (e.g. transport infrastructure or utilities) is typically provided by state monopolies or publicly owned companies. To a certain degree, a firm can substitute for mediocre public services by investing privately in complementary capital (e.g. private electric power generators). Heating is undoubtedly an integral component of complementary capital. In most parts of Scandinavia, Russia and a number of other countries of the former Soviet Union, heating is perceived as a sort of semi-public good. The reason is that these countries have historically relied heavily on district heating, usually provided by municipal heat and power plants.

In Russia, the engagement of enterprises in infrastructure provision has its roots in the way Soviet cities were planned. A standardized model of Soviet municipal infrastructure whereby a city of a certain size is linked to a certain number of electric power and heating plants emerged as a by-product of central planning. In fact, most of the classical social infrastructure items like heating utilities, housing, schools, hospitals, water and sanitation were designed on a district-wide or city-wide basis. The heating and power plants as well as the other infrastructure items would be operated either by the city or by individual enterprises according to the plan. (Hill and Gaddy 2003)

Even today large enterprises remain critically important in some areas of infrastructure provision, notably in district heating. In many cases an enterprise continues to be the

monopoly heat provider for the apartment blocks it owned or for a whole district. As an example, at the beginning of the heating period 2004 - 2005, the main concern of the city of Petrozavodsk (Republic of Carelia) was to ensure that two large companies currently in financial difficulties – the Avangard shipyard and the tractor factory Onega – would be ready for the heating season (Karjalan Sanomat, September 2004).

There are two separate reasons for the private enterprises to engage in the production of complementary capital (heating) in Russia. First, some firms have been forced to invest in their own boilers to substitute for or to complement the low-quality municipal district heating. It is widely known that the district heating pipelines are in a sad state, characterized by frequent leakages and considerable thermal losses. News about interruptions in heat delivery due to broken pipes or even a lack of fuel is not uncommon. At least in theory, combined heat and power (CHP) generation is the most efficient method of district heat production. Thus, apart from the enterprises where steam or hot water is a by-product of the production process, investing in enterprises' own heat-only-boilers may cause an efficiency loss compared to a situation where the enterprise could rely on heating produced by a (municipal) CHP plant.

Secondly, as noted above, enterprises sometimes are, by design, themselves responsible for providing district heating for their surroundings. This unavoidably leads to a somewhat special relationship between the enterprises providing district heating and the local administration. The consumer price for heat is determined by regional energy commissions and municipalities. In most cases the tariffs have not been sufficient to cover the costs of supply and consequently heat supply has not been profitable even for the local energy companies running combined heat and power generation. (IEA 2002) Thus, it has been argued that the implicit obligation to provide heat for municipal district heating is an excessive burden for industrial enterprises struggling for their survival in the emerging market environment.

On the other hand, there is (casual) evidence of cases where enterprises use their boilers as a bargaining tool vis à vis the local administration (interview with Starodubrovskaya in Moscow 2002). As our survey results show, heat-providing enterprises are on average larger and older than the enterprises not producing heat. And, especially in a transition economy, size tends to come with connections and influence.[2] An influential firm

[2] This is naturally true for any economy, especially so if the legislative framework is in a state of flux and corruption is widespread.

would typically be a large firm, employing a large share of the local population and consequently affecting directly the local wellbeing and electoral mood (e.g. Hellman et al. 2003).

An influential firm has good opportunities to engage in what Frye (2002) describes as elite exchange. That is, enterprises which receive favourable treatment also provide some benefits to state agents. It is highly probable that at least some heat-providing firms have been able to negotiate with the local government for favours to compensate for the costs of heat production. This would, in fact, suggest that the enterprises have simply adapted to the existing institutions and infrastructure. The Soviet legacy of firms providing complementary capital not only for themselves may seem strange to an outside observer. But if firms have found their way around the local administration, infrastructure provision may not be any great obstacle to growth. Indeed, as pointed out by Rodrik (2003), a vide variety of even fairly unorthodox institutional setups may be compatible with economic growth.[3]

There are several possible reasons for the public sector to be interested in cooperation with enterprises in the provision of public goods and complementary capital. The self-evident reason naturally is that the local public sector in Russia has very little funds available for new investments and it is thus in everyone's interest to use the existing capacities whenever possible. Even if a municipality could manage public infrastructure without the help of the local enterprises, retaining the close relations probably provides local politicians with various possibilities for collecting some private benefits.

The mismatch between considerable expenditure requirements and the lack of own revenues at the regional level also results in peculiar forms of public goods provision. In their analysis of Russian fiscal federalism, Lavrov, Litwack, and Sutherland (2000) argue that regions and localities in Russia favour large incumbent firms capable of providing public goods. As cash-constrained regional and local governments must provide classic public goods such as education and health care as well as heating and road upkeep, local administrations have an incentive to cooperate with local enterprises in providing statutory public services.

One channel for informal budget operations is where large firms contribute directly to the provision of some public services such as road maintenance or health care. In exchange, regional governments may tolerate large tax arrears with no expectation of ever

being paid.[4] At the regional level, everyone is happy; firms roughly pay in some form most of the taxes they would otherwise have to pay, consumers get some public services, and regional leaders have independent discretion over budget operations. The obvious loser here is the federal government, which is effectively deprived of its share of tax revenue. (See also Haaparanta-Juurikkala 2004.) Frye (2002) does, indeed, offer survey evidence that the economic playing field in Russia is tilted in favour of large (formerly state-owned) enterprises and against smaller de novo firms, especially at the regional level.

3 Data

3.1 Data sources

Most of the data used in this paper comes from a firm survey conducted among large Russian industrial enterprises in April-June 2003. The survey focused on enterprises' role in providing social services and infrastructure. The survey, therefore, included many questions on firm involvement in the provision of a wide variety of social services, as well as assessments of public infrastructure items, the generation of heat and electricity as well as regulation and competition. In contrast, detailed balance sheet data was not collected.

The survey covered 404 large and medium-sized industrial enterprises in 40 regions in Russia. Apart from energy production and minerals extraction, which were excluded, the sample is representative of industrial distribution (on a 2-digit level) in Russia. The majority of firms in the sample employ between 500 and 5000 employees. For a thorough discussion of the survey design and implementation, see Haaparanta et al (2003).

3.2 The two dependent variables

The general managerof each firm surveyed was asked if his enterprise currently produces heat and if heating is provided to outside users. Three quarters of the enterprises surveyed

[3] See also Hausman et al (2004).
[4] Tax collection is the duty of the Federal Tax Ministry, but local tax offices have considerable power in implementing tax rules as supervision and guidance from the higher-level tax administration have been rather weak. Employees of regional and local branches of the tax ministry often depend on regional or local governments for their premises, transportation, communications, office equipment, etc. This creates an informal system of dual subordination that may allow regional and local governments to influence decision-making by local tax offices.

produced heating in 2003. Of those who produced heating, over half also provided heating to outside users, mainly to the local housing and utilities sector (*predprijatii zhilizno-kommulnalnavo hozjaistva*). There are no trading houses in the sample, i.e. no enterprise provides heating to outsiders if it does not produce heat. The general managers' answers, reported in Table 1 below, are used to construct two discrete dependent variables, one for heat production (heatprod) and another for district heat provision (heatsell).

Table 1 Production and provision of heating

	Firm owns heating boilers	Firm produces heat (heatprod)	Firm provides heat to outsiders (heatsell)
Yes	306	300	167
No	98	104	130

Note: Due to missing responses, the sum of responses is sometimes less than the total number of firms in the sample.

The general manager was also asked about the reasons for a firm's own production of heating and the reasons for providing district heating to outside users. The answers seem to reflect the fact that in most cases a firm's heat-producing capacity (i.e. boilers) was inherited from the socialist period. The majority of managers failed to name a reason for heat production apart from "history" or "technological needs". Out of the 167 firms providing district heating, only 69 considered it to be profitable. This result notwithstanding, the large majority did not wish to get rid of their heat-generating capacity. Therefore we intend to enquire deeper into the determinants of district heat provision.

3.3 The main independent variables

First and foremost a set of basic enterprise-level controls are used. We control for firm size, industrial branch, ownership and size of the municipality. To control for enterprise size, data on employment in 2002 is used, since employment data is always reported and is less prone to irregular reporting than sales or other accounting measures. The 2-digit level industry classification is used to construct dummies for the 9 main industries in the Russian classification. The number of inhabitants of the locality was obtained from the CEFIR municipal database. In the empirical analysis, the log of the population as well as the log of employment is used in order to smooth the distribution.

In the survey, the general manager was asked about the detailed ownership structure of the firm. Given the generally low transparency and unwillingness to reveal the firm's owners, the response rate to this question was quite high: more than three quarters of firms provided information on their owners. A series of dummies on the largest shareholder (insiders, private, state, foreign, other) was constructed. The category "insiders" includes employers and managers and the category private includes both private individuals and private Russian companies. The category state includes all three levels of government in Russia. The data confirms observations on the increased concentration of industry ownership in Russia. Of the 342 firms for which we have ownership data, in only 31 cases did no single shareholder group own the absolute majority (over 50% of the shares). Further, in only six firms were two ownership groups in control of equal amounts of shares. Large Russian firms do seem to be controlled by one type of owner.

The survey provides us with data on whether the enterprise had boilers before 1990. Given the a priori assumption that history and inheritance play a large role in infrastructure services in Russia, one easily assumes that a dummy variable indicating if the firm had boilers before 1990 is a powerful determinant of heating production also today. Given that housing entities still comprise the largest customers of the district heating produced within firms, one could suppose that enterprises which had housing on their books in 1990 are likely to provide district heating even today. Consequently, a dummy indicating whether the enterprise had housing in 1990 is included.

The main variables of interest include a set of variables on regulation and government support as well as on the business environment. It is also possible that heat producers have tighter relations with the state along many dimensions. Each of the top managers interviewed was asked how many working days they personally spent on dealing with various regulative agencies.[5] This allows one to use a variety of different variables measuring the regulatory burden a firm faces. The variable used in the analysis is the time spent personally by the general manager in dealing with various licensing, certification and inspection agencies, with customs as well as with the local officials dealing with matters regarding the use of public infrastructure. Further, the survey asked if the enterprise had received credits, tax breaks, engaged in restructuring tax debts, or had received subsidies or other forms of support from the state budget during the last three years (2000-2002). This is used

[5] Partly due to the formulation of the questions managers sometimes cite amounts exeeding 250 working days per annum. In these cases the answers are coded as 250.

to define a dummy variable that takes the value one if the enterprise received any form of budget assistance. The hypothesis is that firms engaged in heat production and district heat provision to outside users are more likely to receive budget assistance (especially so if heat deliveries are not profitable).

Further, we asked if the firm gives voluntary financial or non-financial support, i.e. makes payments on top of compulsory taxes and fees, for the construction or maintenance of certain items of public infrastructure. The results are reported in Table 2 below. A dummy variable indicating if the enterprise gave support to any of the infrastructure items (infrasup) has been constructed.

Table 2 Support for public infrastructure

	Municipal district heating	Municipal electricity system	Local gas network	Municipal water networks	Municipal waste collection	Roads outside the plant area	Railroads not owned by the firm	Any of these (infrasup)
Yes	67	48	34	70	62	97	31	173
No	336	356	369	334	341	306	372	231

Finally, the sample includes subjective assessment by the chief engineer on the quality of the outside-provided infrastructure. An unweighted average of the assessments is used to proxy for the quality of the surrounding infrastructure (infa_assess) (1-good, 2-satisfactory, 3-poor). One could reasonably assume that the enterprises that estimate the quality of outside-provided services as being poor are more prone to producing some infra items within the plant. We also have data on the proportion of state sales in total sales in three consecutive years (2000-2002) and the firm's share in the regional market.

4 Empirical results

4.1 Heat production

Having first a look at the descriptive statistics in Table 3, it seems clear that firm size, as measured by total employment, has good chances of being significant in explaining the probability that an enterprise produces heat within the plant. Also the size of the locality where the enterprise is located should indeed matter for heat production.

Table 3 Employment, population and heat production.

	heatprod =0	heatprod =1	P>t	N.obs
mean of employment	1329	1817	0.20	402
mean of city population	1 528 119	1 138 803	0.16	401

Note: the p-value refers to the t-test on the equality of means, corrected for unequal variances.

It is assumed that the probability of a firm producing heat ($heatprod_i$) is dependent on sets of enterprise characteristics, inheritance controls, relations with the public sector and the normally distributed error term. The analysis is based on standard probit regression using STATA 8.2 statistical software. The results are reported in Table 4.

Table 4 Probit results for heat production

	(1) Baseline	(2) Baseline plus ownership	(3) Baseline plus relations with public sector	(4) Preferred model	(5) Preferred model plus Federal Districts
Lnemployment	0.039	0.041	0.038	0.037	0.040
	(2.50)**	(2.79)***	(2.58)***	(2.70)***	(2.77)***
Lnpopulation	-0.022	-0.016	-0.016	-0.018	-0.016
	(2.21)**	(1.44)	(1.65)*	(2.12)**	(1.86)*
Boilers90	0.579	0.563	0.598	0.590	0.595
	(13.14)***	(11.66)***	(14.73)***	(14.45)***	(14.91)***
Housing90	0.005	0.019	-0.011		
	(0.14)	(0.54)	(0.34)		
Est.year	0.001	0.001	-0.001		
	(0.30)	(0.23)	(0.30)		
Owner (Insiders is the omitted category)					
Private		-0.032			
		(0.97)			
State		-0.001			
		(0.04)			
Foreign		0.092			
		(0.99)			
Other		-0.128			
		(3.16)***			
Regulation			-0.006	-0.005	-0.005
			(2.21)**	(2.29)**	(2.15)**
Budget support			0.070	0.076	0.082
			(2.51)**	(2.71)***	(2.93)***
Federal Districts (Central is the omitted category)					
Northwest					0.018
					(0.36)
South					0.070
					(1.17)
Volga					-0.015
					(0.42)
Urals					0.066
					(1.33)
Siberia					0.022
					(0.51)
Far East					0.167
					(3.22)***
Infrasup			0.022		
			(0.72)		
Sales to state sector in 2000			0.003		
			(1.08)		
Sales to state sector in 2001			-0.007		
			(1.44)		
Sales to state sector in 2002			0.003		
			(1.14)		
Share of regional market			0.048		
			(0.81)		
Industry dummies	Included	Included	Included	Included	Included
Observations	313	270	313	313	313
Pseudo R2	0.63	0.66	0.66	0.65	0.67

Results reported in average marginal effects on Prob(heatsell=1) calculated using delta method by STATA's margeff after probit, robust. Absolute value of z statistics in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%.
(4) The preferred model is derived from (3) by stepwise dropping the insignificant variables one at a time.

As expected, firm size is significant. The larger the firm, the more probable it is that it produces heat. Further, it is evident that the firm's size relative to the surrounding population matters. The larger the municipality, the less probable it is that an individual enterprise produces district heating. The variation between different industrial branches is surprisingly small. Only the food processing industry differs somewhat from the general picture by having a larger probability of producing heat and a smaller probability of selling it outside. Even this variation is not statistically significant.[6]

Current ownership does not seem to be a decisive factor in determining a firm's probability of producing heat. Enterprises in which the state (whether federal, regional or local government) still is the largest shareholder are less likely to produce heating. The contrary is true for foreign-owned firms which seem to favour autarky at least when it comes to heating. This finding may be explained by the fact that foreign owners tend to favour self-sufficiency over possibly time-consuming negotiations with an outside provider. But the differences are statistically insignificant, most likely due to the fact that our sample includes only large firms. In practical terms all of them are former state-owned enterprises, mostly established during the Soviet period. The explanatory power of the ownership dummies is generally not very high and, disturbingly enough, their levels of significance are not at all robust to choice of the omitted variable. Consequently, ownership dummies are not used in the subsequent analysis. This also helps to significantly increase the sample size.

In explaining heat production, we therefore prefer to control for the size of the firm and of the locality as well as for the industry but not for the ownership structure of the firm. Also the dummy for having heating boilers in 1990 is naturally included. These four variables together explain a fair amount of the total variation as indicated by the high pseudo-R squared. The dummy on having housing in 1990 as well as the year in which the enterprise was founded (est.year) turned out to be insignificant in explaining the probability of producing district heating.

A wide range of additional variables characterising relations with the public sector were included in the regression. The only variables that really seem to make a difference are the dummy on receiving budget assistance and our measure of the regulatory burden. Heat-producing enterprises seem to face a slightly smaller regulatory burden than other firms, but the economic significance of this variable is extremely small. Nonetheless, heat

[6] Visually the phenomenon may be seen in Figure A1 in Appendix 1.

producers are, somewhat surprisingly, significantly more likely to receive budget assistance from public funds. This would be natural if heat producers were very poor performers. But the result holds even if we control for the enterprise's profit level during the same period or during a longer period (1998-2002). One explanation is that the heat-producing enterprises are powerful in negotiating with the administration and they are therefore able to grab additional benefits from the local public sector. But the possibility of reverse causality (probability of receiving budget support being determined by whether a firm is a heat producer or not) cannot be ruled out.

As the sample covers regions in all of the seven federal districts, we have the opportunity to test if geography affects the picture. The initial hypothesis was that enterprises located further North and East, i.e. in harsher climatic conditions, would be more likely to produce heating at least for themselves. This seems to be partly true; firms located in the Urals and Far Eastern federal districts are more likely to produce heating. The result, however, is likely to stem from the fact that we also control for inheritance, i.e. whether a firm had boilers in 1990. Firms situated in the Urals, Siberian and Far Eastern federal districts were less likely to have boilers in Soviet times. This may indicate that the average type of locality where a firm is situated differs between those districts and the European part of the country. Many Siberian industrial towns were, in fact, established only after WWII and they tended to be planned as an entity including specialised electricity and heat production companies (Hill and Gaddy 2002). One could, therefore, prefer to control for climatic conditions directly by using a variable measuring the mean January temperature of the region. But this variable does suffer from a similar problem. Enterprises located in colder regions were less likely to have their own boilers in 1990.

Also the variable measuring the quality of outside-provided infrastructure was significant and had the expected sign, indicating that a firm which gives a better assessment of the quality of publicly provided infrastructure is less likely to produce heating. This variable is, however, negatively correlated with the size of the locality and it is therefore not reported. Firms situated in bigger cities tend to rate the quality much better than the firms in smaller localities. It is therefore not surprising that including the infra_assessment variable reduces the coefficient on the size of the locality, making it statistically significant only at the 15% level. Finally, a large set of additional variables characterising competitive pressures and the financial strength of the enterprises was included in the model, but these variables were not significant in any specification.

4.2 Model specification and results for district heat provision

When analysing the determinants of district heating provision, it should be remembered that we are examining the sub-sample of heat-producing enterprises. That is, large enterprises which tended to have boilers already during the Soviet period and which are nowadays likely to receive budget support in various forms. Therefore one could see an enterprise as facing three alternative choices: to not producing heat, producing heat only for itself or producing heat for both its own needs and those of outsiders. This setup leads to a multinominal model. A multinominal logit model using the explanatory variables found significant in individual logit models for heatprod and heatsell was estimated.[7] The estimated model fails the independence of irrelevant alternatives (IIA) assumption (tested with a Hausman test as suggested by Hausman and McFadden 1984 and by the Small-Hsiao test), which is indeed a very strong assumption. Therefore an alternative formulation is needed. It would be tempting to move to a nested logit model as a two-level choice problem, where a firm first chooses between producing and not producing heat and then picks the final choice within that set. A nested logit model, however, assumes one has both firm and choice-specific data, which we do not have. One therefore needs to concentrate on treating the two discrete choices separately.

It is possible to argue that some enterprises have chosen to not produce heating because they know they would not be able to sell it outside the plant. Ignoring the selection bias would lead to imprecise estimates and therefore it would be advisable to use the Heckman correction to correct for the possible bias. The practical problem we are faced with is, however, that due to the nature of the data we do not have a clear single selection variable. As both the selection and the main equation are in probit, even the functional form cannot be used as the selection criterion. We do argue, however, that the selection bias is likely to be extremely small if it exists at all, as the decision to produce or not to produce seems to be largely determined by inherited factors, as shown in the previous section.

The basic control variables are again found to have the expected signs, as reported in Table 5. Both the size of the enterprise and the population size of the municipality are significant in explaining the probability of providing district heating. The results concern-

[7] The results confirm the earlier findings about the importance of inherited factors, having boilers in 1990 especially. See Appendix A2 for details.

ing the ownership structure are unchanged from the analysis of heat production and are therefore not repeated here. Enterprises that provide district heating for outside users are significantly larger and situated in smaller municipalities than the other heat-producing enterprises. Further, the enterprises which had boilers or housing in 1990 are more likely to provide district heating 13 years later. For district heating provision, also the age of the enterprise seems to matter. Older firms are somewhat more likely to provide district heating for outside users.

Table 5 Probit results for district heating provision

	(1) Baseline	(2) Baseline plus relations with public sector	(3) Preferred model plus relations	(4) Preferred model plus regulation
	heatsell	heatsell	heatsell	heatsell
Lnemployment	0.076	0.054	0.061	0.076
	(1.81)*	(1.28)	(1.46)	(1.85)*
Lnpopulation	-0.055	-0.045	-0.048	-0.046
	(3.03)***	(2.54)**	(2.60)***	(2.50)**
Boilers90	0.388	0.355	0.385	0.376
	(4.97)***	(3.92)***	(4.64)***	(4.60)***
Housing90	0.159	0.200	0.165	0.160
	(1.69)*	(1.97)**	(1.74)*	(1.71)*
Est.year	-0.014	-0.010	-0.011	-0.014
	(1.70)*	(1.97)**	(2.64)***	(2.18)**
Divest		0.109	0.141	0.141
		(1.45)	(1.90)*	(1.86)*
Infra_assess		0.195	0.177	0.190
		(2.52)**	(2.16)**	(2.33)**
Regulation		0.005		0.008
		(1.07)		(1.71)*
Budget support		0.005		
		(0.08)		
Infrasupp		0.031		
		(0.56)		
Sales to state sector in 2000		-0.011		
		(1.04)		
Sales to state sector in 2001		0.019		
		(1.77)*		
Sales to state sector in 2002		-0.007		
		(1.05)		
Share of regional market		-0.065		
		(0.58)		
Relations		0.084	0.140	
		(1.09)	(1.84)*	
Industry dummies	Included	Included	Included	Included
Observations	179	179	179	179
Pseudo R2	0.31	0.37	0.35	0.35

Results reported in average marginal effects on Prob(heatsell=1) calculated using delta method by STATA's margeff after probit, robust. Absolute value of z statistics in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%. The preferred model, spec (3) and (4) are derived from (2) by stepwise dropping the insignificant variables one at a time.

Next, the set of variables characterising the public-private relationship is included (second column in Table 5). In addition to the variables used earlier, we have at our disposal two potentially interesting indicator variables. Divest-dummy takes the value of one if the general manager said the enterprise would like to get rid of their heating boilers. The other dummy variable, Relations, takes the value of one if the general manager thinks their relations with the local administration would worsen if they sold their boilers to a third party. Once again the insignificant variables are removed from the model one at the time in order to arrive at the preferred model. Unfortunately, the relations dummy is correlated with the regulation variable and including the former always makes the latter insignificant. Therefore, in the final stage, we are unable to include them both in the same specification.

The high significance level of the divest-variable suggests that delivering district heating is not a fortune. The probability of being a heat seller increases by 10-15% if a firm would like to get rid of its boilers. Here one is inclined to believe that the result is indeed driven by reverse causality. Being a district-heating provider may increase the possibility of wishing to divest the boilers. Either way, the relation between the wish to divest and district heating provision is interesting. It seems to confirm our hypothesis that heat provision is not a profitable line of business that the enterprises would like to maintain.

The effect of the assessment on local infrastructure quality (infra_assess) is significant and fairly large. The enterprises that rate the quality as being poor have a 20% higher probability of delivering district heating than enterprises rating the quality as satisfactory. We may thus conclude that where the local infrastructure is of poor quality, the enterprises are bound to engage in providing some parts of it by themselves. Due to the lack of suitable instruments, we cannot, however, rule out the possibility of the result being driven by reverse causality.[8]

The relations dummy has a positive effect on the probability of being a heat provider. Here the interpretation is fairly clear. If an enterprise not engaged in district heat provision were to divest its boilers, the relations with local administration would not change. Whereas if an enterprise engaged in this type of infrastructure provision were to divest or sell its boilers, the local administration would likely oppose it. In most cases there is no alternative district heating provider available. This means that anyone in possession of the boilers is, at least temporarily, a monopoly provider for the surrounding districts.

[8] The firms selling district heating to outside users are simply more engaged in infrastructure issues and consequently the quality of infrastructure matters for them.

The local administration has presumably created a mutually beneficial relationship with the current monopolist. Even if the enterprise engaged in infrastructure provision would like to get rid of this function, it may not be willing to do that for fear of worsening relations with the local administration.

Heat-producing enterprises seem to face a somewhat higher regulatory burden. The effect of regulation is positive and statistically significant. The economic significance, however, is minor. An increase of 10 days spent with various regulative agencies by the general manager would increase the probability of providing district heating by 0.01%. Here one should note that the time spent by the general manager with regulative agencies is not necessarily a burden for the firm at large. Time spent with local agencies may also be one of the main tasks of management and bring considerable financial benefits for the enterprise. What the regulation variable indeed tells us is that the manager in enterprises providing district heating has more contacts with the local agencies entitled to regulate and licence their line of business.

Analogous to the preceding subsection, a large set of additional variables characterising the business environment and competition was added. None of these turned out to be significant in explaining district heat provision.

4.3 Robustness and some additional results

The results presented in this section are therefore robust for the inclusion of a large set of additional variables as described in the previous subsections. The existence of endogeneity of the variables characterising the relations with the public sector was tested using the industry means as instruments. The Rivers-Vuong (1988) two-step procedure does not reject the null hypothesis of the dummy on divest being exogenous. Similar tests were run for the regulation, divest and relations variables in the heat provision equations. Based on the test results, exogeneity cannot be rejected.[9] Further, all of the interesting variables do cause some degree of concern for reverse causality. As there is no way to exclude the possibility of reverse causality, we prefer to speak about the connection between heat deliveries and the variables characterising relations with the public sector-- not about causality.

[9] Details on endogeneity testing are provided in Appendix 2.

The preceding analysis revealed that the decisions to produce and sell heating are largely determined by inherited factors. In addition, heat-producing firms are, on average, more likely to receive budget assistance. Firms selling heat to outside users, on average, face a heavier regulatory burden and more often would like to get rid of their boilers. Do the firms engaged in district heating provision suffer in terms of sales, growth or investments?

We have data on sales, labour productivity and profits for the five-year period 1998-2002 for most but by no means all of the enterprises in our sample. On average, it seems that heat-producing enterprises are characterised by higher sales, higher investments and higher profits per employee than non-heat-producing ones. Among the heat-producing enterprises, those providing district heating for outside users have, on average, somewhat lower sales, lower investments and lower profits per employee. These differences are, however, fairly small and usually not statistically significant. Only sales per employee turn out to be statistically significant in explaining heat provision, but their economic significance is close to zero.[10] One is therefore inclined to draw the conclusion that enterprises providing district heating are able to cover the costs associated with heat production and delivery either directly from their consumers or indirectly via closer ties with the local public sector.

The survey provides us with interesting additional information about the engagement of large enterprises in infrastructure provision. In addition to providing district heating, enterprises give voluntary support to many other types of public infrastructure such as road construction and maintenance. One can reasonably assume that the decisions on heat provision and infrastructure support are made simultaneously and therefore a seemingly unrelated bivariate probit model was used. Surprisingly enough, the results suggest that these two issues are not determined simultaneously. The available data is not very helpful in analysing the determinants of support for public infrastructure. What we can say, based on the results reported in Appendix 4, is that large firms are no more likely to support public infrastructure but firms located in smaller municipalities certainly are.

Finally, we split the sample of heat-sellers into two groups according to whether the general manager estimates heat deliveries as being profitable or not. At the descriptive level, the only notable differences between these two types of heat providers are found in firm size as well as in the size of the locality. Only the size of the locality remains signifi-

cant in the simple probit model reported in Table 6. Enterprises situated in large cities are significantly more likely to provide district heating profitably. This result may be caused either by firms situated in large cities being better negotiators or by the fact that generally smaller cities are simply poorer and more cash-constrained. We do, however, have some indication that ownership matters in being profitable. Insider-owned firms are less likely to consider heat provision to be profitable and especially in comparison to state-owned enterprises, the difference is statistically significant.

Table 6 Probit results for probability of being a profitable heat distributor

	(1) Baseline	(2) Ownership
Lnemployment	-0.004	-0.014
	(0.08)	(0.29)
Lnpopulation	0.076	0.072
	(3.06)***	(2.94)***
Boilers90	-0.008	
	(0.05)	
Housing90	0.128	
	(0.95)	
Infra_assess	-0.169	
	(1.63)	
Divest	-0.152	
	(1.67)*	
Industry dummies	Included	Included
Ownership (Insiders is the omitted category)		
Private		0.109
		(1.23)
State		0.303
		(2.35)**
Foreign		0.248
		(1.42)
Other		0.357
		(2.31)**
Observations	141	141
Pseudo R2	0.11	0.12

Results reported in average marginal effects on Prob(heatsell=1) calculated using delta method by STATA's margeff after probit, robust. Absolute value of z statistics in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%.

[10] Basic results are provided in Appendix 3.

5 Conclusions

In this paper heat production and district heat provision by Russian industrial enterprises was analysed based on new survey evidence. First, three quarters of the surveyed enterprises produce heating in one way or another. Of those, over half produce heat in such magnitudes that they are able to provide heating also for users outside their plant area. As only less than 40% of the enterprise managers stated that heat deliveries bring any profit, it seems natural to wish to enquire more deeply into the determinants of those activities.

Compared to the firms relying solely on municipal district heating, heat-producing firms are, on average, larger, situated in smaller municipalities and had boilers and housing in Soviet times. Further, compared to other heat-producing firms, also firms providing district heating are, on average, larger, situated in smaller municipalities and had housing in Soviet times. These inherited factors do explain a great deal in the variation of heat production. District heating, however, is not the main business of any of the surveyed firms and only a few consider it to be profitable. Therefore it seems fair to conclude that most heat producers are sort of locked into the situation. Due to historical reasons, public district heating is occasionally missing and some enterprises are burdened with the obligation to provide heating not only for their own use but also for the surrounding community. Thus, one would suppose that heat production and provision comprise an additional financial burden for an enterprise. Our data, does not, however, support that view. In terms of productivity or productivity growth, there is no statistically significant difference between heat producers, heat sellers and other firms.

Therefore one is inclined to believe that heat producers are, on average, better placed to negotiate for benefits in some other areas. There is, indeed, robust evidence on heat producers being more likely to receive budget assistance. This result remains even if we control for profits or sales per employee. Thus, we may conclude that heat producers are successful in negotiating for direct or indirect financial aid in the form of budget assistance to – possibly – cover the costs of heat production. The survey data reveals that firms providing district heating are on average more likely to face a high regulatory burden. The reason may be that the enterprises have adapted to the institutional requirements by building up good relations with the local administration. Many a firm engaged in district heating provision would like to get rid of their heat-generating capacity, but they are locked into the status quo for fear of losing the valuable relations.

In short, the enterprises producing and providing heating are more likely to have close ties with the local public sector. These enterprises both receive benefits in the form of increased budget assistance or better connections with local administration and face additional costs in the form of contributions to public infrastructure. If district heat provision is an additional burden for an enterprise, the results show that the enterprises have found their own ways to accommodate the costs. The performance of the enterprises engaged in heat deliveries and production, as measured by sales and productivity, is no worse than that of the other firms. The results indicate that close ties with the local administration may be used to compensate for the direct costs of heat delivery.

This result does not necessarily mean good news for reforming, repairing and updating Russian municipal infrastructure. The results indicate that infrastructure provision by large enterprises has created a situation where enterprises have a continued interest in maintaining close connections with the local public sector. As Russian municipalities generally lack resources for infrastructure investments, it is most probably in their interest to ensure that the enterprises continue to be engaged in infrastructure provision. This unavoidably leads to an equilibrium that no party has a direct interest in departing from. The economic playing field therefore will remain tilted in favour of large, incumbent firms. New entrepreneurs or small and medium-sized enterprises will have a hard time in competing with the infrastructure-providing incumbents.

This raises an interesting policy question: should the central government wish to break the status quo, what could be its options? The situation could be analysed as an outcome of a lobbying game, where ailing firms lobby self-interested local politicians by providing public infrastructure, see Solanko (2003). In order to break the status quo, the central government would need to ensure that entry costs to the sectors dominated by large incumbents are minimised. Another possibly fruitful path could be to give the local politicians a greater direct interest in small and medium-sized enterprise (SME) development. The differences between Russia and China indicate that linking regional tax revenues to the success of new enterprises can create powerful incentives for favouring those firms (Gordon-Li 1997). The emergence of a new SME sector as an important regional revenue source could greatly level the economic playing field.

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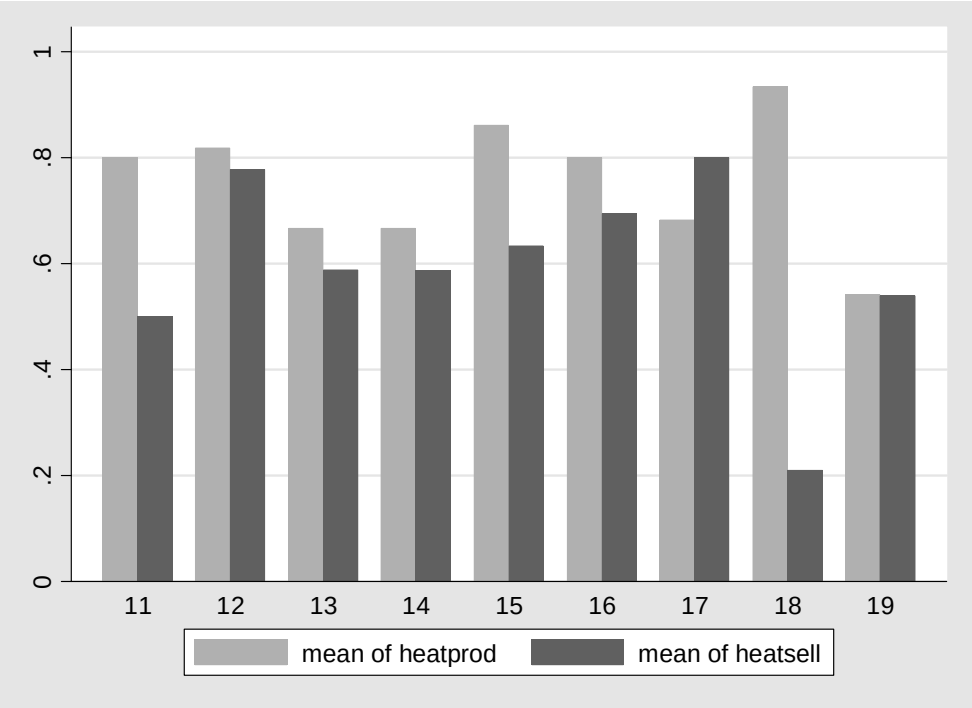
Appendices

Appendix 1 Probabilities of being a heat producer and a heat provider by industry.



11 Power & fuel
12 Metallurgy
13 Chemical industries
14 Machinery
15 Forestry, paper & pulp
16 Construction materials
17 Light industries
18 Food industries
19 Other

Appendix 2 MLOGIT

Table A2.1 Multinominal logit on heat production choices.

Prod_choice=1 (no heat production) is the comparison group	Prod_choice2 (heatprod, no heatsell)	Prod_choice3 (heatsell)
Boilers90	5.922**	7.961**
Housing90	0.154	0.909
Lnemployment	0.688*	0.809*
Lnpopulation	-0.090	-0.458*
Budget support	1.382**	1.506*
Infra_assess	1.577*	2.023**
Regulation	-0.125*	-0.068
Industry dummies	Included	Included
Observations	331	
Pseudo R2	0.49	

Absolute value of z statistics in parentheses, * significant at 5%; ** significant at 1%

Tests of IIA

Omitted choice	Hausman tests of IIA assumption P>Chi2	Small-Hsiao tests of IIA assumption P>Chi2
2	1.000	0.000
3	0.598	0.000

Ho: Odds(Outcome-J vs Outcome-K) are independent of other alternatives.

Appendix 3 On Rivers-Vuong testing

Endogeneity, however, may pose serious problems. As an example, one can imagine there exists a variable unknown to us, like managerial ability, that affects both the amount of regulation a firm faces and a firm's decision to provide district heating. Or it is also possible that the probability of wishing to divest the heating boilers and a firm's decision to provide heating are in fact determined simultaneously. To test endogeneity, we need to have in mind an alternative model for the suspected endogenous variable including at least one exogenous variable (instrumental variable) correlated with the suspected variable but uncorrelated with the dependent variable. The problem is that the survey data does not provide us with plenty of alternatives for reliable instruments. We will instrument the suspected variables by the industry means. The industry mean certainly is correlated with the individual variable, but any single firm is unlikely to have any (much) influence on the mean. Since we have only one possible instrument for every endogenous variable, overidentification is not an issue. To test for endogeneity, we use the Rivers-Vuong (1988) two-step procedure as defined in Wooldridge (2002).

Assume the model is

1) $y1 = b1x1 + ay2 + u1$, $y1=1$ if $y1^*>0$, 0 otherwise

2) $y2 = b1x21 + b2x22 + u2 = bx2 + u2$

3) $Var\ u1 = Var\ u2 = 1$

Then the Rivers-Vuong (1988) two-step procedure is a) Run linear OLS regression on the endogenous variable y2 explained by the instrumental variable and the exogenous variables b1 and save the residuals $\hat{u}2$ and b) Run probit y1 on the exogenous variables b1, on y2 and on the residual term $\hat{u}2$ to get consistent estimators of the scaled coefficients. The usual t-statistic on $\hat{u}2$ is a valid test of the null hypothesis of y2 being exogenous.

The two-step procedure suggests that the budget support-dummy in the probit regression on heat production is, indeed, exogenous. The estimated scaled coefficient of the residual term is insignificant and therefore the null hypothesis cannot be rejected. Further, when compared to probit estimation without the residual term, the estimated scaled coefficients of the other variables are largely unchanged but somewhat smaller. This is additional evidence for the null hypothesis. Assuming that the instruments themselves are exogenous (and that y2 and u2 are not correlated or that the residuals u_2 are normally distributed), we cannot reject the null hypothesis of the dummy being exogenous.

The exogeneity of the regulation, divest and relations variables in the probit models for heatsell (Table 5 in the text) were tested similarly. The residuals were insignificant and consequently we feel that the assumption of exogeneity may reasonably be retained.

Appendix 4 On sales, profits, investments and heat provision

Table A4.1 Financial variables and heat production and district heating provision

Heatprod				
	0	1	P>t	N.obs
Mean of sales per employee in 2002, ths rbls	344.8	370.8	0.72	355
Mean of profits per employee in 2002, 000[?] rbls	25.7	31.2	0.50	344
Mean of investments per employee in 2002, rbls	16.2	25.6	0.29	340
Heatsell				
	0	1	P>t	N.obs
Mean of sales per employee in 2002, [ths?] rbls	461.2	306.9	0.07	264
Mean of profits per employee in 2002, rbls	40.4	24.9	0.19	260
Mean of investments per employee in 2002, rbls	40.2	15.3	0.2	251

Note: P-value refers to t-test on equality of means corrected for unequal variances

Table A4.2 Probit results for district heating provision

	Spec(1)	Spec(2)	Spec(3)
Lnemployment	0.101**	0.087*	0.071
Lnpopulation	-0.059***	-0.054**	-0.057***
Boilers90	0.337***	0.295***	0.276***
Housing90	0.154	0.163*	0.136
Sales per employee	-0.000*	-0.000	-0.000**
Infra_assess		0.223***	
Regulation		0.009	
Divest		0.191**	0.164**
Relations			0.245***
Industry dummies	Included	Included	Included
Observations	169	169	169
Pseudo R2	0.27	0.32	0.32

Results reported in average marginal effects on Prob(heatsell=1) calculated using delta method by STATA's margeff after probit, robust.. Absolute value of z statistics in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%

Appendix 5 District heating provision and voluntary support for public infrastructure

Table A5.1 Seemingly unrelated bivariate probit results

	Heatsell	Infrasupport
Lnemployment	0.369	-0.028
	(2.59)***	(0.25)
Lnpopulation	-0.196	-0.165
	(3.05)***	(2.97)***
Boilers90	1.298	-0.132
	(4.96)***	(0.60)
Housing90	0.485	
	(1.86)*	
Infra_assess	0.582	0.386
	(2.11)**	(1.77)*
Regulation	0.048	0.024
	(2.85)***	(1.56)
Divest	0.595	
	(1.99)**	
	(0.52)	(0.17)
Industry dummies	Included	Included
Constant	-4.562	0.286
	(3.37)***	(0.24)
Observations	249	249
Rho	0 .23 (0.116)	

Wald test rejects the null hypothesis of Rho=0 at 10% level. Robust z statistics in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%.

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