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Labor Productivity in Transition: A Regional Analysis of Russian Industry

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Abstract

This paper examines within-industry variation in labor productivity at the beginning of Russia's transition process in 1992, as well as regional variation in the percentage of firms that exhibit below industry average labor productivity. The main hypothesis is that industries and regions where a disproportionate share of firms exhibited below average labor productivity in 1992 will experience above average employment reductions between 1992 and 1995.

In only 25 percent of the locales included in this analysis, however, does the predicted match emerge. Most of these locales are located in the Central region.

Key Words: labor productivity, transition, Russia
JEL Classification: J24, O12, P31, P42

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Summary

This paper examines within-industry variation in labor productivity at the beginning of Russia's transition process in 1992, as well as regional variation in the percentage of firms that exhibit below industry average labor productivity. The main hypothesis is that industries and regions where a disproportionate share of firms exhibited below average labor productivity in 1992 will experience above average employment reductions between 1992 and 1995.

Part I describes Russia's regional production and employment patterns, based on a listing of more than 20,000 civilian manufacturing firms compiled in December 1992 by Goskomstat. Two hypotheses govern the summary statistics presented in Part I. First, industries and regions where a disproportionate share of firms exhibited below average labor productivity in 1992 will experience above average employment reductions. Second, the extent of workforce downsizing at each firm will depend upon the firm's initial labor productivity conditions; firms exhibiting below industry average labor productivity in 1992 are predicted to release more workers than firms exhibiting above industry average labor productivity, *ceteris paribus*. Consequently, firm characteristics that potentially influence labor productivity are summarized, as are industry and regional differences in production, employment, and ownership patterns. Appendix A presents regression results which illustrate the effect of industry on employment patterns across the eleven regions of Russia.

Part II analyzes labor productivity differences by industry and region. First, average labor productivity is calculated, and variation across industries in the percentage of firms with below industry average labor productivity is evaluated. The process is repeated for each of the eleven regions in Russia. Second, regression results by industry and region highlight factors contributing to labor productivity differences in 1992. In particular, when the ruble value of output per employee is used as the dependent variable, regression results indicate that labor productivity in Russian industry in 1992 was positively related to the value of the firm's capital stock, export experience, and location in the capitol city, Moscow. Firms that were leased in 1992 exhibited significantly higher labor productivity than state-owned enterprises. Firms in the food, light, construction materials, chemicals, and metallurgy industries exhibited significantly higher labor productivity in 1992 than firms in machine building. Holding industry, ownership structure, export experience, and workforce size constant, regional variation is significant. Firms in the Far East, Urals, Volga-Vyatka, Central, and Northwestern regions exhibited significantly higher labor productivity than firms in the Volga region. Appendix B evaluates the possibility of a "capital effect" dominating employment decisions and thus labor productivity differences in Russian firms using production function analysis. With few exceptions, industry and regional differences in output in 1992 replicate those associated with labor productivity.

Part III examines the extent to which regions predicted to experience above average employment reductions based on below average labor productivity match with those reported as having relatively high employment reductions, or above-average unemployment. At best, in only 25% of the locales included in this analysis does the predicted result emerge. Only six of the twenty-one locales that experienced above average unemployment in 1995 exhibited below average labor productivity in 1992. Part IV summarizes the main findings and offers concluding remarks.

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Key Words: labor productivity, transition, Russia

Labor Productivity in Transition: A Regional Analysis of Russian Industry

Russia's transition from plan to market ultimately will cause major readjustments in production and employment patterns inherited from the Soviet economy. Under central planning, state-owned enterprises produced the quantity and assortment specified by planners, with little regard for cost or quality. In comparison to firms in developed market economies, Soviet firms, even those in high-priority sectors, employed surplus workers and out-dated capital.[1] Consequently, productivity in Soviet industry was low (Gomulka 1972, Kushnirsky 1987, Leggett 1987).[2] However, the absence of firm-level data precluded detailed analyses of productivity differences in Soviet industry. Without such data, estimating the magnitude of productivity differences across industries, or across regions within the same industry, was problematic (Bond *et al.* 1990, Thornton 1970, Desai 1985, Whitesell 1994). Similarly, because the available data required the use of industry or region as the unit of analysis (McCants 1992, Escoe 1995 1996), identifying the relative importance of variables contributing to firm-level differences in productivity was impossible.

Russia's transition from plan to market has increased the availability of firm-level data. Thus, it is now possible to investigate industry and regional productivity differences in civilian manufacturing firms in 1992. Such data permit identification of industries and regions where a disproportionate number of firms exhibited below average labor productivity at the beginning of the transition process. These firms risk experiencing a greater magnitude of workforce downsizing as market allocation of physical and financial resources replaces socialist planner-determined patterns.

This analysis of industry and regional variation in labor productivity in Russia at the beginning of the transition process focuses on two main questions. First, how much variation in labor productivity

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[1] For a detailed discussion of enterprise overstaffing, see Berliner (1976), Linz and Martin (1982), Freris (1986), and Granick (1989), among others.

[2] Numerous industry studies published in the Joint Economic Committee ***Gorbachev's Economic Plans*** (U.S.G.P. O.: Washington D.C, November 1987 include: for example, Christopher Pederson (construction materials). Cheryl Harris (steel), Matthew Sagers and Theodore Shabad (petrochemicals), Jeanine Braithwaite (chemicals), Shelley Deutch (weapons), Judith Thornton (electric power). See also Amann, Cooper and Davies (1982).

within industry was there in 1992, and, to what extent were within-industry differences driven by such firm characteristics as size (employment, capital stock), ownership structure, or export experience? Second, how much regional variation was there in the percentage of firms exhibiting below industry average labor productivity? That is, are some regions likely to face a higher incidence and/or longer duration of unemployment as result of above-average employment reductions? To the extent that released workers are unable to find alternative employment, either because of the worker characteristics or local labor market conditions, the incidence and duration of unemployment is likely to be higher in locales with a concentration of firms exhibiting below-industry-average labor productivity. Policy makers responsible for designing and financing appropriate unemployment compensation, or job placement and retraining programs, would necessarily utilize such information in their decision-making processes, as would those involved in developing strategies for local and regional economic development. Equally importantly, providing a systematic analysis of labor productivity differences by industry and region in 1992 lays the foundation for estimating changes in labor productivity as Russia moves from plan to market. Indeed, one test of the extent to which a market economy is developing in Russia is whether employment patterns are emerging that are consistent with labor productivity differences across industries or regions.[3]

The paper is divided into four parts. Part I describes Russia's regional production and employment patterns, based on a listing of more than 20,000 civilian manufacturing firms compiled in December 1992 by Goskomstat.[4] Two hypotheses govern the summary statistics presented in Part I. First, industries and regions where a disproportionate share of firms exhibited below average labor productivity in 1992 will experience above average employment reductions. Second, the extent of workforce

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[3] Labor productivity patterns in Russia at the beginning of the transition process matching those of a market economy are unlikely, given the underdeveloped infrastructure, out-dated capital stock, and distorted wages and prices inherited from the Soviet economy. Within the Russian economy, however, industries where a disproportionate share of firms perform above the industry average in terms of labor productivity are likely to emerge as winners in the transition process. Indeed, problems with capital valuation and estimating capital productivity may result in labor productivity differences being the key variable used by domestic and foreign investors to target winners.

[4] Civilian manufacturing firms account for 75-90% of the total number of firms in Russian industry (Gaddy 1996). Because these firms are not engaged in the centrally-administered defense conversion program (Cooper 1993, Noren 1994), they generate a more typical view of the impact of transition. That is, for the purposes of investigating firm-level differences in labor productivity at the beginning of the transition process, analyzing firms outside the defense sector offers a broader insight into how the majority of Russian firms may respond to new economic conditions.

downsizing at each firm will depend upon the firm's initial labor productivity conditions; firms exhibiting below industry average labor productivity in 1992 are predicted to release more workers than firms exhibiting above industry average labor productivity, *ceteris paribus*. Consequently, firm characteristics that potentially influence labor productivity are summarized, as are industry and regional differences in production, employment, and ownership patterns. Appendix A presents regression results which illustrate the effect of industry on employment patterns across the eleven regions of Russia.

Part II analyzes labor productivity differences by industry and region. First, average labor productivity is calculated, and variation across industries in the percentage of firms with below industry average labor productivity is evaluated. The process is repeated for each of the eleven regions in Russia. Second, regression results by industry and region highlight factors contributing to labor productivity differences in 1992. In particular, when the ruble value of output per employee is used as the dependent variable, regression results indicate that labor productivity in Russian industry in 1992 was positively related to the value of the firm's capital stock, export experience, and location in the capitol city, Moscow. Firms that were leased in 1992 exhibited significantly higher labor productivity than state-owned enterprises. Firms in the food, light, construction materials, chemicals, and metallurgy industries exhibited significantly higher labor productivity in 1992 than firms in machine building. Holding industry, ownership structure, export experience, and workforce size constant, regional variation is significant. Firms in the Far East, Urals, Volga-Vyatka, Central, and Northwestern regions exhibited significantly higher labor productivity than firms in the Volga region. Appendix B evaluates the possibility of a "capital effect" dominating employment decisions and thus labor productivity differences in Russian firms using production function analysis. With few exceptions, industry and regional differences in output in 1992 replicate those associated with labor productivity.

Part III examines the extent to which regions predicted to experience above average employment reductions based on below average labor productivity match with those reported as having relatively high employment reductions, or above-average unemployment.[5] At best, in only 25% of the locales included

[5] Since neither employment reduction nor unemployment figures are reported by industry in the statistical handbooks, a comparison by industry cannot be made. Moreover, the regional comparison made here must be interpreted with the caveat that regional unemployment data reported in the statistical handbooks are not limited to manufacturing.

in this analysis[6] does the predicted result emerge. Only six of the twenty-one locales that experienced above average unemployment in 1995 exhibited below average labor productivity in 1992. Part IV summarizes the main findings and offers concluding remarks.

I. Russian Industry in 1992

A listing of civilian manufacturing firms based on December 1992 Goskomstat data published by a privately-owned Moscow-based company was obtained for the purpose of summarizing the ownership and employment characteristics of Russian industry at the beginning of the transition process (Business Information Agency 1993). These firm-level data are used here to investigate labor productivity differences in 1992.

Production Patterns: Regional Distribution of Industry and Output

Table 1 presents a regional distribution, by industry, of the 21,756 firms included in this analysis. Overall, about 5% of the firms are in the power and fuel industries. Machine building accounts for just under 20% of the firms. Firms in the forestry/wood/paper industry, a major export product in the Soviet economy, account for about 15%. Firms in the food industry represent 25% of the total; firms in light industry less than 10%. Construction materials accounts for 10% of the total; chemicals, about 3% and printing, 5%. Firms identified in 1992 as part of the consumer services industry,[7] a low priority sector in the Soviet centrally-planned economy, account for just over 1% of the total firms in the country.

Since Soviet planners sought regional self-sufficiency (Gregory and Stuart 1990),[8] one would not

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[6] A total of sixty subregions, incorporating all eleven regions in Russia (see Table 1), are included in this analysis: from Magadan in the Far East to Kaliningrad in the Northwestern region; from Murmansk in the Northern region to Krasnodar in the North Caucasus. A listing of the sixty subregions is included in Table 8.

[7] Examples of firms in the "consumer services" industry include firms that produce footwear, plastic household goods and souvenirs; firms that produce custom-made apparel; dry-cleaning firms; firm that repair and manufacture footwear; firms producing furniture, footwear and offering funeral services. Examples of firms included in the "miscellaneous" industry category are firms that produce musical instruments and electronic apparatus; firms that produce ceramic wall tiles and toys; firms that produce computer software; firms that produce orthopaedic appliances.

[8] Khrushchev's economic reforms in the late 1950s focused on region rather than industry or sector as the unit of analysis. The reform introduced *sovnarkhozy* to break the ministerial system and power structure created by Stalin. The reform failed to achieve its objectives, but regional self-sufficiency was not abandoned. Regional self-sufficiency allowed planners to invest (relatively) less in the development of transport and storage facilities. Given the geographic size of former Soviet Union, expenditures required to put in place road/rail network similar to Europe, the U.S., would be enormous. Regional self-sufficiency may also stem from planners' preferences to reduce (or maintain low) mobility of the population. Consequences of this policy are described by Leijonhufvud

Table 1: Regional Distribution of Russian Firms by Industry (December 1992)

Industry	Far East		E. Siberia		W. Siberia		Urals		N. Caucasus		Volga	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Power	87	5.8	61	3.5	15	0.6	16	1.5	45	2.3	62	2.8
Fuel	49	3.3	25	1.4	201	7.8	21	2.0	68	3.5	46	2.1
Metallurgy	38	2.5	39	2.3	37	1.4	70	6.6	14	0.7	84	3.8
Machine building	144	9.6	203	11.7	423	16.5	263	24.8	370	19.0	337	15.2
Chemicals	17	1.1	31	1.8	74	2.9	30	2.8	53	2.7	67	3.0
Forestry/Wood/Paper	292	19.4	575	33.2	425	16.6	163	15.4	138	7.1	260	11.7
Construction materials	140	9.3	149	8.6	290	11.3	101	9.5	278	14.3	241	10.8
Light industry	67	4.5	80	4.6	169	6.6	75	7.1	162	8.3	206	9.3
Food industry	409	27.2	376	21.7	675	26.3	215	20.2	618	31.7	681	30.6
Printing	143	9.5	100	5.8	83	3.2	50	4.7	76	3.9	150	6.8
Consumer services	44	2.9	11	0.6	76	3.0	0	0.0	48	2.5	23	1.0
Miscellaneous	74	4.9	83	4.8	98	3.8	58	5.5	78	4.0	66	3.0
Total	1504		1733		2566		1062		1948		2223	

Industry	Black Earth		Volga Vyatka		Central		Northern		Northwestern		Total	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Power	27	2.0	20	1.8	120	2.1	26	3.1	36	2.1	515	2.4
Fuel	8	0.6	12	1.1	123	2.1	5	0.6	52	3.1	610	2.8
Metallurgy	18	1.3	14	1.3	68	1.2	13	1.6	22	1.3	417	1.9
Machine building	225	16.4	139	12.8	1361	23.7	90	10.8	444	26.4	4000	18.4
Chemicals	25	1.8	30	2.7	210	3.7	16	1.9	52	3.1	605	2.8
Forestry/Wood/Paper	116	8.5	228	21.0	553	9.6	265	31.7	226	13.4	3241	14.9
Construction materials	154	11.2	93	8.6	507	8.8	60	7.2	153	9.1	2166	10.0
Light industry	99	7.2	96	8.9	863	15.0	109	13.0	206	12.3	2132	9.8
Food industry	588	42.9	307	28.3	1159	20.2	189	22.6	336	20.0	5553	25.5
Printing	52	3.8	66	6.1	338	5.9	23	2.8	73	4.3	1154	5.3
Consumer services	11	0.8	0	0.0	0	0.0	0	0.0	37	2.2	250	1.2
Miscellaneous	49	3.6	80	7.4	443	7.8	41	4.9	44	2.6	1113	5.1
Total	1372		1085		5745		837		1681		21756	

Source: Calculated from firm-level data provided in *BusinessMap 93: Industry in Russia*, vol. 1-18 (Moscow: Business Information Agency, 1993).

expect to find much variation in the industry distribution of firms across regions.[9] Indeed, these data indicate that conformity across regions is the norm. Consequently, we would not expect to find the impact of transition on industrial employment patterns to be greater in one region than another.[10] There are several exceptions worthy of note, however. In the power industry, for example, in the Far East there are significantly more firms than the countrywide average (5.8% as compared to 2.4%). To the extent that domestic power prices were regulated in 1992, this region may rank lower in terms of labor productivity, where labor productivity is measured by ruble value of output per employee. In the Far East, the prediction regarding regional employment reduction or unemployment concentration would be too high. Regional variation in the metallurgy industry — that is, the concentration of metallurgical plants in the Urals and Volga regions — also is evident in these data. Regional variation in metallurgy may be explained by the evacuation policies associated with the war effort in the 1940s, and the postwar investment strategies in the 1950s and 1960s (Dyker 1985, Zaleski 1980). Finally, there is signficant variation across regions in the number of firms in light industry. The distribution of light industry firms coincides with the population distribution: higher in the Central (Moscow) and Northwestern (St. Petersburg) regions, lower in the Far East and Siberia.

Regional variation in production, as measured by the ruble value of output, is evident in nearly all industries included in this analysis.[11] When the Volga region is used as the comparison region, several

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(1993) using workstation analogy. Sparse transport services require firms to rely on local suppliers and buyers. If one workstation (local supplier or buyer) fails to perform, that failure "cascades", having the potential to bring the whole network/system to a halt. Thus once the commitment to such an organizational structure is made, the commitment to maintaining/sustaining each workstation also is made. Sustaining each workstation prolongs the time and increases the cost of the transition process.

[9] Exceptions include agriculture/food processing, fuel and forestry products. The Black Earth region is noted for its abundance of agricultural products, and given the Soviet strategy of under-investment in temperature-controlled transportation and storage facilities (Millar 1971 1981), we would expect this region to dominate the food processing industry. Regarding fuel and forestry products, planners had little control over the location of the natural gas/oil fields, and, despite the extensive tree-planting campaign in late 1940s and early 1950s, planners were unable to control the location of forest lands. As a final exception, given reported investment strategies, and the proximity of machine building to defense, we expect Moscow (Central region) and St. Petersburg (Northwestern region) to have a higher than average proportion of firms in machine building.

[10] For a broader analysis of regional differences, that is, one not linked exclusively to industry, see Hanson (1996).

[11] The ruble value of output (log value) for each industry was regressed on dummy variables for each region, with the Volga used as the comparison region. Only in the power industry was there little regional variation

patterns emerge. Output in the fuel and chemical industries was significantly higher in the Volga region in 1992 than elsewhere; output in the metallurgy, wood, and printing industries was significantly lower in the Volga region. In machine building, the Volga region dominated all but the Urals in terms of output. In construction materials, the Volga region surpassed all but the Far East, Urals, and Central (Moscow) regions. The Central region dominated the Volga region in 1992 in output in food, light, and printing industries. However, firms in the Central region, while producing more output in the food, light, and printing industries than firms in the Volga region, did so with the same or significantly less capital. Moreover, in metallurgy, wood, and printing, the lower output values in the Volga region in 1992 may be driven by the fact that the capital stock in these industries in the Volga region was significantly less than elsewhere.[12] As with output, in machine building, there was almost no regional variation in mean value of the capital stock by industry.[13]

Employment Patterns

If socialist employment patterns change during the course of transition, it is likely the change will be greatest in industries and regions where employment is most concentrated.[14] Employment concentration can be measured directly by calculating the percent of each industry's workforce employed by largest firm in the industry, or by four largest firms in the industry. Alternatively, employment concentration can be measured by calculating mean workforce size. In regions where industries with above average employment concentration or mean workforce size are more prevalent, one would predict a greater initial reduction in employment, and thus a greater potential incidence of unemployment.

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in output — the North Caucasus region produced somewhat less that the Volga region in 1992. No other significant differences emerged in the power industry.

[12] The exception being the capital stock in printing firms in the Central region was less on average than in printing firms in the Volga region.

[13] When the ruble value of capital stock (logged value) for firms in the machine building industry was regressed on dummy variables for each region, only the Urals emerged with a higher capital stock in machine building than the Volga; Western Siberia had a significantly lower capital stock.

[14] Overall, 14% of the civilian manufacturing firms in December 1992 employed fewer than 50 workers; about a third employed 50-200 workers; and slightly more than one-third employed 201-1000 individuals. That is, about 84% of the civilian manufacturing firms in Russia employed fewer than 1000 workers in 1992. Less than 1% of the firms employed more than 10,000 workers. There is no significant regional variation in the distribution of firms by workforce size.

Table 2: Employment Concentration by Industry: Percent of Industry Workforce Employed at Largest Firm, Four Largest Firms (December 1992)

Industry	Far East		E. Siberia		W. Siberia		Urals		N. Caucasus		Volga	
	Largest Firm	*4 Largest Firms*	*Largest Firm*	*4 Largest Firms*	*Largest Firm*	*4 Largest Firms*	*Largest Firm*	*4 Largest Firms*	*Largest Firm*	*4 Largest Firms*	*Largest Firm*	*4 Largest Firms*
Power	24	49	28	48	31	75	63	83	25	58	24	48
Fuel	28	64	43	62	6	18	36	73	16	42	28	50
Metallurgy	21	58	11	37	27	68	11	30	34	70	14	39
Machine building	7	22	7	23	5	18	7	18	5	15	7	23
Chemicals	55	80	24	51	11	32	16	53	10	30	13	32
Forestry/Wood/Paper	16	24	7	17	5	15	8	22	13	29	6	18
Construction	12	33	12	30	16	28	13	26	7	15	7	16
Light industry	11	29	10	31	7	21	7	23	7	21	8	23
Food industry	10	29	5	16	5	17	8	21	5	16	10	21
Printing	20	44	14	44	14	43	25	63	23	47	11	39
Consumer services	22	41	33	64	11	31	-	-	19	44	15	36
Miscellaneous	10	32	9	29	26	50	29	59	18	31	14	47

Industry	Black Earth		Volga Vyatka		Central		Northern		Northwestern		Total	
	Largest Firm	*4 Largest Firms*	*Largest Firm*	*4 Largest Firms*	*Largest Firm*	*4 Largest Firms*	*Largest Firm*	*4 Largest Firms*	*Largest Firm*	*4 Largest Firms*	*Largest Firm*	*4 Largest Firms*
Power	21	69	45	57	11	29	26	63	15	46	4	15
Fuel	65	87	38	85	8	24	54	99	17	51	4	14
Metallurgy.	24	73	33	76	12	41	27	76	21	63	4	16
Machine building	6	16	12	25	2	6	19	43	5	15	3	10
Chemicals	13	48	18	56	5	15	65	93	11	35	2	8
Forestry/Wood/Paper	5	20	4	13	11	18	7	21	12	27	5	11
Construction	17	27	18	31	2	6	17	42	6	17	21	27
Light industry	10	29	16	33	2	7	51	63	7	18	3	6
Food industry	5	15	5	18	5	13	16	51	9	25	1	4
Printing	16	53	20	54	13	27	33	76	13	37	6	12
Consumer services	23	69	--	--	--	--	--	--	17	40	7	19
Miscellaneous	28	53	5	19	4	13	18	44	17	54	7	20

Source: Calculated from firm-level data provided in *BusinessMap 93: Industry in Russia*, vol. 1-18 (Moscow: Business Information Agency, 1993).

Table 2 summarizes employment concentration by industry for each region. With the exception of the Central region, about half of the workers in the power industry in December 1992 were employed in the industry's four largest firms. A similar result appears for employment concentration in the fuel and metallurgy industries; chemicals and printing also appear highly concentrated with respect to employment. If the premise that workforce downsizing is positively correlated to employment concentration is true, then regions where industries with high employment concentration are prevalent will face an above average incidence of unemployment. As seen in Table 2, industries with high employment concentration (power, fuel, metallurgy, chemicals, printing) tend to account for less than 3% of the firms in any particular region. Exceptions to this are evident in the Urals (metallurgy), and the Far East and Volga (printing). The absence of regional specialization by industry, especially those industries where employment concentration is greatest, means that no one region will necessarily face a greater employment reduction or higher incidence of unemployment during the transition than another.[15]

Table 3 summarizes mean workforce size by industry for each region.[16] Firms in the power, fuel, metallurgy, machine building and chemical industries tend to employ, on average, more people than firms in the light, food, printing, forestry/wood/paper and construction materials industries.[17] This may be explained by technological differences or differences in scale economies across sectors. Alternatively, it may be explained by the Soviet legacy of enterprise overstaffing in firms in priority sectors (Granick 1989, Linz 1995 1996). Not surprisingly, mean workforce size tends to be greater in Siberia and in the Urals than in the European parts of Russia. Campaigns to develop "socialist" industry in Siberia and the Urals

[15] Sub-region specialization -- textiles in Ivanovo, steel in Magnitogorsk, for example -- is not addressed explicitly in this analysis. That is, within-region unemployment concentration may vary, but at the regional level, variation in unemployment concentration is expected to be rather small.

[16] Table 1 in Appendix A presents results of OLS regression analysis which identifies the relative explanatory power of industry on workforce size. Dummy variables were constructed for each industry, with machine building designated as the comparison industry. F-test results indicate that not only is there significant variation across industries by workforce size, but also across regions. In particular, in the Far East, Siberia and the Urals, firms in the power, fuel, and metallurgy industries in 1992 were significantly larger than firms in machine building in those same regions. In all regions, firms in the food and printing industries were significantly smaller in terms of workforce size than firms in machine building. These results are duplicated when "ruble value of capital assets" is used as the dependent variable.

[17] The high correlation between employment concentration and mean workforce size does not hold for the printing industry.

Table 3: Mean Workforce Size by Industry
(December 1992)

Industry	Far East		E. Siberia		W. Siberia		Urals		N. Caucasus		Volga	
	Number of Firms	*Mean Workforce Size*	*Number of Firms*	*Mean Workforce Size*	*Number of Firms*	*Mean Workforce Size*	*Number of Firms*	*Mean Workforce Size*	*Number of Firms*	*Mean Workforce Size*	*Number of Firms*	*Mean Workforce Size*
Power	55	1810	61	1105	15	4836	15	2322	45	1060	612	1016
Fuel	39	2131	25	1774	198	2448	21	2080	66	2382	45	2467
Metallurgy	23	1765	38	2290	37	2619	62	4167	14	2281	74	1491
Machine building	117	646	195	964	399	1072	229	1415	348	1014	289	1645
Chemicals	16	963	30	2795	72	1523	24	1245	52	987	64	2714
Forestry/Wood/Paper	251	578	572	677	420	472	163	543	137	473	258	332
Construction materials	122	654	145	620	285	610	98	709	275	286	240	502
Light industry	57	580	80	729	167	612	75	848	162	769	204	841
Food industry	341	681	375	205	668	367	215	345	618	330	675	320
Printing	117	108	100	45	82	104	50	113	76	140	150	85
Consumer services	23	126	11	181	75	266	0	--	48	618	23	86
Miscellaneous	164	537	79	237	93	742	57	1227	75	497	63	454
Total	1225	697	1711	648	2511	800	1009	1073	1916	621	2146	731

Industry	Black Earth		Volga Vyatka		Central		Northern		Northwestern		Total	
	Number of Firms	*Mean Workforce Size*	*Number of Firms*	*Mean Workforce Size*	*Number of Firms*	*Mean Workforce Size*	*Number of Firms*	*Mean Workforce Size*	*Number of Firms*	*Mean Workforce Size*	*Number of Firms*	*Mean Workforce Size*
Power	26	863	19	707	105	981	26	634	35	576	463	1208
Fuel	8	194	12	1322	120	621	5	451	52	463	591	1799
Metallurgy	17	3767	14	2477	62	1614	12	3983	22	1343	375	2403
Machine building	221	1430	133	1087	1167	1198	83	647	417	1446	3598	1211
Chemicals	25	2163	29	1892	200	1263	14	2212	52	903	578	1563
Forestry/Wood/Paper	115	203	226	439	547	482	262	1017	225	591	3176	553
Construction materials	153	458	93	392	498	491	56	495	152	338	2117	492
Light industry	99	682	96	604	829	911	102	567	204	637	2075	782
Food industry	586	331	304	189	1128	284	183	411	336	355	5429	334
Printing	52	56	66	55	321	187	23	67	73	172	1110	121
Consumer services	11	415	0	--	0	--	0	-	37	596	228	364
Miscellaneous	48	485	80	377	357	453	40	350	44	386	1000	504
Total	1361	620	1072	511	5334	700	806	738	1649	733	20740	711

Source: Calculated from firm-level data provided in *BusinessMap 93: Industry in Russia*, vol. 1-18 (Moscow: Business Information Agency, 1993).

began in the 1930s, and continued with the war and postwar reconstruction efforts in the 1940s and 1950s (Gregory and Stuart 1990, Kotkin 1991, Scott 1989). "Socialist" industry frequently is associated with gigantomania.

From these firm-level data, several characteristics of the 1992 employment patterns in Russian industry emerge. First, on average, one-in-six employees in civilian manufacturing worked in machine building. This figure varies somewhat by region, from a low of 9.6% in the Far East, to a high of 26.4% in the Northwestern region. Firms in the machine building industry (n = 3,951) typically employed more than 1200 workers in 1992, and in total number, are second only to firms in the food industry (n = 5,553). Consequently, how machine-building firms fare in the transition process will have a major impact on employment patterns. Second, most civilian manufacturing firms (84% of the 20,740 firms reporting workforce size) employed 1000 or fewer workers in 1992. Regional variation in the size distribution of these firms is minimal, occurring mostly in the percentage of firms in the region employing fewer than 50 workers. Third, holding the impact of transition on demand conditions constant, regional conformity in the distribution of firms by employment concentration and mean workforce size suggests that the incidence of unemployment among manufacturing employees will not vary significantly across regions; exceptions might include the Volga, Urals, Siberia and the Far East regions. Finally, in December 1992, the vast majority of employees in civilian manufacturing worked in state-owned enterprises. Of the sixty subregions included in this analysis, in only 14 cases does the share of state-owned enterprises in the subregion total fall below 80%.[18] In short, holding demand conditions constant, the employment effects of privatization are unlikely to be localized.

Ownership Structure

Ownership structure frequently is cited as a key determinant in labor productivity and changing employment patterns in transition economies (Estrin *et al.* 1995, Commander and Coricelli 1995, Commander *et al.* 1996). Privatized firms are hypothesized to adjust workforce size more rapidly and extensively than state-owned firms as the economy moves from plan to market. In Russia, several types of ownership structures had been legalized prior to the transition process (Buck *et al.* 1996, Weisskopf 1994).

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[18] These subregions include: Khabarovsk, Altai territory, Novosibirsk, Omsk, Tyumen, Tatarstan, Voronezh, Lipetsk, Ivanovo, Moscow city, Vologda, Murmansk, Novgorod, and Kaliningrad.

Table 4 summarizes the regional and industry distribution of firms by ownership structure in the first year of Russia's transition process.

As seen in Tables 4a and 4b, more than 80% of the civilian manufacturing firms were state-owned in December 1992, despite the leadership's commitment to rapid privatization and the streamline mechanism adopted in June 1992 for transferring ownership (Frydman *et al.* 1993, Nelson and Kuzes 1994). This result is not surprising given the mechanics of ownership transfer which required that each firm prepare and submit a privatization document (plan), register as a joint stock company, and participate in a voucher auction.[19] Even in economies with well-developed capital markets, it may take 12 to 18 months to complete the equivalent procedures (Ott and Hartley 1991, Megginson et al 1994).

Given the geographical and institutional features of the Russian economy, one would expect to find significant regional variation in ownership structure; in the Central (Moscow), Northwestern (St. Petersburg, Kaliningrad) and Black Earth regions, in particular. The fact that Moscow is the administrative and financial hub of the country, St. Petersburg has a long-standing tradition of linkages to Europe, and Kaliningrad is the Russian region and port city located between Poland and Lithuania might cause a greater proliferation of non-state-owned firms. Furthermore, given the popularity of leasing and cooperatives in agricultural-dominated regions, these ownership structures are expected to predominate in the Black Earth region.

As seen in Table 4a, even in the aggregated form in which these data are presented, the Central region emerges as a leader in the proportion of leased firms and joint ventures. When Moscow is analyzed separately, the results are more striking: only 74% of the civilian manufacturing firms were state-owned at the end of 1992. Some 6% of the Moscow firms had successfully completed the privatization process, that is, registered as a joint stock company and held a voucher auction by December 1992. While this is a relatively small fraction of the total number of civilian manufacturing firms in Moscow (74 of 1,228

[19] In Russia's privatization program, each citizen was given a voucher with a face value of 10,000 rubles. Each firm was obliged to sell some fraction of their shares for vouchers. In this sense, the privatization program included the entire population. To implement the privatization program, it was necessary first to establish the State Property Committee and staff the corresponding offices for the program implementation to begin. Moreover, the Soviet tradition of secrecy necessitated establishing a mechanism for providing basic information about each firm to potential investors. Previously, such information was considered a state secret; providing production, sales, employment or other financial figures, for example, was a criminal offense.

Table 4a: Regional Distribution of Russian Firms by Ownership Structure (December 1992)

Type of Ownership	Far East		E. Siberia		W. Siberia		Urals		N. Caucasus		Volga	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%
State-owned	1307	87.5	1518	87.8	1956	76.8	953	89.7	1753	90.2	1934	87.3
Leased	54	3.6	70	4.0	139	5.5	73	6.9	35	1.8	94	4.3
Cooperative	43	2.9	83	4.8	210	8.2	4	0.4	70	3.6	105	4.7
Collective	21	1.4	10	0.6	102	4.0	24	2.3	28	1.4	16	0.7
Joint stock	54	3.6	43	2.5	119	4.7	8	0.7	49	2.5	60	2.7
Joint venture	14	1.0	4	0.2	5	0.2	0	0.0	9	0.5	4	0.2
Other	0	0.0	2	0.1	6	0.6	0	0.0	0	0.0	1	0.1
Total	1493		1730		2547		1062		1944		2214	

Type of Ownership	Black Earth		Volga Vyatka		Central		Northern		Northwestern		Total	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%
State-owned	1065	78.2	881	81.2	4714	83.4	701	83.8	1392	84.0	18175	84.2
Leased	63	4.6	23	2.1	338	6.0	18	2.2	65	3.9	972	4.5
Cooperative	125	9.2	121	11.2	178	3.2	58	6.9	131	7.9	1128	5.2
Collective	45	3.3	11	1.0	155	2.7	21	2.5	9	0.5	442	2.1
Joint stock	61	4.5	38	3.5	181	3.2	8	1.0	15	0.9	636	2.9
Joint venture	1	0.1	9	0.8	78	1.4	27	3.2	13	0.8	164	0.8
Other	1	0.1	2	0.2	8	0.1	3	0.4	32	1.9	65	0.3
Total	1361		1085		5652		836		1657		21,582	

Source: Calculated from firm-level data provided in *BusinessMap 93: Industry in Russia*, vol. 1-18 (Moscow: Business Information Agency, 1993).

Table 4b: Industry Distribution of Russian Firms by Ownership Structure
(December 1992; percent)

Type of Ownership	Power (n = 515)	Fuel (n = 609)	Metallurgy (n = 416)	Machine Building (n = 3951)	Chemicals (n = 599)	Wood/Forestry/ Paper (n = 3230)
State-owned	99	95	89	86	86	89
Leased	1	4	6	5	4	4
Cooperative	--	--	0.7	3	4	2
Collective	--	--	--	2	1	1
Joint stock	--	0.5	3	4	3	3
Joint venture	--	0.5	1	1	1	0.5
Other	--	--	--	--	--	0.5

Type of Ownership	Construction materials (n = 2162)	Light (n = 2111)	Food (n = 5541)	Printing (n = 1144)	Consumer Services (n = 236)	Miscellaneous (n = 1078)
State-owned	78	80	82	99	73	67
Leased	8	8	3	0.5	4	5
Cooperative	7	3	11	--	1	9
Collective	2	3	2	0.5	3	9
Joint stock	4	6	2	--	19	4
Joint venture	0.5	1	--	--	--	5
Other	0.5	--	--	--	--	2

Source: Calculated from firm-level data provided in *BusinessMap 93: Industry in Russia*, vol. 1-18 (Moscow: Business Information Agency, 1993).

firms),[20] it amounts to twice the national average. Similarly, 8.5% of the Moscow manufacturing companies were leased in December 1992, compared to a countrywide average of 4.5%. Most dramatic is the number of firms registered as joint ventures: 5% in Moscow, compared to less than 1% for the country as a whole. These data indicate that, with regard to ownership structure, Moscow may be likened to the Disney World of Russia.

Variation in ownership structure in the Northwestern (St. Petersburg, Kaliningrad) and Black Earth regions was somewhat less than expected. While the Northwestern region has the highest percentage of cooperatives of any region in the country, overall, 84% of the civilian manufacturing firms at the end of 1992 were state-owned. In St. Petersburg, more than 90% of the civilian manufacturing firms (457 of 508 firms) at the end of 1992 were still state-owned. Variation in ownership structure is evident in Kaliningrad, however. Of the 232 civilian manufacturing firms registered in Kaliningrad, only 74% were state-owned in December 1992; 19% were registered as cooperatives. Moreover, 8 of the 13 joint ventures registered in the Northwestern region in December 1992 were located in Kaliningrad. As expected, the smaller percentage of state-owned firms in the Black Earth region, where agriculture/food processing dominate, is accounted for by the concentration of cooperatives. Indeed, the percentage of cooperatives in the Black Earth region in 1992 was nearly double that for Russia as a whole: 9.2% as compared to 5.2%. The number of leased firms in this region, however, was not significantly different than the countrywide average, about 4.5%.

The dispersion of ownership structures by industry is reported in Table 4b. State ownership in 1992 was most concentrated in the power and printing industries; least concentrated in the construction materials, light, food and consumer services industries.

The firms characterized above, in addition to providing information on output and capital stock values, ownership structure, and workforce size, also provided information on export experience.[21] Thus, it is possible to evaluate the relative contribution of these variables to labor productivity differences across

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[20] This figure does not include firms in the Moscow region, only those registered in the capitol city.

[21] Output and capital stock values were reported in current rubles. Since export experience was listed in terms of physical units sold, rather than ruble value, it is not possible to calculate the share of a firm's output that was exported. Consequently, export experience is treated as a dummy variable with a value of one when any output is exported. At total of 1,108 firms (5%) reported export experience in 1992.

industries and regions in the Russian economy at the beginning of the transition process. Wage, profit and other financial data were not provided.

II. Determinants of Labor Productivity

As Russia moves from plan to market, firms will adjust production and employment levels to meet new demand conditions. The extent of workforce downsizing at each firm is hypothesized to depend in part upon the firm's initial labor productivity characteristics. This section analyzes the factors influencing labor productivity at the beginning the transition process. First, the industry average is calculated, as is the number of firms in each industry exhibiting below average labor productivity. Second, regression analysis is used to identify the relative importance of variables contributing to differences in labor productivity across firms in particular industries, as well as across regions. These two approaches lay the foundation for predicting the industries and regions where employment reductions and/or unemployment is likely to be higher than average. In a market economy, industries where labor productivity is below average, average wages are likely to be lower. To what extent was the relationship between productivity and wages evident in Russia at the beginning of the transition process?

Labor Productivity: Descriptive Statistics

One proposition tested here is whether at the beginning of Russia's transition from plan to market there was significant variation in labor productivity across particular industries. Using firm-level data to calculate the industry mean is the first step in testing this proposition. Table 5 reports average labor productivity (log value) for each industry, where labor productivity is measured by the ruble value of output per employee. In the top panel, all firms (n = 20,300) are included in the industry average calculations. Labor productivity ranges from a low of 2.4 in consumer services (2.9 in power) to a high of 4.49 in the food industry; overall, the labor productivity mean is 3.66.

For comparison purposes, average wage by industry also is reported in Table 5. For industry as a whole, the average (monthly) wage at the end of 1992 was 7.1 thousand rubles. Wages in power, fuel, and metallurgy were about twice the overall industry average. Yet only in metallurgy is labor productivity above the overall industry average. Firms in the food industry, ranked highest in terms of average productivity, received only a marginally higher than average wage in 1992. Light industry ranked second in terms of productivity, and last in terms of wages.

Table 5: Labor Productivity Average, by Industry, 1992

I. All Firms

	Mean[a]	Standard Deviation	Number of Firms	% State-Owned Firms	Labor Productivity Rank	Average Wage (thousand rubles)
Power	2.90	2.62	375	99	10	13.2
Fuel	3.14	1.38	581	94	9	17.4
Metallurgy	3.82	1.11	371	88	4	15.0[b]
Machine building	3.34	0.90	3478	85	7	5.2
Chemicals	4.12	1.18	568	85	2	7.6
Forestry/Wood/Paper	3.19	0.78	3145	89	8	6.6
Construction materials	3.42	0.86	2092	77	6	6.9
Light industry	4.00	0.96	2038	79	3	5.1
Food industry	4.49	1.02	5375	82	1	7.6
Printing	2.58	0.84	1089	98	11	--
Consumer services	2.40	0.92	220	70	12	--
Miscellaneous	3.44	1.14	968	65	5	--
Total Industry	3.66	1.18	20,300			7.1

II. Firms With Above Industry Average Labor Productivity

	Mean[a]	Standard Deviation	Number of Firms	% State-Owned Firms	Above-average as a % of All Firms	Labor Productivity Rank
Power	4.52	0.91	238	98	63	5
Fuel	4.52	0.92	240	97	41	5
Metallurgy	4.60	0.80	182	87	49	4
Machine building	3.93	0.72	1717	83	49	9
Chemicals	4.95	0.99	265	86	47	2
Forestry/Wood/Paper	3.72	0.72	1569	86	50	10
Construction materials	3.98	0.70	1077	77	51	8
Light industry	4.70	0.68	999	80	49	3
Food industry	5.35	0.59	2561	88	48	1
Printing	3.24	0.98	411	98	38	11
Consumer services	3.22	0.83	87	71	40	12
Miscellaneous	4.30	1.02	440	64	45	7
Total Industry	4.37	0.87	9,786			

[a] log value

[b] Nonferrous metallurgy wage (white metals) reported as 15.0; ferrous (black metal) reported as 10.2.

Source: Average wage data for 1992 reported in *Trud i zanyatost' v Rossii* (Goskomstat: Moscow), pp. 95, 106-110. All other calculations based on firm-level data provided in *BusinessMap*.

Differences in average labor productivity across industries may be explained in part by price level changes in 1992.[22] High labor productivity in the food industry, for example, was driven in large part by the hyper-inflationary situation for the majority of food products that arose with price liberalization in January 1992.[23] That labor productivity is low in the printing industry may reflect low fixed prices associated with continued state ownership of printing presses and the relatively large fraction of industry orders in 1992 submitted by state organizations. Chemicals and light industry score high in the industry average labor productivity ranking, as does metallurgy. Distortions caused by price variations are unlikely to be the cause of above-average labor productivity in these industries since their price indices are not significantly different than the overall industry average (Goskomstat 1996). Nor are distortions caused by price variations likely to be the cause of below-average labor productivity in machine building and construction materials.

Is productivity influenced by ownership structure? The literature suggests that productivity will be lowest in industries with the highest concentration of state-ownership (Brada *et al.* 1996, Earle and Estrin 1997, Krueger 1995, Linz and Krueger 1996). As seen in the top panel of Table 5, in the power, fuel, and printing industries, more than 95% of the firms were state-owned in December 1992.[24] The chemical industry ranks high in terms of labor productivity, with a state-ownership percentage equal to that for the country as a whole. The lowest concentration of state-owned firms is in the consumer services, construction materials, and light industries; yet, only light industry exhibits above average labor productivity (4.0 as compared to 3.66). While the correlation coefficient for labor productivity and ownership structure is negative for state-owned firms (-.0358), and positive for leased firms (.0312) and joint ventures (.0196), the small magnitude suggests that other factors are more important in explaining

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[22] In 1992, power, fuel, and some food prices (bread and dairy products, for example) remained centrally determined; that is, fixed at below-market clearing levels. Fixed prices would impose a downward bias on the labor productivity figures calculated here.

[23] Food prices, held artificially low by Soviet planners, rose by 300 - 500 percent in the first week of January, and continued to increase dramatically over the course of the year. By year end, food prices had increased by well over 1,500 percent (Goskomstat 1996).

[24] Since firms in these industries faced relatively fixed prices in 1992, we expect labor productivity to be lower than average. Separating the ownership effect from the price effect is not possible for these industries in this framework.

productivity differences.

In the bottom panel of Table 5, firms with below industry average labor productivity have been dropped; only firms characterized by labor productivity above the industry average are included.[25] For the power industry, 63% of the firms exhibited above industry average labor productivity; for fuel, 41%; for printing, only 38%. The impact on average productivity of dropping the below average firms was greatest in the power industry — average labor productivity rose by 97%. As expected, the printing industry experienced the smallest increase in industry average labor productivity. In the grouping of firms with above industry average labor productivity, the ranking of industries remains relatively stable when the below average firms are dropped — food and chemicals are at the top, followed by light industry and metallurgy, with printing and consumer services at the bottom. Only power and fuel significantly improve their industry ranking.

The regional distribution of firms, grouped by concentration of firms with below industry average labor productivity is summarized in Table 6.[26] The Far East has the greatest proportion of firms with below industry average labor productivity, followed closely by the Black Earth, Urals and Northwestern regions. Most interesting is the lack of regional variation in the industries where more than 55% of the firms exhibit below industry average labor productivity. That is, with the exception of Siberia and the Northern regions, machine building, chemicals, and printing show up in nearly every region as industries where more than 55% of the firms exhibit below industry average labor productivity. Only in the North Caucasus region does the chemical industry emerge as one where less than 45% of the firms exhibit below industry average labor productivity. If labor productivity guides workforce downsizing, these data suggest that the biggest changes will occur in Kamchatka and Khabarovsk in the Far East, Tuva and Kemerovo in Siberia, Astrakhan and Penza in the Volga region, Tambov in the Black Earth region, Kostroma, Kaluga,

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[25] The industry average is calculated for all firms in the industry, regardless of region. If only state-owned firms had exhibited below-industry average labor productivity and thus been dropped, in industries where there is a greater dispersion of ownership structures, the percentage of state-owned firms of those remaining should be lower than the share based on all firms in that industry. As seen in Table 4b, the ownership dispersion in 1992 was greatest in construction materials, machine building, chemicals, light and food industries. Yet, in these industries, the share of state-owned firms in the above-industry average grouping fell only for machine building.

[26] The industry average for each region was calculated and the firms with below the industry average in the region are reported.

Table 6: Firms with Below-Industry-Average Labor Productivity

Industry	Far East		E. Siberia		W. Siberia		Urals		N. Caucasus		Volga	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Power	25	52	21	34	5	33	3	25	12	35	15	29
Fuel	20	51	14	56	106	53	12	57	40	60	20	45
Metallurgy	11	58	20	51	18	49	31	49	7	54	40	54
Machine building	65	58	89	46	192	49	119	52	187	54	164	57
Chemicals	9	56	15	50	38	53	18	78	23	45	32	50
Construction materials	63	54	63	44	144	51	57	59	139	51	110	46
Forestry/Wood/Paper	150	60	303	53	229	56	87	54	83	60	143	55
Light industry	30	53	42	53	81	48	44	59	86	53	99	48
Food industry	183	55	190	51	342	52	109	51	299	49	358	53
Printing	67	63	49	50	43	52	30	60	46	55	89	59
Consumer services	9	53	7	64	32	42	--	--	27	56	12	54
Miscellaneous	26	46	42	53	51	58	37	66	46	61	39	63
Total	658	56	855	50	1281	52	547	54	995	52	1121	53

Industry	Black Earth		Volga Vyatka		Central		Northern		Northwestern	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Power	11	52	3	27	27	35	5	36	11	35
Fuel	4	50	8	67	71	62	3	60	31	66
Metallurgy	8	50	6	43	36	60	8	67	14	64
Machine building	127	58	76	58	617	55	40	48	182	50
Chemicals	15	62	16	55	108	55	6	43	25	49
Construction materials	71	47	42	45	280	57	24	43	81	54
Forestry/Wood/Paper	71	62	126	56	338	63	139	54	129	58
Light industry	53	54	52	54	438	55	58	57	98	49
Food	306	53	162	53	587	53	101	55	182	55
Printing	41	79	33	50	210	67	14	64	46	63
Consumer services	7	64	--	--	--	--	--	--	22	61
Miscellaneous	24	51	42	53	202	58	18	45	22	54
Total	738	55	566	53	2476	48	416	53	843	54

Source: Calculated from firm-level data provided in *BusinessMap 93: Industry in Russia*, vol. 1-18 (Moscow: Business Information Agency, 1993).

Tver, Smolensk, Tula and Orel in the Central region, Arkhangelsk in the Northern region, and Novgorod and Pskov in the Northwestern region.[27] The incidence and duration of unemployment among manufacturing employees resulting from the release of workers from firms with below industry average labor productivity is likely to be higher in these locales.

Factors Influencing Labor Productivity in Russian Industry

What explains the variation in labor productivity in Russian industry in 1992? In this study, five variables are examined: ownership structure, firm size (as measured by the ruble value of the capital assets, and by workforce size), export experience, and location in Moscow.[28] For the ownership, export experience, and location in Moscow variables, the expected influence on labor productivity is unambiguous. First, regarding ownership, we expect to find that state-owned firms have lower labor productivity than firms registered as privately-owned, leased, joint stock, joint venture, cooperatives or collectives. State-owned firms are the least likely to be governed by profit motive and more likely to face a soft budget constraint. Consequently, state-owned firms would be less likely to release workers at the beginning of the transition process.[29] State-owned firms exhibiting below industry average labor productivity in 1992 are posited here to be the firms that ultimately will reduce workforce size the most. Second, we expect to find firms that reported exports in 1992 to have higher labor productivity than firms that did not export. Quality standards associated with global markets would suggest that exporters had access to better than industry-average technology and materials; thus labor productivity would be higher. Finally, Moscow was the center of the former Soviet economy, providing firms with access to the highest quality inputs, and employees with access to goods unavailable elsewhere in the country. Consequently, we expect to find labor productivity higher in the capitol city than elsewhere.

The impact of firm size on labor productivity will differ, depending upon whether firm size is measured by value of capital assets or measured by workforce size. We hypothesize that labor

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[27]In these locales, labor productivity is significantly below the region average.

[28] The inclusion of this variable is to test for a capitol city effect posited by Nuti and Portes (1994), Linz and Krueger (1996).

[29] The fact that state-owned firms may pay lower wages, less frequently, may cause workers to voluntarily leave these firms.

productivity will be positively related to the value of capital stock, but negatively related to workforce size; that is, for a given capital stock, the larger the workforce, the lower the productivity of labor.[30] We know that mean workforce size varies significantly by industry (see Table 3). In comparison to firms in machine building, firms in the power, fuel, metallurgy, and chemical industries were significantly larger in terms of workforce size in 1992; firms in the wood/forestry, construction materials, light, food, and printing industries generated a mean workforce size significantly below that of machine building. Thus we would expect labor productivity to be lower in the former and higher in the latter industries. The same pattern of labor productivity variation also holds between capital asset value and industry: significantly higher in comparison to machine building in power, fuel, metallurgy and chemicals; significantly lower in comparison to machine building in the remaining industries.

To estimate the effect of ownership on labor productivity, dummy variables were created for each ownership structure (lease, collective, cooperative, joint stock, joint venture, private, and state-owned), with state-owned firms used as the comparison group.[31] Export experience and location in Moscow also are treated as dummy variables.[32] Finally, dummy variables were constructed for firm size, as measured by number of employees — "small" (less than 200 workers), "medium" (200-1000 workers), "large" (1001-5000 workers), "very large" (5001-10,000 workers), and "extra large" (more than 10,000 workers); where "medium" is the comparison group.[33] The log value of the 1992 ruble value of capital stock is used as the second measure of firm size.

To test for industry and regional variation, dummy variables were constructed for each of the twelve industries (machine building used as comparison industry) and eleven regions (Volga used as the comparison region).

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[30] If labor productivity is inversely related to workforce size, we expect that industries with above-average mean workforce size will be associated with lower than average labor productivity.

[31] State-owned firms account for 84% of the firms in this data set.

[32] Some 1,292 firms in this data set were located in Moscow (6% of the total); this does not include firms in surrounding Moscow region.

[33] Dummy variables were created for workforce size to avoid any multicollinearity associated with including number of employees on both sides of the equation. Medium-sized firms account for 7,621 (38%) of the firms in this data set.

Empirical Results

Results from the OLS regression[34] are reported in Table 7. Regarding firm size as measured by capital value (lnK), the coefficient was positive and significant — firms with higher valued capital assets exhibited higher labor productivity. The coefficient on workforce size was significant and positive for "small" firms (< 200 employees), and significant and negative for "larger" firms. Thus workforce size does appear to influence labor productivity, but not in a monotonic fashion. Export experience in 1992 had a positive effect on labor productivity, as did being located in Moscow.

Regarding the effect of ownership, the results suggest that firms leased in 1992 had significantly higher labor productivity than state-owned firms; privately-owned firms exhibited only marginally higher labor productivity. Labor productivity in collectives and joint stock companies was not significantly different than in state-owned firms. Cooperatives, however, exhibited significantly lower productivity.

Industry variation is pronounced. We expected to find labor productivity lower in industries where mean workforce size was higher than average (power, fuel, metallurgy, chemicals), or where prices in 1992 were still controlled by central authorities (power, fuel, printing). Labor productivity in the power, fuel and printing industries is significantly below that of machine building, as predicted. This was not the case for metallurgy or chemicals, however, both of which had significantly higher labor productivity than machine building. For firms in construction materials, light, and food industries this result also holds.[35]

Regional variation also is evident in these results. Holding industry, ownership, export experience and firm size constant, firms in the Far East, Urals, Central, Northwestern and Volga-Vyatka regions exhibit significantly higher labor productivity than firms in the Volga region. Firms in Western Siberia

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[34] To correct for possible heteroskedasticity, we used the robust option in the *STATA* regression package (StataCorp.1997. *Stata Statistical Software,* College Station, TX).

[35] For informational purposes, we ran regressions for each industry to investigate the variation in factors contributing to differences in labor productivity. Ownership structure was important in the power, machinery, chemicals, wood/forestry, and food industries. In particular, firms that were leased in 1992 exhibited significantly higher labor productivity than state-owned firms. Export experience contributed to higher labor productivity for firms in the fuel, metallurgy, machinery, wood/forestry, and food industries. Only for firms in wood/forestry and construction materials did location in Moscow have significant positive effect on labor productivity.

Table 7: Variation in Average Labor Productivity

Independent Variables	Dependent Variable = Ln(Q/L)		
	Coefficient	**Standard Error**	**t-static**
Firm Size			
Capital value (log value)	.150*	.006	18.12
Workforce size			
< 200 employees	.086*	.020	4.16
1001 - 5000 employees	-.126*	.028	-4.42
5001 - 10,000 employees	-.494*	.087	-5.66
> 10,000 employees	-.572*	.111	-5.16
Export	.160*	.035	4.56
Moscow	.432*	.123	3.41
Ownership			
Lease	.139*	.033	4.19
Cooperative	-.097*	.032	-2.98
Collective	.052	.066	0.88
Joint stock	.041	.045	0.94
Joint venture	.344	.219	1.57
Private/other	.472*	.260	1.82
Industry			
Power	-.734*	.150	-4.88
Fuel	-.249*	.059	-4.20
Metallurgy	.347*	.055	6.36
Chemicals	.701*	.053	13.22
Forestry/Wood/Paper	-.078*	.022	-3.66
Construction Materials	.076*	.024	3.03
Light industry	.754*	.026	28.32
Food industry	1.274*	.022	56.70
Printing	-.428*	.032	-13.15
Consumer services	-.632*	.062	-10.12
Miscellaneous	.229*	.040	5.70
Region			
Far East	.091*	.036	2.52
E. Siberia	-.024	.030	-0.81
W. Siberia	-.069**	.029	-2.33
Urals	.168*	.034	4.86
N. Caucasus	.008	.031	0.28
Black Earth	-.114*	.031	-3.6
Volga Vyatka	.129*	.031	4.19
Central	.126*	.026	4.92
Northern	-.155*	.040	-3.90
Northwestern	.124*	.033	3.72
Constant	2.039*	.058	35.19

$R^2 = .3282$
N = 18,029

* significant @ 1%. ** significant @ 5%.

and the Black Earth regions generate significantly lower labor productivity coefficients.[36]

In sum, these results indicate that ownership, firm size, export experience and location in Moscow are significant in explaining the variation in labor productivity in Russian industry in 1992. They also indicate significant variation in labor productivity by industry and region. Overall, however, these variables explain only one-third of variation in labor productivity in 1992. Appendix B examines the extent to which output patterns by industry and region match those of labor productivity.

III. Regional Employment Patterns: 1992-1995

In percentage terms, changes in Russian employment patterns were relatively minor in the first three years of the transition process. The share of total employment in industry fell from just under 30% in 1992 to just over 25% in 1995. In trade and other retail services, the employment share increased from 8% to 10% between 1992 and 1995. Only in finance/credit did the share of total employment increase significantly: from 0.7% in 1992 to 1.3% in 1995; but in absolute terms, the change was rather modest.

The initial stability of Russian employment patterns is explained in part by the strength and persistence of the Soviet legacy. Russian firms produced their traditional assortment, regardless of payment.[37] Enterprise arrears grew to an alarming 25-40% of GDP (Ickes and Rytermann 1993, Earle and Estrin 1997). Subsidies to loss-making firms persisted for years after bankruptcy law was adopted. Russian managers engaged in barter, and developed other types of payment arrangements to keep their firms afloat (Linz and Krueger 1998). The net result is reflected in the surprisingly low unemployment rates recorded for Russia: 4.7% in 1992, 5.5% in 1993, 7.4% in 1994 and 8.3% in 1995 (Goskomstat 1996a, p. 32).[38]

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[36]Regional variation in labor productivity by industry is pronounced. In construction materials, firms in the Far East, Urals and Northwestern regions exhibit significantly higher labor productivity than comparable firms in Volga region; firms in Black Earth region exhibit significantly lower labor productivity. In power and fuel industries, firms in Volga region exhibit higher labor productivity than elsewhere; for firms in metallurgy, wood/forestry, and printing, the reverse is true. Firms in machine building, chemicals, and light industry, exhibited very little regional variation in labor productivity in 1992.

[37] "Producing for the warehouse," as the saying goes, resulted in inventories increasing to 16% of GDP in 1992 (*Statisticheskoe obrozrenie* 1995, no 4, p.11). Hough (1994) reports production and sales figures which further illustrate this point: 1 million cars produced in 1992, but only 400,000 sold; 3.2 million refrigerators and freezers produced compared to 1.1 million sold.

[38] Given overstaffing estimates of 15-30% (Linz 1995, 1997) and industrial output reductions of 25-50% (Goskomstat 1996, p. 249), many predicted that Russia's unemployment rate would match the double-digit rates

Are changing employment patterns linked to productivity differences in Russian industry? The summary statistics presented in Table 8 illustrate the regional variation in labor productivity,[39] percentage change in the economically active population between 1992 and 1995,[40] percentage change in employment for this same period,[41] and the unemployment rate in 1995.[42] The labor productivity figures were calculated by subregion from the firm-level data described above; the employment/unemployment figures were calculated from data provided in Goskomstat (1996).

At first glance, there appears to be no systematic relationship between the labor productivity figures and the employment/unemployment figures. In the Far East, for example, labor productivity is significantly above the regional average in Magadan, yet, the percentage reduction in employment is greatest for this locale. In Kamchatka, where labor productivity is below the regional average, the percentage reduction in employment is relatively high: 10.14 in comparison to the regional average of 11.09. Small sample size may be driving these results. However, the percentage reduction in employment is significantly higher in Sakhalin (n = 271) than the regional average, yet there is no significant difference in the labor productivity figures. Similarly, in all of Siberia, in only one locale, Kemerovo, does the predicted relationship between labor productivity and employment reduction hold.

The predicted relationship between labor productivity and employment reduction does appear in relatively more locations in the Central region. That is, in Kostroma, Tver, Kaluga, Orel, Smolensk and Tula, where labor productivity in 1992 was below the regional average, employment reduction between 1992 and 1995 significantly exceeded the regional average. In Moscow, where labor productivity was above the regional average in 1992, employment expanded between 1992 and 1995. The predicted

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experienced by other transition economies; e.g., Poland, Czech Republic, Slovakia, Hungary.

[39] To maximize the comparability of the two data sets used in Table 8, the labor productivity figure (log value) reflects the output per employee using the (sub)region, not the industry, as the unit of analysis.

[40] Economically active population includes both employed and unemployed, working age (16-72 years) individuals.

[41] This figure includes all those who were employed and performed work in return for payment, as well as those on leave (paid and unpaid), absent because of illness, training, or other reasons, and those working in family businesses who may not be receiving pay.

[42] The unemployment rate is calculated by dividing the number of unemployed by the economically active population. The numbers of registered unemployed tend to be significantly lower than these figures.

relationship does not hold in the regions surrounding Moscow, however; nor is it strongly evident in the other locales in the Central region. Indeed, even with a rather generous interpretation of the figures, in only twelve to fifteen of the sixty locales included in this analysis does the predicted relationship between labor productivity and employment reduction hold.

Is unemployment higher in regions where labor productivity is low? Regional unemployment data reported in statistical handbooks are not limited to manufacturing workers. Thus, comparing the two sets of figures will generate skewed results. In particular, employment in industry accounts for just over one-quarter of total employment in the Russian economy. With this caveat in mind, it is interesting to note whether the locales with an above average incidence of unemployment match those exhibiting below average labor productivity. In 1995, the official unemployment rate in Russia was 8.8%. Twenty-one locales included in this analysis experienced unemployment significantly higher than the overall rate (see Table 8). Of these, only six exhibited below average labor productivity in 1992.

If the test of the extent to which a market economy is developing in Russia is whether employment patterns are emerging that are consistent with labor productivity differences across regions, then Russia in 1995 performed rather poorly. Regions exhibiting low labor productivity in 1992 in only one-in-four cases match with regions experiencing above average employment reductions between 1992 and 1995; the majority of these locales are found in the Central region.

A number of characteristics of the Russian transition economy between 1992 and 1995 served to weaken any link between labor productivity and employment patterns. Few firms had adopted pro-active restructuring programs prior to 1995 (Linz and Krueger 1998). Institutions to facilitate the development of labor and capital markets were still underdeveloped. Legislation forcing banks and firms to adopt hard budget constraints and pursue profits, as opposed to government subsidies, was not routinely enforced. Housing shortages made labor mobility exceedingly difficult. Indeed, given the relative lack of infrastructure supporting a market economy in Russia in 1995, it is perhaps surprising that any link at all between labor productivity and employment patterns is evident.

IV. Labor Productivity Differences: Summary and Conclusions

Firm-level data are used here to estimate industry and regional differences in labor productivity in Russian industry at the beginning of the transition from plan to market. The objective is to identify

Table 8: Regional Labor Productivity and Unemployment Patterns

REGIONS	Labor Productivity 1992	Number of firms	% Change in Economically active population 1992-1995	% Change in workforce 1992-1995	Unemployment rate 1995
FAR EAST	**3.71**	1171	-5.31	-11.09	
Amur	3.63	170	4.94	-3.61	12.5
Kamchatka	3.45	13	-8.62	-10.14	8.5
Magadan	4.14	13	-28.23	-31.14	10.4
Maritime territory	3.69	285	-4.64	-10.32	10.7
Yakutia	3.94	118	-3.41	-6.29	6.4
Sakhalin	3.74	271	-8.91	-19.95	12.7
Khabarovsk	3.64	301	-5.67	-11.52	11.6
EASTERN SIBERIA	**3.48**	**1699**	**-5.30**	**-10.74**	
Irkutsk	3.51	538	-6.93	-11.34	9.2
Krasnoyarsk	3.80	562	-5.64	-10.54	9.0
Buryat Republic	3.33	186	-1.04	-9.77	13.7
Tuva Republic	2.86	87	7.66	-0.74	14.7
Khakass Republic	3.53	123	-5.04	-11.29	9.6
Chita	3.49	203	-7.46	-12.90	10.2
WESTERN SIBERIA	**3.49**	**2475**	**-5.66**	**-8.40**	
Altai Territory	3.61	533	-6.71	-13.05	10.8
Novosibirsk	3.82	388	-8.21	-12.16	9.5
Tomsk	3.47	237	-9.19	-10.76	8.5
Kemerovo	2.83	506	-10.77	-12.61	6.6
Omsk	3.45	401	-11.90	-12.60	5.2
Tyumen	3.90	410	7.49	6.06	6.1
URALS	**3.78**	**1004**	**-5.71**	**-9.26**	
Sverdlovsk	3.77	579	-5.58	-8.94	8.5
Chelyabinsk	3.78	425	-5.90	-9.68	8.3
NORTH CAUCASUS	**3.68**	**1896**	**-5.06**	**-9.90**	
Karachayevo-Cherkess	3.60	64	-2.53	-17.99	24.0
Rostov	3.62	597	-11.02	-14.68	8.2
North Ossetian Republic	3.50	143	11.58	-13.22	24.0
Stavropol	3.86	392	-6.96	-10.73	9.2
Krasnodar	3.67	700	-0.01	-2.94	8.8
VOLGA	**3.65**	**2125**	**-2.38**	**-6.42**	
Astrakhan	3.26	293	-1.70	-9.22	13.1
Samara	3.88	367	-0.90	-4.85	7.3
Tatarstan	3.72	500	-5.24	-8.36	6.4
Volgograd	3.65	419	3.09	-2.73	10.3
Penza	3.49	310	-5.70	-13.91	12.5
Ulyanovsk	3.79	274	-5.03	-9.20	7.8

Table 8 (cont'd)

	Labor[a] Productivity 1992	Number of firms	% Change in Economic active population 1992-1995	% Change in workforce 1992-1995	Unemployment rate 1995
BLACK EARTH	**3.71**	**1344**	**-6.87**	**-10.19**	
Belgorod	3.89	209	-1.08	-3.65	5.6
Voronezh	3.63	391	-6.13	-9.12	7.4
Kursk	3.73	249	-11.62	-14.84	5.9
Lipetsk	3.88	220	-7.80	-9.71	6.3
Tambov	3.52	275	-8.58	-14.86	10.0
VOLGA-VYATKA	**3.72**	**1060**	**-3.39**	**-5.22**	
Kirov	3.67	496	-9.08	-13.97	9.2
Nizhni Novogorod	3.77	564	-0.89	-4.79	7.8
CENTRAL	**3.80**	**5164**	**2.44**	**-5.17**	
Vladimir	3.76	304	-6.60	-14.28	12.3
Ivanovo	4.38	360	-8.51	-8.91	14.9
Kostroma	3.43	247	-6.27	-10.71	8.7
Tver	3.61	492	-6.90	-9.92	8.0
Yaroslavl	3.70	266	-5.13	-11.72	11.5
Bryansk	3.73	261	-11.60	-16.71	9.3
Kaluga	3.50	266	-3.57	-7.81	8.3
Orel	3.57	230	-7.88	-12.03	7.2
Ryazan	3.70	327	-11.51	-13.74	6.4
Smolensk	3.62	303	-10.27	-15.64	9.6
Tula	3.62	357	-10.23	-12.23	5.9
Moscow	3.91	1027	1.09	9.80	5.2
Moscow Region	4.05	724	-6.65	-10.42	9.5
NORTHERN	**3.41**	**789**	**-5.93**	**-12.31**	
Arkhangelsk	3.15	388	-8.89	-15.03	11.3
Vologda	3.61	298	-2.18	-7.41	8.1
Murmansk	3.83	103	-10.26	-16.97	12.9
NORTHWESTERN	**3.70**	**1573**	**-3.52**	**-5.20**	
St. Petersburg	3.90	458	1.44	-1.62	9.8
Leningrad	3.80	309	-2.57	-6.90	11.0
Novgorod	3.41	309	-6.47	-10.93	9.3
Pskov	3.53	261	-11.70	-18.06	11.7
Kaliningrad	3.74	236	-2.78	-6.93	9.4

[a] Calculated from firm-level data provided in *BusinessMap 93: Industry in Russia*, vol. 1-18 (Moscow: Business Information Agency, 1993).

Source: *Goskomstat, Trud i zanyatost v Rossii* (Moscow 1996), pp. 148-153.

industries and regions where unemployment is likely to be concentrated as Russia extends the share of the economy where profit motive and market allocation of goods and services dominates. The basic premise is that, if soft-budget constraints (subsidies to loss-making firms) are eliminated and Russian firms act as profit-maximizers, workforce downsizing will occur to a greater extent in civilian manufacturing firms that in 1992 exhibited below industry average labor productivity.

To lay the foundation for this analysis of labor productivity differences, characteristics of the firms included in the study are analyzed. In particular, the focus is on industry and regional variation in ownership structure and firm size. In addition, several hypotheses regarding the industry and regional employment reduction are proposed, each of which implicitly assumes the impact of the transition across industries on demand conditions is fixed. First, workforce downsizing will be greater in state-owned than in non-state-owned firms, thus unemployment will be concentrated in industries or regions where state-ownership is greatest (and remains so). Second, workforce downsizing will be positively related to employment concentration; that is, industries or regions where employment is most concentrated will experience a greater incidence of unemployment over the course of the transition process. Third, workforce downsizing, and thus unemployment concentration, is more likely to occur in industries with an above-average mean workforce size.

Based on ownership structure, one would predict that the incidence of unemployment would be greatest among employees in the power, fuel, metallurgy, machine building, chemicals, wood/forestry, and printing industries, especially if they are located in the Far East, Eastern Siberia, Urals, North Caucasus, or Volga regions (Tables 4a and 4b). Based on employment concentration (Table 3), the incidence of unemployment is predicted to be higher in the power, fuel, metallurgy, machine building and chemical industries. These industries are slightly more concentrated in the Urals, Volga, and Far East regions. If the employment concentration measure is mean workforce size, Siberia would be added to the above-mentioned regions.

In the second approach to predicting the industry or regional concentration of unemployment, labor productivity differences are calculated. Firms with below industry average labor productivity are expected to experience a higher than average reduction in workforce size. As seen in Table 5, printing, machine building, forestry/wood/paper, and construction materials rank lowest in terms of labor

productivity. Regression analysis generates similar results (Table 7); firms in the printing, forestry/wood/paper, power and fuel industries exhibited significantly lower labor productivity in 1992 than firms in machine building. Moreover, the labor productivity in the Urals, Western Siberia, and the Black Earth regions was significantly below that of firms located in the Volga region. Production function analysis demonstrates that output patterns match those of labor productivity (see Appendix B).

This study takes the first step in determining the extent to which a market economy is developing in Russia. In 1995, the hypothesis linking labor productivity to changes in employment was only weakly supported. By many measures, however, 1995 appears to have been a watershed year in Russia's transition process. As additional firm-level data become available, it will be possible to determine whether employment patterns are now emerging that are consistent with labor productivity differences across industries or regions.

Appendix A: Regional Analysis of Employment Patterns by Industry

Is the variation in employment by industry the same across all eleven regions in Russia? In 1992, the answer is yes (see Table 1). In an OLS regression with workforce size (log value) as the dependent variable and dummy variables for each industry, with machine building used for comparison purposes, a single pattern emerges across all regions. Firms in the power, fuel, and metallurgy industries tend to be significantly larger in terms of workforce size than machine building firms. Firms in the wood, construction materials, food, and printing industries tend to be significantly smaller. Only firms in the chemicals and light industries exhibit significant regional variation. That is, firms in the chemicals industry in 4 of the 11 regions are significantly larger than machine building firms; firms in light industry in 6 of the 11 regions are significantly smaller.

Appendix A
Table 1: Industry Effect on Workforce Size, by Region
(December 1992)

Independent Variable — Dependent Variable = Ln (Number of Employees)

Industry	Far East (n = 1225) Coefficient	Far East t-statistic	E. Siberia (n = 1711) Coefficient	E. Siberia t-statistic	W. Siberia (n = 2511) Coefficient	W. Siberia t-statistic	Urals (n = 1009) Coefficient	Urals t-statistic
Power	0.876*	3.824	0.662*	3.522	1.508*	3.815	0.305	0.920
	(.2292)		(.1879)		(.3953)		(.3223)	
Fuel	0.770*	2.971	0.803*	2.952	1.504*	11.565	0.681*	2.194
	(.2592)		(.2721)		(.1287)		(.2757)	
Metallurgy	0.386	1.203	1.440*	6.371	0.788*	3.097	1.281*	7.504
	(.3197)		(.2271)		(.2545)		(.1731)	
Chemicals	0.006	0.017	1.219*	4.853	0.295	1.558	-0.047	-0.405
	(.3736)		(.2512)		(.1924)		(.2594)	
Forestry/Wood/Paper	-0.494*	-3.151	-0.252*	-2.376	-0.620*	-5.903	-0.982*	-8.220
	(.1569)		(.1062)		(.1035)		(.1239)	
Construction materials	-0.138	-0.758	-0.028	-0.200	-0.440*	-3.827	-0.338*	-2.667
	(.1814)		(.1405)		(.1148)		(.1460)	
Light industry	0.015	0.064	0.069	0.406	-0.241**	-1.767	-0.153	-1.297
	(.2264)		(.1711)		(.1365)		(.1609)	
Food industry	-0.705*	-4.697	-1.075*	-9.509	-0.661*	-6.946	-1.240*	-11.796
	(.1502)		(.1131)		(.0937)		(.1148)	
Printing	-2.474*	-13.502	-2.826*	-17.938	-2.094*	-11.480	-2.659*	-14.016
	(.1833)		(.1575)		(.1796)		(.1888)	
Consumer services	-1.252*	-3.915	-0.879*	-2.214	-0.489*	-2.622		
	(.3197)		(.3969)		(.1864)			
Miscellaneous	-0.422**	-1.934	-0.971*	-5.681	-0.702*	-4.822	-0.329*	-2.123
	(.2180)		(.1708)		(.1715)		(.1790)	
Constant	5.780*	44.607	5.724*	62.398	5.692*	76.781	6.406*	80.175
	(.1296)		(.0917)		(.0741)		(.0799)	
Adjusted R^2	0.2283		0.2906		0.1750		0.3189	

Appendix A
Table 1 (continued)

Industry	N. Caucasus (n = 1915) Coefficient	t-statistic	Volga (n = 2145) Coefficient	t-statistic	Black Earth (n = 1361) Coefficient	t-statistic	Volga Vyatka (n = 1072) Coefficient	t-statistic
Power	0.162	0.852	0.123	0.688	-0.386	-1.541	0.132	0.426
	(.1889)		(.1788)		(.2495)		(.3113)	
Fuel	1.065*	6.662	0.855*	4.233	-1.745*	-4.014	0.274	0.717
	(.1601)		(.2022)		(.4332)		(.3826)	
Metallurgy	0.823*	2.519	-0.031	-0.187	0.678*	2.290	0.844*	2.366
	(.3250)		(.1654)		(.3029)		(.3567)	
Chemicals	0.152	0.858	0.741*	4.217	0.556*	2.180	0.588*	2.262
	(.1778)		(.1753)		(.2540)		(.2601)	
Forestry/Wood/Paper	-1.251*	-10.354	-1.323*	-12.154	-1.483*	-10.677	-0.544*	-3.929
	(.1204)		(.1089)		(.1384)		(.1384)	
Construction materials	-0.891*	-9.224	-0.605*	-5.447	-0.969*	-7.628	-0.586*	-3.423
	(.0962)		(.1163)		(.1266)		(.1714)	
Light industry	-0.048	-0.426	-0.376*	-3.234	-0.546*	-3.741	-0.466*	-2.747
	(.1139)		(.1154)		(.1456)		(.1698)	
Food industry	-1.092*	-13.637	-1.244*	-13.929	-1.191*	-12.494	-1.348*	-10.240
	(.0799)		(.0893)		(.0950)		(.1317)	
Printing	-2.329*	-15.347	-2.942*	-23.019	-3.096*	-16.632	-2.858*	-14.965
	(.1518)		(.1280)		(.1855)		(.1909)	
Consumer services	-0.135	-0.730	-1.999*	-7.248	-0.660**	-1.768	-	
	(.1836)		(.2758)		(.3718)		-	
Miscellaneous	-0.516*	-3.385	-0.948*	-5.564	-1.149*	-5.976	-0.552*	-3.079
	(.1518)		(.1754)		(.1917)		(.1794)	
Constant	6.138*	95.625	6.219*	83.300	6.316*	77.755	5.939*	54.139
	(.0639)		(.0746)		(.0810)		(.1097)	
Adjusted R^2	0.2418		0.3020		0.2371		.2601	

Appendix A
Table 1 (continued)

Industry	Central (n = 5334) Coefficient	t-statistic	Northern (n = 806) Coefficient	t-statistic	Northwestern (n = 1649) Coefficient	t-statistic	Russia (n = 20,767) Coefficient	t-statistic
Power	0.038	0.289	0.055	0.176	-0.390	-1.528	0.184*	2.738
	(.1344)		(.3182)		(.2554)		(.0672)	
Fuel	-0.445*	-3.532	-0.221	-0.343	-1.267*	-5.938	0.466*	7.745
	(.1259)		(.6519)		(.2134)		(.0601)	
Metallurgy	0.238	1.383	1.948*	4.660	-0.231	-0.727	0.654*	8.913
	(.1719)		(.4181)		(.3174)		(.0734)	
Chemicals	0.134	1.331	0.336	0.829	-0.387	-1.814	0.246*	4.031
	(.1009)		(.4090)		(.2134)		(.0610)	
Forestry/Wood/Paper	-0.735*	-10.770	0.568*	3.219	-0.958*	-7.983	-0.762*	-23.005
	(.0683)		(.1766)		(.1200)		(.0331)	
Construction materials	-0.430*	-6.095	0.144	0.593	-1.146*	-8.332	-0.578*	-15.512
	(.0705)		(.2428)		(.1375)		(.0372)	
Light industry	-0.194*	-3.240	-0.608*	-2.930	-0.750*	-6.052	-0.308*	-8.213
	(.0598)		(.2076)		(.1240)		(.0375)	
Food industry	-1.144*	-20.790	-0.594*	-3.199	-1.305*	-12.268	-1.108*	-37.892
	(.0550)		(.1855)		(.1064)		(.0292)	
Printing	-2.281*	-27.445	-2.309*	-6.896	-2.210*	-12.007	-2.554*	-54.666
	(.0831)		(.3361)		(.1841)		(.0467)	
Consumer services	-	-	-	-	-0.402	-1.615	-0.758*	-8.158
	-		-		(.2489)		(.0929)	
Miscellaneous	-0.792	-9.924	-0.247	-0.916	-1.517*	-6.597	-0.802*	-16.510
	(.0797)		(.2698)		(.2300)		(.0486)	
Constant	6.111	158.449	5.361*	34.840	6.260*	88.100	6.073*	268.037
	(.0385)		(.1539)		(.0711)		(.0226)	
Adjusted R^2	.1782		0.1651		0.1391		0.1927	

* Significant at 1%.
** Significant at 5%.

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Appendix B: Do Output Patterns Match Labor Productivity Patterns?

Production function analysis is used to evaluate whether industry and regional output patterns match those of labor productivity. If so, one can rule out the possibility of a "capital effect" dominating employment decisions in Russian firms during the transition from plan to market.

The results of estimating an unrestricted Cobb-Douglas production function for each industry, where the log value of output was regressed on the log values of capital and labor, and dummy variables for each region are reported in Table 1. Using the Volga region for comparison purposes, regional variation is most prominent in the metallurgy, wood, construction materials, and food industries.

The results of estimating an unrestricted Cobb-Douglas production function, where the log value of output was regressed on the log values of capital and labor, and dummy variables for export experience, location in Moscow, workforce size, industry and region, are summarized in Table 2.[43] In this specification, the marginal productivity of labor can be calculated using the coefficient on labor times the average product of labor. Because marginal product is proportional to average product, the results derived earlier based on the proposed link between productivity and employment are strengthened.

As seen in Table 2, the coefficient on labor (.797) is more than three times that for capital (.206). The sum of the two coefficients indicates constant returns to scale for industry as a whole in Russia. Yet, when regressions are run separately by industry, in heavy industry (metallurgy, machine building, chemicals) the coefficients indicate decreasing returns to scale.[44] In the light and printing industries, the sum of the coefficients indicates increasing returns to scale; 1.29, 1.12, respectively. This same result holds for the fuel industry (1.17). Constant returns to scale emerges in the wood, construction materials, and

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[43] In all regressions, robust standard errors were calculated, thus correcting for heteroskedasticity. In the simplest Cobb-Douglas specification, when the log value of output was regressed on the log values of capital and labor, Russian industry as a whole exhibited increasing returns to scale: the coefficient on capital was .19; the coefficient on labor was .85. For exporters, in a separate regression including only those firms reporting exports in 1992, the capital and labor coefficients were .27 and .69, respectively, indicating decreasing returns to scale.

[44] Regressions with robust standard errors were run for each industry. In all but power and food, the Cobb-Douglas specification with dummy variables included for export experience, location in Moscow, ownership structure, workforce size, and region, explained more than 75% of the variation in output. Heavy industry exhibited decreasing returns to scale. The sum of the coefficients equaled .88, .80, and .86 in metallurgy, machine building, and chemicals, respectively.

Appendix B

Table 1: Regional Variation in Output by Industry

	Power ($N = 332$, $R^2 = .3088$)		Fuel ($N = 488$, $R^2 = .7731$)		Metallurgy ($N = 339$, $R^2 = .8101$)		Machine Building ($N = 2932$, $R^2 = .7543$)	
	coefficient	**t-statistic**	**coefficient**	**t-statistic**	**coefficient**	**t-statistic**	**coefficient**	**t-statistic**
lnL	1.467*	8.86	.465*	7.71	.845*	8.62	.823*	28.84
	(.166)		(.060)		(.098)		(.028)	
lnK	-.079	-0.65	.528*	11.46	.198*	2.76	.151*	7.39
	(.122)		(.046)		(.071)		(.020)	
Far East	-.886	-1.61	-.734*	-2.64	.558*	2.69	-.050	-0.63
	(.551)		(.278)		(.207)		(.079)	
E. Siberia	-.850	-1.74	-.260	-1.09	.209	1.03	-.210*	-2.46
	(.488)		(.238)		(.203)		(.085)	
W. Siberia	-.920	-1.71	-.163	-0.86	.366	1.69	-.085	-1.32
	(.539)		(.188)		(.216)		(.064)	
Urals	-1.119	-1.06	-.471	-1.60	.573*	3.14	.198*	3.25
	(1.060)		(.294)		(.182)		(.060)	
N. Caucasus	-1.573**	-2.25	-.331	-0.95	.466**	1.96	.040	0.64
	(.699)		(.349)		(.238)		(.062)	
Black Earth	-1.031	-1.68	-.305	-1.09	.099	0.50	.026	0.39
	(.612)		(.281)		(.199)		(.067)	
Volga Vyatka	.589	0.77	.337	-1.06	.452**	1.95	.022	0.31
	(.767)		(.319)		(.232)		(.070)	
Central	-.381	-0.76	-.559**	-2.52	.508**	2.22	.119**	2.07
	(.498)		(.221)		(.229)		(.057)	
Northern	-.745	-0.84	-.753	-1.56	.305	1.20	-.115	-1.45
	(.887)		(.481)		(.254)		(.079)	
Northwestern	-.480	-0.67	-.757*	-2.80	.600**	2.27	.020	0.32
	(.718)		(.270)		(.264)		(.064)	
Constant	1.389**	2.01	1.889*	5.07	2.620*	12.24	3.14*	34.67
	(.690)		(.372)		(.214)		(.090)	

Table 1 (cont'd)

	Chemicals (N = 487, R^2 = .6917)		Forestry/Wood/Paper (N = 2982, R^2 = .8306)		Construction Materials (N = 1850, R^2 = .7390)		Light (N = 1767, R^2 = .8200)	
	coefficient	**t-statistic**	**coefficient**	**t-statistic**	**coefficient**	**t-statistic**	**coefficient**	**t-statistic**
lnL	.686*	4.82	.958*	41.33	.920*	18.80	1.063*	37.70
	(.142)		(.023)		(.049)		(.028)	
lnK	.274*	2.74	.144*	6.40	.155*	5.05	.157*	7.84
	(.099)		(.022)		(.030)		(.020)	
Far East	-.015	-0.05	.334*	5.05	.270*	3.17	.023	0.23
	(.287)		(.066)		(.085)		(.100)	
E. Siberia	.052	0.20	.216*	4.08	-.066	-0.88	.027	0.28
	(.258)		(.052)		(.075)		(.097)	
W. Siberia	-.114	-0.69	.072	1.14	.064	0.86	-.125	-1.35
	(.164)		(.062)		(.075)		(.092)	
Urals	.686**	2.36	.215*	3.05	.219*	2.95	.114	1.29
	(.290)		(.070)		(.074)		(.089)	
N. Caucasus	-.040	-0.22	.182*	2.52	-.019	-0.33	-.058	-0.74
	(.184)		(.072)		(.057)		(.078)	
Black Earth	.034	0.20	.065	0.90	-.161*	-2.52	.002	0.02
	(.167)		(.072)		(.063)		(.108)	
Volga Vyatka	-.019	-0.11	.219*	4.16	-.028	-0.35	.199**	2.26
	(.170)		(.052)		(.080)		(.088)	
Central	.108	0.70	.319*	5.42	.105	1.79	.264*	3.90
	(.154)		(.058)		(.058)		(.068)	
Northern	-.190	-0.76	.021	0.37	-.099	-0.75	-.459*	-4.06
	(.248)		(.057)		(.131)		(.112)	
Northwestern	-.018	-0.14	.460*	6.79	.241*	2.92	.025	0.32
	(.140)		(.067)		(.082)		(.078)	
Constant	3.638*	17.63	2.101*	23.31	2.540*	21.99	2.388*	18.43
	(.206)		(.090		(.115)		(.129)	

Table 1 (cont'd)

	Food ($N = 4974$, $R^2 = .5819$)		**Printing** ($N = 946$, $R^2 = .8581$)		**Consumer Services** ($N = 206$, $R^2 = .8529$)		**Miscellaneous** ($N = 794$, $R^2 = .7030$)	
	coefficient	**t-statistic**	**coefficient**	**t-statistic**	**coefficient**	**t-statistic**	**coefficient**	**t-statistic**
lnL	.718*	24.54	.976*	14.63	.932*	10.11	.674*	11.03
	(.029)		(.067)		(.092)		(.061)	
lnK	.287*	14.08	.169*	3.35	.152**	2.00	.306*	7.08
	(.020)		(.050)		(.076)		(.043)	
Far East	-.004	-0.07	.261*	2.86	.173	0.29	-.107	-0.70
	(.066)		(.091)		(.584)		(.153)	
E. Siberia	-.086	-1.51	.129	1.81	.721*	2.68	-.620	-3.99
	(.056)		(.071)		(.269)		(.155)	
W. Siberia	-.255*	-4.53	-.016	-0.16	.262	1.21	-.062	-0.35
	(.056)		(.097)		(.216)		(.175)	
Urals	.333*	4.73	.212*	2.57	--	--	-.107	-0.61
	(.070)		(.082)				(.176)	
N. Caucasus	.012	0.22	.161**	1.97	.388	1.54	-.034	-0.24
	(.057)		(.081)		(.251)		(.141)	
Black Earth	-.166*	-3.01	-.015	-0.10	.652**	2.25	-.257	-1.49
	(.055)		(.151)		(.290)		(.173)	
Volga Vyatka	.252	3.98	-.057	-0.93	--	--	-.023	-0.18
	(.063)		(.061)				(.133)	
Central	.158*	3.28	.103	1.65	--	--	-.178	1.40
	(.048)		(.062)				(.127)	
Northern	-.050	-0.67	.124	1.80	--	--	-.879*	-4.10
	(.074)		(.069)				(.214)	
Northwestern	.142	2.22	.141**	1.96	1.739*	7.23	-.069	-0.40
	(.063)		(.072)		(.240)		(.171)	
Constant	3.77	42.38	1.623*	24.16	1.246*	2.97	3.119*	15.55
	(.089)		(.067)		(.419)		(.200)	

* Significant @ 1% ** Significant @ 5%.

Appendix B
Table 2: Production Function Results

Independent Variables	**Dependent Variable = Ln(Q/L)**		
	Coefficient	**Standard Error**	**t-statistic**
ln K	.206*	.010	19.34
ln L	.796*	.018	43.46
Export	.177*	.034	5.09
Moscow	.406*	.126	3.22
Workforce Size			
< 200 employees	-.163*	.026	-6.35
1001 - 5000 employees	.081*	.031	2.61
5001 - 10,000 employees	-.108	.088	-1.24
>10,000 employees	-.056	.112	-0.50
Ownership			
Lease	.163*	.032	4.95
Cooperative	-.128	.031	-4.07
Collective	.056	.063	0.88
Joint stock	.065	.048	1.48
Joint venture	.244	.215	1.31
Private/other	.317	.239	1.33
Industry			
Power	-.826*	.151	-5.46
Fuel	-.310*	.059	-5.28
Metallurgy	.320*	.054	5.90
Chemicals	.691*	.052	13.20
Wood	-.107*	.021	-4.90
Construction materials	.041	.024	1.66
Light	.778*	.027	28.99
Food	1.252*	.022	56.17
Printing	-.573*	.034	-16.77
Consumer services	-.566*	.062	-9.05
Miscellaneous	.244*	.039	6.158
Region			
Far East	.069**	.036	1.92
E. Siberia	-.044	.030	-1.44
W. Siberia	-.081*	.029	-2.75
Urals	.183*	.034	5.32
N. Caucasus	.010	.030	0.32
Black Earth	-.103*	.031	-3.30
Volga Vyatka	.124*	.030	4.06
Central	.132*	.026	5.18
Northern	-.154*	.039	-3.92
Northwestern	.122*	.033	3.66
Constant	2.817*	.088	32.11

R^2 = .7662
N = 18,029

*significant @ 1% **significant @ 5%

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consumer services industries.

The influence of export experience and location in Moscow on variation in output matches that found for labor productivity: both have a significantly positive effect. This is not the case for workforce size.

In comparison to state-owned firms, leased and privately-owned firms produced significantly more, *ceteris paribus*; cooperatives produced significantly less.

The industry and regional patterns are largely the same. That is, in all but two cases, the industry variation in labor productivity is repeated for output. Like the labor productivity results, firms in the metallurgy, chemicals, light, and food industries produced significantly more than machine-building firms, holding ownership, export experience, location in Moscow, and region constant. Unlike the labor productivity results, firms in the forestry/wood industry produced significantly less output than firms in machine building. In construction materials, labor productivity was significantly higher than in machine building, but output differences in these two industries are insignificant. The regional variation in output is identical to that of labor productivity.

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