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Konings J., Lermann H. Marshall and labor demand in Russia: Going back to basics.

Using a unique data set of medium and large enterprises (MLEs), which covers four Russian regions and the three sectors manufacturing and mining, construction and trade and distribution, we estimate fixed effects specifications of static labor demand equations for the year 1997. The most important conclusion that can be drawn is that, even though labor demand is relatively inelastic in international perspective, six years into transition Russian MLEs are responsive to wage changes in their employment decisions. A second interesting finding shows that there are distinct differences in the behavior of state-owned enterprises, which exhibit a weaker wage employment trade-off than privatized and partially privatized firms. Looking at the entire sample and various sub-samples we also try to relate the estimated wage elasticities to the empirical evidence on three of Marshall's rules of derived demand. Our results show that investigating empirically these rules seems a promising avenue for establishing some of the driving forces behind labor demand in Russia.

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1. Introduction[1]

The transition process to a market economy has been extremely difficult in the Russian Federation. Figure 1 shows the evolution of real GDP, employment and real wages since 1991, where all values are normalized to 100 in 1991. In less than 10 years GDP collapsed by 40% points, with no clear signs of recovery by 1999. The fall in employment was slower, but caught up with the collapse in output towards the end of the 1990s, resulting in employment levels in 1999 at 65% of the pre-transition level in 1991. The collapse in real wages was drastic as can be seen from Figure 1. By 1999 real wages were not even at 40% of the pre-reform level. The substantial collapse in real wages suggests that if this had not occurred, the collapse in employment would have been even more drastic. It also suggests that wage cuts may have been preferred over employment cuts, provided a well-behaved relationship between wages and employment.

This paper uses micro data spanning 1996 and 1997 to analyze labor demand in the Russian Federation. We will focus in particular on the labor demand elasticity with respect to real wages in order to investigate how important wages have been in shaping the employment adjustment process in Russia. We will also point out factors that can explain this relationship, by appealing to Marshall's rules of derived demand.

Most of the studies on labor market adjustment in Russia that use micro data have focused on responses of *workers* to transition or have used household data to get at firm behavior[2]. But little is known about

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[2] See for example Newell and Reilly (1996), Foley (1997), Lehmann and Wadsworth (2000), Earle and Sabirianova (2002) and Lehmann, Wadsworth and Acquisti (1999).

the actual employment adjustment of *firms* in response to output shocks and changes in wages. There are four papers that study employment adjustment of Russian firms in the context of gross job flows. Konings and Walsh (1999) and Richter and Schaffer (1997) both use firm level surveys to study gross job creation and destruction in "de novo" and "traditional" firms, while Acquisti and Lehmann (2000) and Brown and Earle (this symposium) analyze the gross flows of "traditional" firms using census-type data. However, none of these papers focuses on the relationship between employment adjustment and wages. Basu, Estrin and Svejnar (2000) look at labor demand in transition countries, including Russia, but the latter country is not at the center of their analysis. Their analysis of Russian labor demand is confined to the early years of transition and uses data from a very small survey of Russian firms.

This paper is to our knowledge the first study that uses a large firm level data set to estimate labor demand in Russia[3]. In the estimations we employ unique census-type micro data of more than 3500 state-owned, privatized and partially privatized firms in four regions of the Russian Federation assumed to be representative of a certain labor market type as we explain below.

Much of the empirical literature on firm adjustment in the early years of transition shows little difference in the behavior of state-owned and privatized firms. Five years into transition one might wonder whether and how Russian privatized firms differ in their employment decisions from their state-owned counterparts. We will discuss this issue in this paper and, in conjunction with our estimates of wage elasticities, we provide some insights into the nature of the trade off between wages and employment at the firm level in Russia.

The paper is innovative in several respects. By investigating empirically three of Marshall's rules of derived demand, we try to establish whether basic neoclassical theory can give us some guidance in understanding firm behavior in Russia. Furthermore, the evidence on these rules might help us uncover some of the underlying factors behind labor demand in Russia, which is, after all, a derived demand. In the estimation of labor demand equations we take measurement error seriously and use ranking schemes when instrumenting to attenuate

[3] Luke and Schaffer (2000) test wage determination models in Russia employing the same data set. This paper also summarizes the major data cleaning effort undertaken by Peter Luke in connection with these data.

the bias due to measurement error. To our knowledge this approach has not been used in the literature on firm behavior in transition economies. The investigation of Marshall's rules involves the estimation of Lerner indices and the imputing of Morishima partial elasticities of substitution, neither of which has been applied to the transition context.

The next section discusses the data set that we use to estimate labor demand. The third section sketches the derivation of an estimable labor demand equation, based on cost minimization, and discusses estimation issues that are predominantly related to measurement problems and to problems arising from the fact that our data span only two years. Section 4 in turn outlines the procedures used to produce evidence on three of Marshall's rules. Section 5 presents OLS and IV estimates of labor demand equations for the entire sample and various sub-samples, while section 6 reports the evidence on three of Marshall's rules and hence attempts to provide a partial interpretation of the estimated wage elasticities. The final section offers some tentative conclusions.

2. Data

The research is based on end-year 1996 and 1997 data for MLEs in four representative regions, the City of Moscow, Chelyabinsk Oblast, Krasnoyarski Krai and Chuvashia (see below). The data on MLEs are census-type data that are collected by Goskomstat and that go back to Soviet times. In the Soviet Union virtually all state-owned enterprises were of medium or large size and had to report certain statistics to Goskomstat on a quarterly or annual basis. After the beginning of the reforms Goskomstat sent modified questionnaires to the same firms accommodating the need for different information in a changed economic environment. Small firms, which hardly existed in the Soviet Union but had been created in large numbers after the economic regime switch, were not covered by any official data collection. Consequently, starting in 1994 Goskomstat has been sending a questionnaire designed for "small firms" ("malye predpriyatiye") to a random sample of such firms in each administrative region of the Russian Federation. In our assessment, data on MLEs refer, therefore, above all to enterprises that have already existed under central planning and that have continued their activities during transition, while data on "small firms" refer for the most part to firms that have been born after January 1992. Labor demand of the latter firms is not investigated in this paper.

The characterization of MLEs as enterprises continuing from Soviet times has an important implication. The MLEs come in three ownership categories; they are labeled "state-owned", "private" and "mixed". The vast majority of MLEs that are "private" in our data can be considered privatized firms, while those labeled "mixed" refer to partially privatized enterprises where private capital is domestically owned and the state still has a stake in the firm. In our assessment, de novo private firms are virtually absent in the used data set and labor demand of these firms is not analyzed here.

The data cover three industries: manufacturing and mining, construction and distribution and trade. They make up the lion share of employment in the non-budgetary sector of the Russian economy well into the transition and most restructuring in the Russian economy is taking place in these three industries (Gimpelson and Lippoldt, 2001). By choosing manufacturing and mining, construction and distribution and trade we intend to capture some general patterns of labor demand in Russia[4].

The four regions that are covered by our data set are, of course, statistically not representative of the Russian Federation. Nevertheless, they are indicative of certain labor market types in Russia, so that our results might have some explanatory power beyond the four regions analyzed. *The City of Moscow,* while interesting as a labor market in its own right given its status as the capital of the Russian Federation, is also representative of a regional type with a diversified industrial base, is demographically characterized by low natural population growth and little migration activity, and has a registered unemployment rate substantially lower than the average rate in Russia. *Chelyabinsk Oblast* is representative of those regions dominated historically by the military-industrial complex. There are many settlements in such regions where the labor force is entirely dependent on huge multi-profile enterprises, i.e. where local labor markets might exhibit monopsonistic elements. Despite a dramatic fall in production, registered unemployment has been relatively low in these regions as a high level of hidden unemployment has been maintained through much of the nineties by implicit or

[4] MLEs are officially defined by the Russian Statistical Office (Goskomstat) as those firms employing over 100 employees in manufacturing and mining, construction or transportation, and over 50 employees in the wholesale trade or over 30 in the retail trade. Inspection of the data set shows, however, that the average annual employment of quite a few MLEs falls below the cited lower bounds. This is another reason why one might want to characterise MLEs as firms existing already before transition.

explicit subsidies from the federal budget. *Krasnoyarski Krai* is typical of the industrially developed regions dominated by extractive industries, such as oil and gas extraction, timber production, and fisheries, with agriculture practically absent. Output in these regions has fallen less rapidly than the average for the Federation. The demographic situation is characterized by a low rate of natural population growth and a high level of outward migration, which has risen substantially during the years of economic reform. Most of these regions are in the northern European and Asian parts of the country and make up a considerable proportion of the Russian Federation. *Chuvashia* reflects the economic situation of agro-industrial areas where processing plants are the main form of industrial enterprise. These areas are not well endowed with minerals and energy sources. A relatively high natural population growth and a low degree of labor mobility are observed in these regions. The fall in industrial and agricultural production has been greater than the average in the Russian Federation. The infrastructure of social services is underdeveloped while the level of registered unemployment is much higher than the Russian average[5].

Our data set is rich, containing many variables on employment, variables on sales, labor costs and material costs as well as variables on balance sheet items. However, it is important to note that we have not enough information in our data set to calculate unit cost of capital and unit cost of material inputs. This lack of information influences our estimation strategy. A brief description of the variables used in our empirical work is provided in appendix 1.

Those variables that are particularly interesting in connection with the estimation of labor demand equations for the total sample and various sub-samples are presented in Tables 1-3. Table 1 gives summary statistics for the whole sample and for firms with different ownership.[6] Both real annual output and employment have fallen substantially in 1997, but the decline in employment has been smaller on average than the decline in output. Implied by these numbers, the large labor shedding by the firms in our sample is striking. Real annual wages, on the other hand, fell only marginally. This suggests little downward wage flexibility in 1997. This is consistent with what has been observed in aggregate

[5] For a more detailed discussion of this regional taxonomy see Lehmann, Gontmakher and Starodubrovskyi (1999).

[6] To deflate nominal values we take 1995 as a base year. Here and in the subsequent analysis we excluded firms with labor shares greater than one.

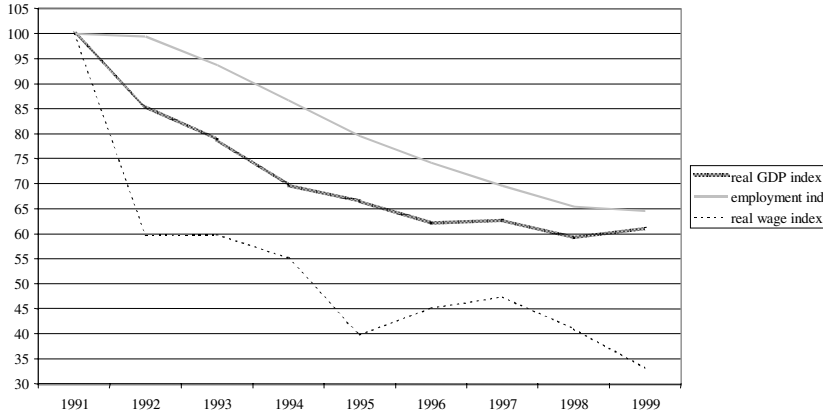
Table 1. Summary Statistics of Employment, Annual Wages and Output: Total Sample and by Ownership Type

	Total Sample Mean (St. Dev.)	*State Firms Mean (St. Dev.)*	*Privatized Firms Mean (St. Dev.)*	*Mixed Firms Mean (St. Dev.)*
Employment 1997	363.8	215.7	236.7	727.2
(1477.02)	(772.7)	(641.6)	(2519.4)	
Average Real	51.6	52.4	38.8	73.3
Wage 1997	(46.4)	(41.5)	(43.8)	(47.7)
Real Output 1997	19.3	7.4	9.9	46.7
(143.8)	(32.5)	(40.7)	(262.1)	
Change	-0.146	-0.107	-0.179	-0.128
in Employment	(0.30)	(0.38)	(0.271)	(0.27)
Change in Real	-0.020	-0.022	-0.039	0.004
Wages	(0.27)	(0.26)	(0.28)	(0.26)
Change in Real	-0.154	-0.112	-0.191	-0.161
Output	(0.37)	(0.35)	(0.36)	(0.40)
Number of Firms	3584	1026	1436	1012

Note: Wages in 100 000 of Roubles, Output in billions of Roubles, Deflator is PPI with base year 1995. Changes are changes in log values.

data. From Figure 1 we can indeed infer that real wages in 1997 did not change much. We should also stress the absence of an unconditional wage employment trade-off for the average firm in our sample as both wages and employment fell in 1997.[7] Some interesting differences across ownership types can also be observed. Average employment is largest in mixed firms, smallest in state-owned firms, while the average real wage is lowest in privatized firms and highest in mixed firms. The contraction in real output is nearly twice as large in privatized compared to state-owned firms. The fall in employment is also lowest in state-owned firms and highest in privatized firms. Privatized firms have a fall in the average real wage twice as large as that of the whole sample and of state-owned firms, while in mixed firms the average real wage shows a slight positive growth. On this evidence, mixed firms are more responsive to wage changes than firms of other ownership types.

[7] This does not preclude, of course, that we find such a trade-off once we condition on output.



Source: International Monetary Fund, Staff Country Report No 00/150. Washington, D.C. 2000.

Figure 1 — The Evolution of Real GDP, Employment and Real Wages in Russia: 1992-1999

Average employment is far higher in Chelyabinsk than in the other regions (see Table 2), hinting at the further existence of large vertically integrated firms in the region. The average real wage is substantially higher in Krasnoyarsk and Chelyabinsk than in Moscow and Chuvashia. The relatively low wage paid by firms in our Moscow sample can be explained by the fact that more than half of all state-owned and privatized firms are located in Moscow. The fact that wages are highest in those regions where wages were high under central planning can be taken as evidence that in the "traditional" firms covered by our sample administered wages might still play an important role. The fall in real output is particularly large in Krasnoyarsk and Chelyabinsk, as is the fall in the real average wage. In contrast, labor shedding seems to have been particularly strong in Moscow and Chuvashia in 1997, reaching 12% and 16% of the workforce respectively.

Manufacturing firms are roughly eight times and construction firms roughly 5 times larger on average than firms engaged in trade and distribution, where the average real wage reaches only a quarter of the wage in construction (Table 3). Wage losses are three times as large in trade than in manufacturing, although they are very moderate across all sectors. Falls in employment and real output, on the other hand, are large across all sectors, with manufacturing showing the largest fall in real output while employment contraction is largest in construction.

Table 2. Summary Statistics of Employment, Annual Wages and Output by Region

	Krasnoyarsk	*Moscow*	*Chelyabinsk*	*Chuvashia*
Average Employment	423.8	285.9	602.3	281.7
	(1096.7)	(1059.5)	(2597.1)	(841.3)
Average Real Wage	77.4	45.5	59.4	40.7
	(46.7)	(51.9)	(32.5)	(21.5)
Average Real Output	23.4	15.1	35.6	8.7
	(121.4)	(77.2)	(280.6)	(43.2)
Change in Employment	-0.093	-0.118	-0.096	-0.159
	(0.4)	(0.26)	(0.26)	(0.51)
Change in Real Wage	-0.094	0.007	-0.043	-0.029
	(0.24)	(0.28)	(0.25)	(0.25)
Change in Output	-0.224	-0.137	-0.199	-0.109
	(0.37)	(0.36)	(0.37)	(0.34)
Number of Firms	447	1987	693	454

Note: See Table 1.

Table 3. Summary Statistics of Employment, Annual Wages and Output by Sector

	Manufacturing	*Construction*	*Trade*
Average Employment	633.9	410.2	79.6
	(2009.4)	(1578.5)	(209.9)
Average Real Wage	68.6	85.3	21.5
	(41.5)	(52.6)	(27.2)
Average Real Output	37.9	17.7	16.1
	(211.8)	(102.8)	(4.7)
Change in Employment	-0.097	-0.137	-0.123
	(0.21)	(0.27)	(0.36)
Change in Real Wage	-0.009	-0.011	-0.034
	(0.25)	(0.31)	(0.26)
Change in Output	-0.175	-0.145	- 0.136
	(0.38)	(0.41)	(0.33)
Number of Firms	1483	615	1497

Note: See Table 1

While it is hard to disentangle how firms adjust their employment in response to wage changes from these cross tabulations, one fact emerges very clearly from them. All types of firms in the covered regions and sectors experience on average a very large negative output shock, to which they respond with substantial labor shedding.

3. Labor demand and the russian labor market

One way to derive labor demand is based on cost minimization, under the constraint that a given output level has to be produced with the technology available. If total costs are assumed to be the sum of products of the cost-minimizing input demands and factor prices and if total costs are assumed to be linearly homogeneous in the latter, then the total cost function can be written as

$$C = C\ (w,\ r,\ m,\ Q). \tag{1}$$

Where C are total costs, w the real wage, r the real user cost of capital, m the real unit material cost and Q real output. Using Shepard's lemma,

$$N^* = C_w, \tag{2}$$

where N^* is the cost-minimizing demand for the input labor and C_w is the partial derivative of the total cost function with respect to labor[8]. Equation (2) can be written as

$$N^* = N^d(w,\ r,\ m,\ Q). \tag{3}$$

Log-linearizing equation (3) one gets an easily estimable equation that yields the constant-output own price elasticity of demand for labor, the cross-elasticities of labor demand, as well as the employment-output elasticity. One problem with the data at our disposal is that we have no information on the unit cost of capital, nor on the unit cost of material inputs, which implies that we cannot measure r and m. We therefore assume that the unit cost of capital and the unit cost of material inputs do not vary over time, but may rather vary between different firms. This allows us to capture these unit costs in an unobservable firm level fixed effect, which gives the following empirical estimable equation for labor demand in firm i at time t,

[8] This function is also consistent with models of imperfect competition in the product market.

$$n_{it} = \delta_i + \beta_1 w_{it} + \beta_2 q_{it} + \varepsilon_{it}, \quad (4)$$

where small letters of the variables now refer to natural logarithms, ε_{it} is a white noise error term and δ_i is an unobservable firm level fixed effect. The subscripts denote firm i at time t. The firm level fixed effect may also capture other unobservable factors. Estimating equation (4) in first differences to control for the unobserved fixed effect, we get

$$\Delta n_{it} = \beta_1 \Delta w_{it} + \beta_2 \Delta q_{it} + \Delta \varepsilon_{it}. \quad (5)$$

Equation (5) will form the basis of our analysis, which we estimate for the overall sample of Russian firms and for various sub-samples. By estimating equation (5) we can consistently estimate the wage elasticity, β_1, while at the same time we control for the unobserved firm level fixed effect, which captures various aspects of firm heterogeneity. Before we go on to Marshall's rules we need to discuss various conceptual and econometric issues related to the specification and the estimation of equation (5).

Marshall's rules are valid when the economy is in equilibrium, i.e. in the long run. We understand «long run» in connection with equation (5) as a steady state, corresponding to a static labor demand equation. One could argue, of course, that the Russian economy was not in equilibrium in 1997 as the build-up of various arrears that already occurred in that year and that lead to the August 1998 crisis was a reflection of profound structural imbalances (Pinto, Drebentsov and Morozov, 2000). On the other hand, the year 1997 saw several macro variables being close to a steady state; e.g. the interest rate on Euro bonds, the effective exchange rate, price indices and the unemployment rate changed very little during this year, while real output rose slightly for the economy as a whole (OECD, 2000). This does not, of course, mean that equation (5) captures truly an equilibrium relationship, especially when applied to our sample where both average real output and average employment fall substantially. Nevertheless, we assume that equation (5) represents a steady state situation and use it as a benchmark to inspect the evidence on Marshall's rules. To model labor adjustment properly we would need a longer panel in order to derive an estimable dynamic model. The data at our disposal do not allow such a rich dynamic specification because we only have two years of data available.

The second issue that needs to be touched upon is how firms like those in our sample interact with the labor market and how this is related to the specification of equation (5) and to the estimation

methods used. The dramatic fall in output and the lack of its recovery for the analyzed firms throughout the nineties motivate our empirical strategy to treat output as exogeneous when estimating equation (5). We would also argue that the sharp decline in real wages of the nineties makes it unlikely that workers and managers bargain over wages in our sample of "traditional firms." The majority of workers have been confronted periodically with large cuts in real wages, which they seem to have tolerated. Firms, therefore, seem to pay to most workers a "competitive" real wage, which we treat as exogeneous in equation (5).

The labor demand equation that we estimate has a very simple specification, which in turn is based on a very simple model of cost minimization. Assuming cost minimization as the main driving force behind managers' behavior strikes us as a more reasonable assumption in the Russian context than profit maximization. However, a more complex labor demand equation based on cost minimization can be derived if we assume that firms face quadratic adjustment costs. This assumption leads to a specification where equation (5) is augmented with the change in the log of capital and of material costs as additional regressors. We estimated such equations for the full sample and the various sub-samples that we discuss below. The point estimates of the own wage elasticities did not change in a statistically significant way, even though the change in the log of capital was highly significant.[9]

Another issue that needs to be addressed before we proceed is wage arrears in Russia. Earle and Sabirianova (2002) and Lehmann, Wadsworth and Acquisti (1999) provide convincing evidence that large parts of the workforce are affected by them. As we use the contractual wage bill to calculate average wages at the firm level, it is important to understand whether by using the contractual (or the accrued) wage bill in our calculations we bias our wage measure in a substantial way. To get an idea of the magnitude of the measurement error associated with wage arrears one needs to look at the dynamics of wage arrears. Both cited papers and Lehmann and Wadsworth (2001) find some evidence that many persons who suffer from wage arrears are paid back the arrears over a given calendar year. For many workers wage arrears

[9] These regressions are not shown here, but are available from the authors on request. The robustness of the point estimates of the own wage elasticities can be explained by the fact that in the sample the change in the log of capital and the change in the log of real wages are only weakly correlated.

is, therefore, not a problem of having their pay permanently withheld but a problem of irregular pay. Since we use the annual wage, measurement error associated with wage arrears is certainly attenuated.

Some error in the measurement of wages, but also in output will remain, though. We try to correct for this by instrumenting DDw_{it} and DDq_{it} using ownership and regional dummies and in particular instruments that use two ranking schemes of the variables in question. Instruments that use ranking schemes are considered especially appropriate when right hand side variables are measured with error (Bowden and Turkington, 1984). The first ranking scheme that we use is due to Durbin (1953). We rank the changes in log wage and log output and use this rank as an instrument. Intuitively the rank should be highly correlated with the properly measured variable, but not with the measurement error as long as this error is not too large, thus providing a good instrument. When large measurement error is present it might be better to use Bartlett's (1949) scheme. Bartlett suggests to divide the sample in three groups according to the rank of the improperly measured variable and then use the upper and lower group means to estimate the coefficients, while ignoring the middle group. This amounts to Instrumental Variable estimation, using as an instrument —1 for the lower group, 0 for the middle group and +1 for the upper group. While IV estimation using Bartlett's rankings might be less efficient, it is less sensitive to large measurement error. We, therefore, employ in our regressions OLS and both IV estimation procedures, test the validity of the instruments using a test of over-identifying restrictions and then perform a Hausman test to see whether the OLS estimates are consistent. In some cases, the Hausman test fails to reject the null hypothesis of consistent OLS estimates. Therefore, we report the results of all three estimation methods in our labor demand regressions.

4. Evidence on Marshall's rules

The four rules of derived demand can be synoptically summarized as follows (Hamermesh, 1992; Hicks, 1968): *Ceteris paribus*,

(1) the lower the labor share in total costs, the lower the own wage elasticity;[10]

[10] In the two-input case, this is strictly only true "so long as the elasticity of demand for the final product is greater than the elasticity of substitution." (Hicks, 1968, pp. 245-46). We assume that this holds in Russia.

(2) labor demand is less elastic when the demand for the product, for which labor is used as an input, is less elastic;

(3) the lower is the substitution elasticity between labor and other factors, the lower is the own price elasticity;

(4) labor demand is less elastic, the less elastic is the supply of other factors of production.

The data that we have at our disposal do not allow us to rigorously test these rules. Instead, we use the empirical evidence that we can generate to see whether there are empirical patterns that suggest a nexus between wage elasticities and Marshall's rules. The fourth of these rules cannot be investigated given our data. Since we do not have unit material costs and capital user cost we cannot estimate supply functions of the other factors of production.

Labor shares, on the other hand, can easily be estimated with our data. We can readily compute sales, total material costs and the wage bill in real terms. We then arrive at two measures of labor share, the first one using the ratio of the wage bill over sales, while the second one divides the wage bill by value added, i.e. by sales minus material costs. While the second measure might be preferred as the one commonly used in the literature, it could be affected by particularly large measurement error of the variable material costs.

The estimation of product demand is somewhat less straightforward. Our strategy is to produce estimates of the "Lerner Index", i.e. estimates of the price cost margin, which is equivalent to the inverse of the product demand elasticity. Our methodology is based on Hall (1988), Domowitz, Hubbard and Petersen (1988) and Roeger (1995). We start from a standard production function $Q_{it} = \Theta_{it} F\left(N_{it}, K_{it}, M_{it}\right)$, where i is a firm index for the firm, t is a time index, Θ is the level of productivity, N is labor, K is capital and M is material input.

Under perfect competition, it is well known that the growth rate of output can be decomposed as follows:

$$\frac{\Delta Q_{it}}{Q_{it}} = \alpha_{Nit} \frac{\Delta N_{it}}{N_{it}} + \alpha_{Kit} \frac{\Delta K_{it}}{K_{it}} + \alpha_{Mit} \frac{\Delta M_{it}}{M_{it}} + \vartheta_{it} \qquad (6)$$

where $\alpha_{Jit} = \frac{P_{Jit} J_{it}}{P_{it} Q_{it}}$ (J=N,K,M) is the share of inputs in turnover and $\vartheta_{it} = \frac{\Delta \Theta_{it}}{\Theta_{it}}$.

Under imperfect competition, Equation (6) becomes (Hall, 1986):

$$\frac{\Delta Q_{it}}{Q_{it}} = \mu_{it}\left(\alpha_{Nit}\frac{\Delta N_{it}}{N_{it}} + \alpha_{Kit}\frac{\Delta K_{it}}{K_{it}} + \alpha_{Mit}\frac{\Delta M_{it}}{M_{it}}\right) + \vartheta_{it} \tag{7}$$

where $\mu = \frac{p}{c}$ is the markup of price over marginal cost.

This can also be written:

$$\begin{aligned}\frac{\Delta Q_{it}}{Q_{it}} - \alpha_{Nit}\frac{\Delta N_{it}}{N_{it}} - \alpha_{Mit}\frac{\Delta M_{it}}{M_{it}} - (1-\alpha_{Nit}-\alpha_{Mit})\frac{\Delta K_{it}}{K_{it}} = \\ = \beta_{it}\left(\frac{\Delta Q_{it}}{Q_{it}} - \frac{\Delta K_{it}}{K_{it}}\right) + (1-\beta_{it})\vartheta_{it}\end{aligned} \tag{8}$$

where $\beta = \frac{p-c}{p} = 1 - \frac{1}{\mu}$ is the Lerner index.

It is also possible to derive a similar expression for the price based, or dual Solow residual (Roeger, 1995):

$$\begin{aligned}\alpha_{Nit}\frac{\Delta P_{Nit}}{P_{Nit}} + \alpha_{Mit}\frac{\Delta P_{Mit}}{P_{Mit}} + (1-\alpha_{Nit}-\alpha_{Mit})\frac{\Delta P_{Kit}}{P_{Kit}} - \frac{\Delta P_{it}}{P_{it}} = \\ = -\beta_{it}\left(\frac{\Delta P_{it}}{P_{it}} - \frac{\Delta P_{Kit}}{P_{Kit}}\right) + (1-\beta_{it})\vartheta_{it}\end{aligned} \tag{9}$$

Then subtracting (9) from (8) one gets:

$$\begin{aligned}\left(\frac{\Delta Q_{it}}{Q_{it}} + \frac{\Delta P_{it}}{P_{it}}\right) - \alpha_{Nit}\left(\frac{\Delta N_{it}}{N_{it}} + \frac{\Delta P_{Nit}}{P_{Nit}}\right) - \alpha_{Mit}\left(\frac{\Delta M_{it}}{M_{it}} + \frac{\Delta P_{Mit}}{P_{Mit}}\right) - (1-\alpha_{Nit}-\alpha_{Mit})\times \\ \times\left(\frac{\Delta K_{it}}{K_{it}} + \frac{\Delta P_{Kit}}{P_{Kit}}\right) = \beta_{it}\left[\left(\frac{\Delta Q_{it}}{Q_{it}} + \frac{\Delta P_{it}}{P_{it}}\right) - \left(\frac{\Delta K_{it}}{K_{it}} + \frac{\Delta P_{Kit}}{P_{Kit}}\right)\right] + \varepsilon_{it}\end{aligned} \tag{10}$$

Rewriting the left hand side as Δy and the right hand side as Δx, one obtains a very simple testable equation: $\Delta y_{it} = \beta_t \Delta x_{it} + \varepsilon_{it}$, where we have imposed the same coefficient for all firms.[11] We shall use Equation (10) to estimate the Lerner index or the inverse of the product demand

[11] In order to identify bb we need to impose this restriction.

elasticity. This methodology allows us to use nominal values of the variables and the Lerner index can be estimated consistently using OLS (Roeger, 1995). The methodology is similar to Levinsohn (1993) and Konings, Van Cayseele and Warzynski (2001). OLS estimation produces consistent estimates with Roeger's method when measurement error of the right hand side variables is not a major issue. In our Russian sample of firms, values of total sales, capital stock and material costs might be measured with substantial error. Instrumenting these variables using the Durbin and Bartlett ranking schemes and ownership or regional dummies, we present OLS and IV estimates of the Lerner index[12].

In order to estimate the partial elasticities of substitution between the three input factors labor (N), capital (K) and materials (M), we need to assume a flexible enough underlying production function with non-constant elasticities of substitution. We choose, therefore, the three input translog production function, which we estimate in first differences to control for an unobserved firm-level fixed effect. We then use the coefficient estimates from this translog production function to impute the marginal products of the inputs. These imputed marginal products in turn allow us to construct the bordered Hessian, which is used to calculate the Allen-Uzawa partial elasticities of substitution (AES). In a final step, we derive the Morishima partial elasticities of substitution (MES) from the AES. A formal exposition of the derivation of the MES is given in appendix 2.

In investigating the third of Marshall's rules, we are particularly interested in the "ease" of input substitution for a given subset of firms. Blackorby and Russel (1989) show that when the number of inputs exceeds two, the MES and not the AES are capable of capturing this ease of substitution. A second feature of the MES consists in the asymmetry of the partial elasticities, while the AES are symmetric. With MES, the change in the ratio of two inputs i and j can be different in magnitude and even in its sign if either the price of input i or the price of input j changes as one takes into account the effect of this price change on other inputs.[13] This asymmetry that one can get in the case of the Morishima partial elasticities also implies that two inputs can be classified as substitutes and complements at the same time, depending

[12] Only output and capital appear on the right hand side of equation (10). Instrumenting these two variables is sufficient to ensure consistency.

[13] The main point of Blackorby and Russell (1989) is that the AES are not a natural generalization of the two-variable elasticity, while the MES are.

on which of the input prices changes. We use this property of the MES to investigate Marhall's third rule with our data set looking at the following partial elasticities: MES_{NK} , MES_{KN} , MES_{NM} and MES_{MN}. When all partial elasticities are positive, labor always enters the production function as a substitute of the other two inputs capital and materials. When some of the partial elasticities show negative values, on the other hand, labor becomes at times a complement of the other two inputs. This latter case is taken as evidence that as the price of one of the inputs changes the firm, which is assumed to be cost minimizing and producing a given level of output, has less flexibility in substituting inputs. Given our limited data, we prefer this somewhat "qualitative" interpretation of the MES to a strictly "quantitative" interpretation, which would rank partial elasticities strictly by magnitude, when comparing sub-samples.

5. Results: Labor demand

Tables 4—7 report estimated labor demand equations for the total data set of MLEs and for various sub-samples. Below the coefficients the standard errors are shown in parentheses. In all tables we give the results of OLS and two variants of IV estimation, where the first one uses Durbin's ranking scheme ("IV-Durbin") and the second one that of Bartlett ("IV-Bartlett"). We also present the probability values of two chi square test statistics, related to a test of over-identifying restrictions (OIR test) and to a Hausman test. A probability value of greater than 0.10 in the case of the OIR test indicates that the instruments are valid, i.e. that they are not correlated with the error term of equation (5). We also run auxiliary regressions with the regressors as left hand side variables and the instruments as right hand side variables and find very high F-statistics when testing the joint insignificance of the latter variables. These high F-statistics point to a high correlation of these two sets of variables, so the second condition for being good instruments seems to be fulfilled.[14] A probability value of less than 0.10 for the Hausman tests indicates that there is a systematic difference between the OLS and the IV coefficients and that the OLS estimate might be inconsistent. The own wage and the output elasticities are in virtually all cases estimated with great precision as a quick glance over Tables 4—7 makes clear. This great precision has two implications. On the one hand, we

[14] These auxiliary regressions are not shown here but are available upon request.

can be very confident in our estimates and, on the other hand, the Hausman test can reject the null hypothesis of consistent OLS estimates even if these estimates are very close to the IV estimates.

Table 4. Estimate of Labor Demand Equation — Total Sample Dependent Variable Δn_{it}

	OLS	*IV-Durbin*	*IV-Bartlett*
Δw_{it}	-0.181**	-0.183**	-0.179**
	(0.023)	(0.022)	(0.024)
Δq_{it}	0.265**	0.277**	0.279**
	(0.016)	(0.016)	(0.018)
OIR-test (P-value of $\chi^2(2)$)	—	0.701	0.696
Hausman test (P-value)	—	0.027	0.008
R^2	0.275	0.275	0.096

Note: Lower case variables are in logs. Robust to heteroskedasticity standard errors in brackets, ** denotes statistically significant at the 1% critical level, Δw_{it} is instrumented using its rank and ownership dummies, Δq_{it} is instrumented using its rank and ownership dummies. N=3584. IV-Durbin uses individual rankings to instrument variables; IV-Bartlett uses grouped rankings to instrument variables (see text for details). OIR-test stands for test of over-identifying restrictions.

The estimated wage elasticity for the total sample is roughly — 0.18, while the output elasticity is approximately 0.28, when we focus on the estimates of the IV-Durbin regression. Both these elasticities are low by Western standards, although they do fall in the range reported in the Western literature (see Hamermesh, 1992). The estimated wage elasticity, which is our main object of interest here, is however not excessively small in absolute value within the context of transition. The estimate that we get is at the lower end of values found by Basu, Estrin and Svejnar (2000) for Central European economies in later stages of transition. These authors found a wage elasticity of zero for Russian firms in 1993—1994. Since their sample was very small, one should not necessarily use their imprecise point estimate as a benchmark for the behavior of "traditional" Russian firms in the early period of transition. While comparison of firm behavior over time is, therefore, not really feasible, our very precise point estimate indicates that in 1997 even "traditional" firms in Russia show signs of adjusting employment to wage changes to a considerable extent and in the right direction.

Table 5. Estimate of Labor Demand Equation — by Ownership. Dependent Variable Δn_{it}

	State	*Mixed*	*Private*
OLS			
Δw_{it}	-0.151**	-0.211**	-0.187**
	(0.044)	(0.053)	(0.032)
Δq_{it}	0.262**	0.226**	0.318**
	(0.038)	(0.031)	(0.026)
R^2	0.047	0.102	0.155
IV-Durbin			
Δw_{it}	-0.145**	-0.220**	-0.186**
	(0.044)	(0.041)	(0.034)
Δq_{it}	0.250**	0.233**	0.326**
	(0.030)	(0.027)	(0.026)
OIR-test (P-value of $\chi^2(2)$)	0.725	0.111	0.239
Hausman test (P-value)	0.000	0.869	0.720
R^2	0.047	0.102	0.155
IV-Bartlett			
Δw_{it}	-0.144**	-0.231**	-0.172**
	(0.049)	(0.041)	(0.037)
Δq_{it}	0.262**	0.234**	0.319**
	(0.038)	(0.030)	(0.028)
OIR-test (P-value of $\chi^2(2)$)	0.433	0.116	0.221
Hausman test (P-value)	0.001	0.849	0.603
R^2	0.046	0.102	0.155
Number observations	1026	1012	1436

Chi-square tests of equal pair wise wage elasticities across regions under Ho gives the following p-values:

State and Mixed	p=0.025
State and Private	p=0.163
Private and Mixed	p=0.571

Note: Robust to heteroskedasticity standard errors in brackets, ** denotes statistically significant at the 1% critical level.

Our research strategy tries to detect systematic differences across various sub-samples and relate these differences to the empirical evidence

on Marshall's rules. We start with the regressions by ownership type (Table 5). As we are interested in detecting systematic differences in the wage elasticities across sub-groups, we perform chi square tests of equal pair wise elasticities under the null hypothesis[15]. The bottom panel of Table 5 gives the probability values of these tests performed for firms with different ownership structure. The wage elasticity of state-owned firms is in absolute value lower than the wage elasticities of mixed and privatized firms, while the output elasticities are roughly the same for state-owned and mixed, but substantially higher for privatized firms. The difference in the wage elasticity between state-owned and mixed firms is highly significant and marginally significant between state-owned and privatized firms. Since our test shows no significant difference in the wage elasticities of mixed and privatized firms, we take this as evidence that among "traditional" firms state-owned firms are far less responsive to wage changes in their employment decisions than firms with other ownership structures. This is an important finding in its own right as the evidence in the literature that looks at the nexus of ownership type and performance is rather inconclusive regarding different behavior of state-owned and privatized firms in Russia.

When we estimate labor demand equations by region we get the seemingly surprising result that the wage elasticity is much lower in absolute value in Moscow than in Krasnoyarsk and in Chelyabinsk. As the bottom panel indicates the difference in the Moscow coefficient and the coefficients of the other two regions is highly significant, with the wage elasticity being roughly 10 percentage points lower in Moscow than in these two regions. No difference can be established between Chuvashia and all other regions, but this might be explained by the relatively imprecise estimates for Chuvashia[16]. The distribution of firms by ownership type in the regions explains best these regional results, since in Moscow state-own firms have a disproportionately high share compared to their shares in other regions. An alternative explanation could be that in Moscow firms have to be more cautious in their reaction to wage changes as workers have more outside options. Given our limited data we cannot test this hypothesis properly.

[15] These tests use the most satisfactory model of each-subgroup. The model with a low probability value for the Hausman test and the highest R^2 is considered to be most satisfactory.

[16] In all the regional regressions that we performed the results for Chuvashia are rather imprecise.

Table 6. Estimate of Labor Demand Equation — by Region
Dependent Variable Δn_{it}

	Krasnoyarsk	*Moscow*	*Chelyabinsk*	*Chuvashia*
OLS				
Δw_{it}	-0.220**	-0.141**	-0.273**	-0.252*
	(0.059)	(0.024)	(0.055)	(0.147)
Δq_{it}	0.254**	0.279**	0.304**	0.241**
	(0.040)	(0.020)	(0.035)	(0.086)
R^2	0.172	0.140	0.231	0.022
IV-Durbin				
Δw_{it}	-0.252**	-0.141**	-0.272**	-0.213*
	(0.058)	(0.025)	(0.051)	(0.121)
Δq_{it}	0.255**	0.292**	0.303*	0.288**
	(0.036)	0.019	(0.034)	(0.084)
OIR-test (P-value of $\chi^2(2)$)	0.147	0.097	0.484	0.816
Hausman test (P-value)	0.000	0.177	0.978	0.047
R^2	0.170	0.140	0.231	0.020
IV-Bartlett				
Δw_{it}	-0.265**	-0.133**	-0.243**	-0.219*
	(0.064)	(0.027)	(0.052)	(0.131)
Δq_{it}	0.250**	0.303**	0.286**	0.294**
	(0.037)	(0.021)	(0.034)	(0.098)
OIR-test (P-value of $\chi^2(2)$)	0.139	0.108	0.482	0.808
Hausman test (P-value)	0.258	0.000	0.000	0.567
R^2	0.169	0.139	0.230	0.020
Number observations	447	1987	693	454

Chi-square tests of equal pair wise wage elasticities across regions under Ho gives the following p-values:

Krasnoyarsk and Moscow	p=0.021
Krasnoyarsk and Chelyabinsk	p=0.748
Krasnoyarsk and Chuvashia	p=0.748
Chelyabinsk and Moscow	p=0.013
Chelyabinsk and Chuvashia	p=0.779
Moscow and Chuvashia	p=0.502

Notes: Robust to heteroskedasticity standard errors in brackets, ** denotes statistically significant at the 1% critical level, * statistically significant at the 10% critical level.

Table 7. Estimate of Labor Demand Equation — by Sector Dependent Variable Δn_{it}

	Manufacturing	*Construction*	*Trade*
OLS			
Δw_{it}	-0.156**	-0.228**	-0.188**
	(0.027)	(0.068)	(0.036)
Δq_{it}	0.206**	0.294**	0.334**
	(0.018)	(0.045)	(0.032)
R^2	0.125	0.160	0.084
IV-Durbin			
Δw_{it}	-0.180**	-0.214**	-0.180**
	(0.026)	(0.055)	(0.038)
Δq_{it}	0.215**	0.296**	0.354**
	(0.018)	(0.038)	(0.031)
OIR-test (P-value of $\chi^2(1)$)	0.123	0.216	0.113
Hausman test (P-value)	0.000	0.851	0.010
R^2	0.125	0.160	0.083
IV-Bartlett			
Δw_{it}	-0.183**	-0.216**	-0.165**
	(0.030)	(0.052)	(0.042)
Δq_{it}	0.218**	0.306**	0.346**
	(0.021)	(0.039)	(0.035)
OIR-test (P-value of $\chi^2(1)$)	0.125	0.214	0.122
Hausman test (P-value)	0.953	0.528	0.094
R^2	0.124	0.160	0.083
Number observations	1486	615	1497

Chi-square tests of equal pair wise wage elasticities across regions under Ho gives the following p-values:	
Manufacturing and Construction	p=0.452
Manufacturing and Trade	p=0.996
Trade and Construction	p=0.405

Notes: Robust to heteroskedasticity standard errors in brackets, ** denotes statistically significant at the 1% critical level.

The estimates of labor demand for the three sectors show a slightly higher wage elasticity in absolute value for construction and equal

elasticities for manufacturing and trade (Table 7). The three percentage point difference that we observe between construction and the other two sectors is, however, statistically not significant as the chi square statistics in the bottom panel show.

In summary, the evidence seems to point to ownership structure and regional location as the main determinants of differences in wage elasticities. Six years into the transition, partially privatized and, to a lesser degree, fully privatized firms exhibit a more pronounced wage employment trade-off than do state-owned firms. Labor demand in Chelyabinsk and Krasnoyarsk is significantly more elastic than labor demand in Moscow. Whether Marshall's rules of derived demand can shed some light on these two results will be discussed in the next section.

6. Results: Evidence on Marshall's rules

We first look at two measures of average labor share for the overall data set and the various previously discussed sub-samples (Table 8). Labor shares are defined either as the wage bill divided by total sales or as the wage bill divided by value added. For the sample as a whole the calculated average shares are 26% and 35% respectively, both of which are relatively low by Western standards. So, for the sample as a whole the first of Marshall's rules seems to be fulfilled as a relatively inelastic labor demand coincides with a relatively low labor share.

To see whether we get a consistent pattern within the sample, we compare wage elasticities and the two measures of labor share at the disaggregated level. The comparison of firms under different ownership gives rather poor results. There is no clear pattern when we take the first measure of labor share, while the second measure is slightly lower for state-owned firms than for mixed firms. With regions, however, a clear pattern emerges. Both measures show the same dichotomy between Moscow and the other regions that we observe in the case of own wage elasticities, with the labor share being roughly 25 percentage points lower in Moscow than in the other regions. While we attribute this dramatically lower share mainly to the concentration of state-owned firms in Moscow, the prediction of Marshall's first rule seems to hold when we disaggregate the data by region. In contrast, there is hardly any positive correlation between labor shares and wage elasticities across sectors. For example, the Spearman rank correlation coefficients between

wage elasticities and the two measures of labor share for construction, trade and eight branches of manufacturing are 0.09 and −0.09 respectively, neither of which is statistically significant. Slicing the data by sector provides no insights into the nexus of wage elasticities and labor shares.

Table 8. Average Wage Shares and Wage Elasticities

	Wage Elasticity in Absolute Value	*Raw Share (Wage Bill / Turnover)*	*Raw Share (Wage Bill / Value added)*
Total sample (3854)	0.18	0.26	0.35
State firms (1026)	0.15	0.32	0.41
Mixed firms (1012)	0.21	0.30	0.46
Private firms (1436)	0.18	0.19	0.27
Krasnoyarsk (447)	0.22	0.36	0.51
Moscow (1987)	0.14	0.18	0.25
Chelyabinsk (693)	0.27	0.33	0.49
Chuvashia (454)	0.25	0.35	0.50
Construction (1486)	0.23	0.34	0.49
Trade (615)	0.18	0.18	0.20
Manufacturing (1497)	0.15	0.30	0.48
Metallurgy (38)	0	0.24	0.47
Chemistry (39)	0.15	0.27	0.42
Machine manufact. (344)	0.11	0.34	0.51
Wood manufact. (72)	0.11	0.36	0.51
Construction manufact. (96)	0.17	0.23	0.48
Light manufact. (141)	0.25	0.39	0.58
Food manufact. (180)	0.18	0.17	0.42
Medical and Biological Manufacturing (126)	0.32	0.31	0.45

Note: The Spearman rank correlation coefficients between wage elasticities in different ownership types, regions, sectors and the first (second) raw wage labor share are equal to −0.5 (0.5), 0.2 (0.2) and 0.09 (-0.09) respectively; however, none are statistically significant at conventional levels. Number of firms is given in parentheses.

The estimates of the Lerner Index, are given in Table 9. The OLS and IV estimates are quite close with the exception of one estimate (construction). The slightly higher values of the IV estimates, all of which are highly significant, indicate the existence of measurement error. We, therefore, concentrate on the IV estimates in our discussion

of Table 9. The estimate of 0.46 of the Lerner index for the overall sample implies an elasticity of product demand equal to 2.27. Using firm level data, Konings, Van Cayseele and Warzynski (2001) estimate a product demand elasticity of 4.5 for Belgium and of 2.9 for the Netherlands, which is known to have an economy with one of the most developed cartel structures. So our estimate of product demand in the four Russian regions, hinting at strongly monopolistic product market structures, implies that a relatively inelastic product demand contributes to the low labor demand elasticity.

Table 9. Estimates of the Lerner index, Roeger method

Dep. var.: Δy	*OLS*	*IV*	*OIR-test (p-value)*	*Hausman test (p-value)*
Δx	0.42** (0.02)	0.46** (0.03)	0.39	0.00
By ownership				
State	0.45** (0.04)	0.53** (0.04)	0.42	0.00
Mixed	0.22** (0.07)	0.24** (0.08)	0.88	0.00
Private	0.52** (0.03)	0.56** (0.03)	0.56	0.00
By region				
Moscow	0.46** (0.04)	0.52** (0.04)	0.83	0.00
Chelyabinsk	0.30** (0.03)	0.35** (0.03)	0.22	0.00
Chuvashia	0.34** (0.04)	0.36** (0.04)	0.77	0.30
By sector				
Manufacturing	0.29** (0.05)	0.30** (0.05)	0.97	0.00
Trade	0.72** (0.02)	0.75** (0.03)	0.83	0.10
Construction	0.08* (0.05)	0.25** (0.07)	0.62	0.00

Note: * and ** denotes statistical significance at the 10% and 1% level. Standard errors in parentheses. Durbin and Bartlett ranking variables are both used as instruments.

To investigate the driving forces behind this low product demand elasticity we compare the Lerner indices within the three data groupings. Mixed firms have on average a product demand elasticity, which is more than twice as large as that of state-owned and fully privatized firms. The results in Table 5 found a highly significant difference in the wage elasticities of state-owned and mixed firms, while the difference between state-owned and fully privatized firms was not statistically significant at conventional levels. This might explain why Marshall's

second rule is only borne out when we compare state-owned and mixed firms. However, when we consider the Lerner indices for the different regions, then their rankings correspond exactly with the prediction given by Marshall's second rule. Firms in Moscow, where labor demand is more inelastic than in the other regions, are confronted with an implied product demand elasticity of 1.98, while firms in Chelyabinsk and Chuvashia face an implied average product demand elasticity of 2.85 and 2.77 respectively[17]. While competitive pressure in Russia might have an important regional dimension, as suggested by Brown and Earle (2000), it is hard to think of purely regional factors that make product markets in Moscow less elastic than elsewhere. What could explain less elastic product demand in Moscow is, again, the heavy concentration of state-owned firms in our Moscow sample. The estimated Lerner indices for sectors show no sensible patterns and cannot be related to the estimated wage elasticities in a simple fashion. As differences in wage elasticities across sectors are not statistically significant anyway, these product elasticities will not be discussed any further. Marhall's second rule is, however, borne out by the results when the data are sliced by region and, to a lesser degree, by ownership.

In a last step, we attempt to see to what extent the underlying production technology might drive the estimated wage elasticities. In the three-input case we need to look at the Morishima partial elasticities of substitution (MES) in order to get an idea of the ease, with which factors of production can be substituted while output is held constant. However, it is hard to visualize in three dimensional space, how the ratio of two inputs changes as a consequence of the price change of one of the inputs when this price change also affects the third input. Also, in the three-input case we have four MES that involve labor and one might find it quite difficult to link the imputed values of these four MES unequivocally to the notion "ease of substitution of inputs" for various sub-groups of firms[18]. Given our data limitations, it certainly would seem presumptuous to try this. Instead, we take advantage of the asymmetry property of MES, which can lead to the classification of input *i* as a substitute and a compliment of input *j*, depending which of

[17] We were not able to estimate the Lerner index for Krasnoyarsk since data on capital inputs and material costs were missing for that region.

[18] We should also note that the MES are unbounded. As no one has imputed MES for transition economies, we cannot really tell what the calculated values of the MES imply for the whole sample.

the two input prices is changed. Our essentially qualitative classification scheme then stipulates that a sub-group of firms exhibits a production technology with relative ease of substitution between labor and the other two input factors, if all four MES that involve labor are positive, i.e. if labor is always a substitute for the other two factors, no matter which input price changes. We have a production technology of less flexible input use, if at least one of the MES is negative, i.e., if at least once labor is used in a complementary fashion.

Table 10. Morishima Partial Elasticities of Substitution (MES) based on Estimates from Three-input Translog Production Function — labor (N), capital (K), and materials (M)

	MES_{NK}	MES_{KN}	MES_{NM}	MES_{MN}
Total Sample (N=2707)	1.878	-0.211	7.707	19.633
Ownership				
State Firms	2.965	-16.815	1.083	-3.702
Firms of mixed Ownership	1.107	0.246	1.626	1.070
Private	0.686	0.077	2.711	5.057
Regions				
Moscow	1.339	-0.857	1.940	3.783
Chelyabinsk and Chuvashia	3.237	3.305	3.187	1.945
Sectors				
Manufacturing	-2.836	8.159	-4.906	-1.865
Construction	1.398	-0.299	1.043	0.910
Trade	-3.604	-25.365	17.533	-5.102

Note: Elasticities for total sample are based on OLS regression; elasticities for sub-samples are based on two stage least squares regression.

Given such a qualitative classification approach, we see in Table 10 that state-owned firms clearly exhibit a production technology characterized by less ease of substitution than do mixed and fully privatized firms. In the case of the former, labor alternates between being a substitute and a complement, while in the latter two forms of ownership labor is always a substitute. We get a similar dichotomous

classification for regions. Firms in our Moscow sample have more difficulties to substitute labor for the other inputs than have firms in Chelyabinsk and Chuvashia[19]. Again, this should be explained with the disproportionate share of state-owned enterprises, especially since the imputed MES for the three sectors do not allow us to discriminate on the criterion of ease of substitution of labor with other input factors. In summary, it transpires from Table 10 that state-owned firms, which have on average a more inelastic demand for labor, can substitute labor less easily with other inputs than can firms of other ownership types. Marshall's third rule is borne out by the data quite convincingly, if one follows this approach.

7. Conclusions

In this paper we use a unique enterprise-level data set, which covers the regions Moscow City, Chelyabinsk, Krasnoyarsk and Chuvashia and the three sectors manufacturing and mining, construction and trade and distribution, to estimate static labor demand equations for the year 1997. While the results are tentative we can draw some conclusions with confidence.

There are three important conclusions that can be drawn from the estimated own wage elasticities. First, labor demand is relatively inelastic in international perspective, although the estimated wage elasticity for the whole sample of — 0.18 is within the range reported in empirical studies in the Western literature. Secondly, this estimate also implies that six years into transition Russian firms on average do respond to wage changes by adjusting employment. Thirdly, the estimated wage elasticities provide some evidence that state-owned firms, which have on average a more inelastic labor demand than privatized and partially privatized firms, are performing differently than firms with other ownership structure. They are much more sluggish in their employment responses to wage changes than privatized and partially privatized firms.

Linking these results to Marshall's rules of derived demand for the whole sample and across various subsets of our sample we find some evidence that lower product demand and less ability to substitute

[19] Kasnoyarsk cannot be included, since we have no capital inputs and material costs for firms of this region.

labor for capital and materials is contributing to the more inelastic labor demand of state-owned firms. In future work we will use a dynamic specification of labor demand, once more data points for our sample of MLEs in the four Russian regions become available. While our research on Russian labor demand is still at an early stage, the paper establishes the encouraging result that investigating Marshall's rules of derived demand seems a promising avenue for establishing some of the driving forces behind labor demand in Russia.

Appendix 1
Description of Russian enterprise level data

The data are enterprise level data for large and medium sized firms in the regions of Moscow, Chelyabinsk, Krasnoyarsk and Chuvashia. The data refer to a cross-section in 1997, however, there is information for the year 1996 because retrospective information is reported. The data are reported in millions of roubles and are deflated using the producer price index reported by Russian Economic Trends.

Employment in 1997:	average listed total employment (without part-timers and non-listed employees) for the last month of the reporting quarter of 1997.
Employment in 1996:	average listed total employment (without part-timers and non-listed employees) for the last month of the reporting quarter in the previous year
Unit wage cost in 1997:	total wage bill in 1997 divided by employment in 1997.
Unit wage cost in 1996:	total wage bill in 1996 divided by employment of 1996.
Output in 1997:	production output in current prices (without VAT, excise and special tax) for the reporting year.
Output in 1996:	production output in current prices (without VAT, excise and special tax) for the previous year.
Capital in 1997:	fixed capital at the end of the reporting year 1997.

Capital in 1996:	fixed capital at the beginning of the reporting year 1997.
Material inputs in 1997:	total material costs (raw materials + semi-finished parts + fuel and energy) for the reporting year.
Material inputs in 1996:	total material costs for the previous year.

Appendix 2
Derivation of Morishima Partial Elasticities of Substitution using a three-factor Translog Production Function

• We control for unobserved heterogeneity by differencing a Fixed Effects model of the translog production function with the inputs labor (N), capital (K) and materials (M):

$$\Delta \ln y = \alpha_1 \Delta \ln N + \frac{1}{2}\gamma_{11}\Delta(\ln N)^2 + \frac{1}{2}\gamma_{12}\Delta(\ln N \ln K) + \frac{1}{2}\gamma_{13}\Delta(\ln N \ln M)$$
$$+ \alpha_2 \Delta \ln K + \frac{1}{2}\gamma_{22}\Delta(\ln K)^2 + \frac{1}{2}\gamma_{23}\Delta(\ln K \ln M)$$
$$+ \alpha_3 \Delta \ln M + \frac{1}{2}\gamma_{33}\Delta(\ln M)^2 .$$

• We recover the coefficient estimates from this regression and calculate logarithmic marginal products of the tree factors, evaluated at the mean values of the inputs:

$$m_1 = \ln MP_N = \hat{\alpha}_1 + \hat{\gamma}_{11}\ln \overline{N} + \hat{\gamma}_{12}\ln \overline{K} + \hat{\gamma}_{13}\ln \overline{M}$$
$$m_2 = \ln MP_K = \hat{\alpha}_2 + \hat{\gamma}_{12}\ln \overline{N} + \hat{\gamma}_{22}\ln \overline{K} + \hat{\gamma}_{23}\ln \overline{M}$$
$$m_3 = \ln MP_M = \hat{\alpha}_3 + \hat{\gamma}_{13}\ln \overline{N} + \hat{\gamma}_{22}\ln \overline{K} + \hat{\gamma}_{33}\ln \overline{M} .$$

• The Allen partial elasticities of substitution (AES), σ_{ij}, are then derived using the following ratios:

$$\sigma_{ij} = \frac{|G_{ij}|}{|G|},\ i, j = N, K, M,$$

where $|G_{ij}|$ is the determinant of the three-factor translog bordered Hessian:

$$G = \begin{vmatrix} 0 & m_1 & m_2 & m_3 \\ m_1 & \gamma_{11} + m_1^2 - m_1 & \gamma_{12} + m_1 m_2 & \gamma_{13} + m_1 m_3 \\ m_2 & \gamma_{12} + m_1 m_2 & \gamma_{22} + m_2^2 - m_2 & \gamma_{23} + m_2 m_3 \\ m_3 & \gamma_{13} + m_1 m_3 & \gamma_{23} + m_2 m_3 & \gamma_{33} + m_3^2 - m_3 \end{vmatrix}$$

and $|G_{ij}|$ is the cofactor of G_{ij} in *G*. These AES are symmetric as can be seen from the bordered Hessian.

• The Morishima partial elasticities (MES), σ_{ij}^M, can then be computed easily,

$$\sigma_{ij}^M = \frac{m_j \bar{x}_j}{m_i \bar{x}_i}\left(\sigma_{ij} - \sigma_{jj}\right),$$

where $\bar{x}_i$ are average log inputs, $i, j = N, K, M; i \neq j$.

References

Acquisti, Alessandro, and Lehmann, Hartmut, "Job Creation and Job Destruction in the Russia: Some Preliminary Evidence from Enterprise-Level Data." Trinity Economic Papers Series 1/00. Dublin: Trinity College, January 2000.

Bartlett, Michael S., "Fitting a Straight Line When Both Variables Are Subject to Error." *Biometrics* **5**, 3: 207-212, Sept. 1949.

Basu, Swati, Estrin, Saul, and Svejnar, Jan, «Employment and Wage Behavior of Enterprises in Transitional Economics.» Working Paper No.114. Ann Arbor, Michigan: William Davidson Institute, May 2000, revised.

Blackorby, Charles, and Russell, R. Robert, "Will the Real Elasticity of Substitution Please Stand Up? (A Comparison of the Allen/Uzawa and Morishima Elasticities)." *American Economic Review* **79,** 4: 882-888. Sept. 1989.

Bowden Roger J., and Turkington, Darrell A., *Instrumental Variables*. Cambridge and New York: Cambridge University Press, 1984.

Brown, J. David, and Earle, John S., "Competition and Firm Performance: Lessons from Russia", Center for Economic Policy Research Discussion Paper No. 2444. London: CEPR, May 2000.

Brown, J. David, and Earle, John S., "Gross Job Flows in Russian Industry Before and After Reforms: Has Destruction Become More Creative?" *Journal of Comparative Economics* **30**, 1:PP?, Mar. 2002.

Domowitz, Ian, Hubbard, R. Glenn, and Petersen, Bruce C., "Market Structure and Cyclical Fluctuations in U.S. Manufacturing." *Review of Economics and Statistics* **70**, 1: 55-66, Feb. 1988.

Durbin, James, "Errors in Variables." *Review of the Institute of International Statistics*, **22**, 1: 23-32, 1954.

Earle, John S., and Sabirianova, Klara Z., "Understanding Wage Arrears in Russia." *Journal of Labor Economics*, forthcoming 2002.

Foley, Mark, "Labor Market Dynamics in Russia." Economic Growth Center Discussion Paper No.780. New Haven, CT: Yale University, Aug. 1997.

Gimpelson, Vladimir, and Lippoldt, Douglas, *The Russian Labor Market: Between Transition and Turmoil.* Lanham, Boulder, New York and Oxford: Rowman and Littlefield, 2001.

Hall, Robert E., "The Relation between Price and Marginal Cost in U.S. Industry." *Journal of Political Economy* **96**, 5: 921-947, Oct. 1988.

Hamermesh, Daniel S., *Labor Demand.* Cambridge, MA: MIT Press, 1993.

Hicks, John R., *The Theory of Wages.* London: St. Martin's Press, Second Edition, 1968.

Konings, Jozef, and Walsh, Patrick P., "Employment Dynamics of Newly Established and Traditional Firms: A Comparison of Russia and the Ukraine." Discussion Paper 81. Leuven: LICOS, April 1999.

Konings, Jozef, Van Cayseele, Patrick, and Warzynski, Frederic, "The Dynamics of Industrial Markups in Two Small Open Economics: Does National Competition Policy Matter?" *International Journal of Industrial Organisation* **19**, 5: 841-859, Apr. 2001.

Lehmann, Hartmut, Gontmakher, Evgeniy, and Starodubrovsky, Viktor (Eds.), *Rynok truda w regionach Rosii (The Labor Market in Russia's Regions)*. Moscow: Institute for Management and Business Administration, 1999.

Lehmann, Hartmut, and Wadsworth, Jonathan, "Wage Arrears and the Distribution of Earnings." IZA Discussion Paper No. 410. Bonn: Institute for the Study of Labor (IZA), Dec. 2001.

Lehmann, Hartmut, and Wadsworth, Jonathan, "Tenures That Shook the World: Worker Turnover in Russia, Poland, and Britain." *Journal of Comparative Economics* **28**, 4: 639-664, Dec. 2000.

Lehmann, Hartmut, Wadsworth, Jonathan, and Acquisti, Alessandro, "Grime and Punishment: Job Insecurity and Wage Arrears in the Russian Federation." *Journal of Comparative Economics* **27**, 4: 595-617, Dec. 1999.

Levinsohn, James, "Testing the Imports-as-Market-Discipline Hypothesis." *Journal of International Economics* **35,** 1-2: 1-22, Aug. 1993.

Luke, Peter, and Schaffer, Mark E., "Wage Determination in Russia: An Econometric Investigation", Working Paper No.295. Ann Arbor, MI: William Davidson Institute, Mar. 2000.

Newell, Andrew, and Reilly, Barry, "The Gender Wage Gap in Russia: Some Empirical Evidence." *Labour Economics* **3**, 3: 337-356, Oct. 1996.

Organization for Economic Co-operation and Development, *Economic Surveys: Russian Federation*. Paris: OECD, Mar. 2000.

Pinto, Brian, Drebentsov, Vladimir, and Morozov, Alexander, "Dismantling Russia"s

Nonpayments System: Creating Conditions for Growth." World Bank
Technical Paper No. 471. Washington , D.C.: World Bank, June 2000.

Russian-European Centre for Economic Policy, *Russian Economic Trends*. Moscow: RECEP, 2000.

Richter, Andrea, and Schaffer, Mark E., "The Performance of De Novo Private Firms in Russian Manufacturing." In Simon Commander, Qimiao Fan and Mark E. Schaffer, Eds., *Enterprise Restructuring and Economic Policy in Russia*, pp. 253-274. Washington, D.C.: EDI/ World Bank, 1996.

Roeger, Werner, "Can Imperfect Competition Explain the Difference between Primal and Dual Productivity Measures? Estimates for U.S. Manufacturing." *Journal of Political Economy* **103**, 2: 316-330, Apr.1995.

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В работе оцениваются фиксированные эффекты для уравнения спроса на труд. Для этого использованы уникальные данные, полученные в ходе обследования крупных и средних предприятий в промышленности, строительства и торговли в четырех регионах России в 1997 г. Наиболее важный результат заключается в том, что на шестом году реформ российские предприятия продемонстрировали чувствительность к изменениям в заработной плате при принятии решений о занятости, хотя по международным меркам эластичность спроса на труд относительно невелика. Второй интересный вывод состоит в том, что у государственных предприятий связь между заработной платой и численностью занятых заметно слабее, чем у приватизированных или частично приватизированных. Для полученного уравнения спроса на труд авторы также рассматривают оценки эластичности заработной платы как эмпирическое подтверждение трех правил производного спроса, сформулированных Альфредом Маршаллом. Результаты свидетельствуют о том, что эмпирическое изучение действия этих правил может помочь в анализе движущих факторов спроса на труд в России.

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Йозеф Конингс, Хартмут Леман

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