Redundancies in an industry in transition: who gets fired and why?

Evidence from one consumer-goods industry in Russia

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Abstract

Does employee productivity explain why during a period of crisis firms fired relatively more blue-collar than white-collar workers and why, when conditions improved, they began to hire relatively more blue collars? Are redundancies targeted towards the least productive workers? Was firms' behaviour profit maximising?

These questions are investigated in the extreme circumstances of the footwear industry in Russia in the period 1994-2000.

Firms in this industry underwent a major upheaval in these years. Part of their response was to downsize the blue-collar workforce more severely than the white-collars. Was this because (a) white collar employees had higher marginal productivity or (b) because the technical rate of substitution of white collar labour with blue collar labour was greater than the factor price ratio of these two inputs

If it turns out that the marginal productivity of white collar employees was the higher, we could conclude that they were embodying more human capital (Becker, 1962); if they were no more productive than blue collars, this could mean that they had been privileged during downsizing for some institutional reasons, e.g. a prior commitment towards higher-ranking staff (Lazear, 1979; Lazear and Rosen, 1981). If it turns out that the technical rate of substitution of white collar labour with blue collar labour was greater than their factor price ratio, this would suggest that the firms' downsizing policies were consistent with profit-maximising precepts.

Russian footwear is a suitable industry for investigation because there are many units, which use a standard technology, and with relatively little political interference.

The paper uses Translog and Cobb Douglas production functions with ordinary least squares, two-step least squares and stochastic frontier analysis, both in a panel and in a cross-section setting. Results show that white collar employees were not only more productive than blue collar employees but also the technical rate of substitution of white collar labour with blue collar labour was greater than the factor price ratio of these two inputs. This suggests that even in a turbulent period and with a Soviet heritage, the firms behaved as profit-maximising agents. Institutional factors may also have operated, but they do not need to be invoked in explaining the data.

1. Introduction

Does employee productivity explain why during a period of crisis firms fired relatively more blue-collar than white-collar workers? Does it explain why during a period of recovery firms hired relatively more blue collars? Are redundancies targeted towards the least productive workers? Was firms' behavior profit maximizing? These questions are investigated in the extreme circumstances of the footwear industry in Russia in the period 1994-2000. Firms in this industry underwent a major upheaval in these years. Part of their response was first to downsize the blue-collar workforce more severely than the white-collars and then subsequently to hire relatively more blue collars than white collars.

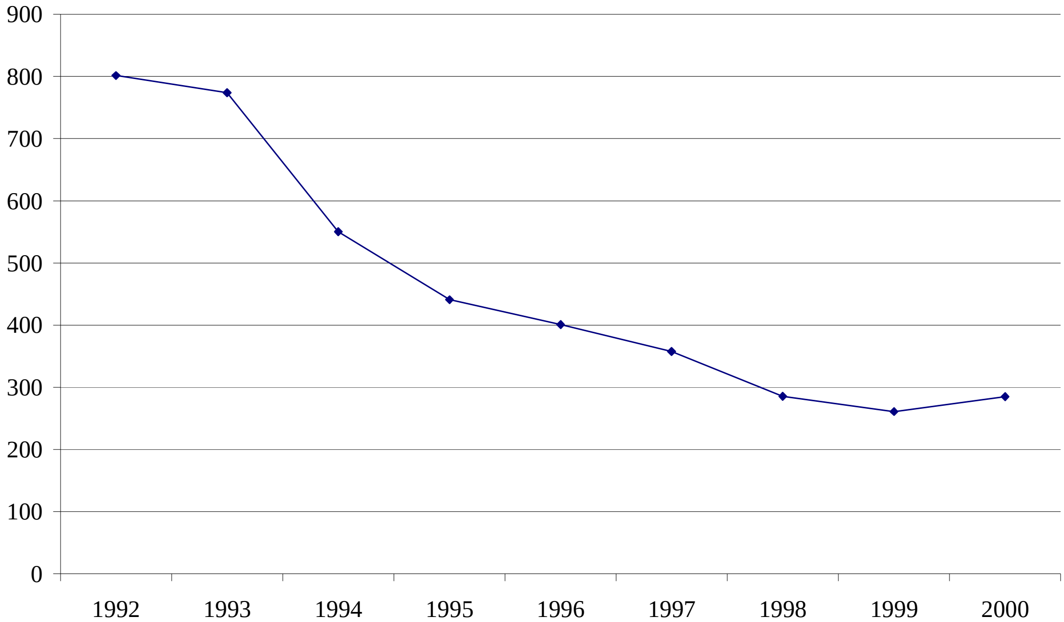

Figure 1 Average number of employees per firm

Figure 1 shows that from 1992 to 1999 the average size of Russian footwear firms has decreased. In part this was due to the entry of new firms, but largely it was due to the shedding of employees by incumbent firms, which passed from 801 employees in 1992 to 353 in the year 2000. Figure 2 shows that the share of blue collar workers in total employment has decreased from 1992 till 1999 (till 1998 in the case of old firms, those already existing in 1992). In the case of better performing medium-large firms there is the same downward trend, but some moderate recovery already took place in 1997, was probably interrupted by the dramatic events of 1998 (financial crisis, devaluation, change of government, etc.) and then continued more strongly in 1999-2000. When shedding workers, firms did not treat every worker in the same way: blue collars were at much higher risk of being dismissed. It also suggests that at the end of the considered period the attitude of firms toward blue collar labour changed and this change of attitude occurred first in medium-large firms and then in the whole data set in general.

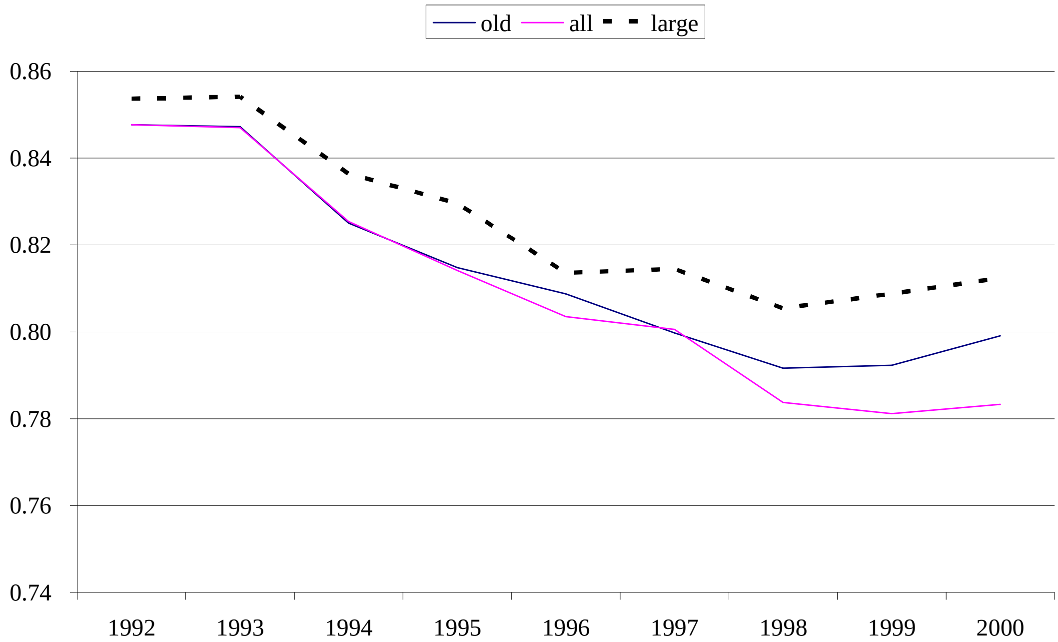

Figure 2 The ratio between blue collars and all employees in Russian footwear firms

Was this because (a) white collar employees had higher marginal productivity or (b) because the technical rate of substitution of white collar labour with blue collar labour was greater than the factor price ratio of these two inputs? i.e.:

$$\frac{\partial y / \partial white}{\partial y / \partial blue} > \frac{wage}{salary}$$

Where:

y is the output of the firm, in value terms, million rubles 1992

white is white collar workers, in units

blue is blue collar labour, in units.

wage is the remuneration of white collar workers, in million rubles 1992

salary is the remuneration of blue collar workers, in million rubles 1992.

If it turns out that the marginal productivity of white collar employees was the higher, we could conclude that they were embodying more human capital (Becker, 1962); if they were no more productive than blue collars, this could mean that they had been privileged during downsizing for some institutional reasons, e.g. a prior commitment towards higher-ranking staff (Lazear, 1979; Lazear and Rosen, 1981). If it turns out that the technical rate of substitution of white collar labour with blue collar labour was greater than their factor price ratio, this would suggest that the firms' downsizing policies were consistent with profit-maximizing precepts.

The available data under-represent small firms, but correctly represent medium-large firms. Was the situation the same in the better represented set of medium and large firms?

Russian footwear is a suitable industry for investigation because there are many units, which use a standard technology, and with relatively little political interference.

This paper uses Translog and Cobb Douglas production functions with ordinary least squares, two-step least squares and stochastic frontier analysis, both in a panel and in a cross-section setting. Results show that for many years white collar employees were not only more productive than blue collar employees but also the technical rate of substitution of white collar labour with blue collar labour was greater than the factor price ratio of these two inputs. This suggests that even in a turbulent period and with a Soviet heritage, the firms often behaved as profit-maximizing agents. Institutional factors may also have operated, but they do not need to be invoked in explaining the data.

Some references to the literature on the subject are given in section 2. Section 3 presents the hypotheses. Methodology is presented in Section 4. Data are presented in section 5. The results for all firms are presented in Section 6 and for medium-large firms in section 7. Conclusions can be found in Section 8.

2. References to previous studies

Several studies have considered the issue of which employees are targeted first for redundancies and why. In a firm, which is target of a merger bid "the group of employees that top executives may try hardest to protect are their immediate subordinates: managers and administrators employed at corporate or divisional headquarters." (Lichtenberg and Siegel, 1990:384). Many studies suggest that in difficult periods, staff reductions tend to fall on production rather than on administrative employees. This has been attributed to different possible causes. Forms of collusion between supervisor and agent have been suggested by Tirole (1986). Becker (1962, 1964) formulated a theory of specific human capital. According to it, when human capital is specific to a certain firm, that firm has an incentive to retain those employees, who embody it most. This incentive can only be weakened by a substantial economic change.

Blakemore and Hoffman (1989) tested if firms were retaining or rehiring senior workers [1] because senior workers, embodying more specific human capital, were more productive or if senior workers were retained just for institutional reasons, finding that staff with more tenure was also more productive. Oi (1962) suggested that senior staff were embodying higher fixed costs e.g. deriving from hiring and training. Certain employees may have negotiated implicit contracts with delayed payments (Lazear 1979; Idson and Valetta, 1996) or rank order tournaments[2] (Lazear and Rosen, 1981).

According to Lazear (1979) and Lazear and Rosen (1981) generally employees with more tenure or with more specific human capital are less at risk of being fired and they have higher chances, if fired, of being recalled; Idson and Valletta (1996) find that if a sector suffers a crisis with employment decline, the tenure effect diminishes, i.e. it is more probable that companies play opportunistically, not honoring previous

[1] The fact that employment stability increases with employment tenure has been studied by many authors (Oi 1962; Parsons, 1972; Mincer and Jovanovic, 1981; Mc Laughlin, 1991.These references are reported by Idson and Valletta, 1996:655)

[2] Rank order tournament is a procedure which puts the remuneration of each employee in relation with the rank that the employee achieves and not with his/her productivity. The system is fair if all

commitments. However the effect of specific human capital should not diminish if there are not technological changes, major enough to make human capital obsolete.

Devereux (2000) has tested the hypothesis that in periods of crisis firms in order to retain senior employees with more specific human capital demote them to lower tasks. This is probably only possible if firms have sufficient functional flexibility (Beatson, 1995).

In conclusion, according to the model of specific human capital, having a relatively low presence of senior (white collar/ supervisory) staff, could induce firms to have lower productivity than firms with a higher presence of this type of staff.

According to the theory of contracts with delayed payments and to the tournament theory, it would not be necessary that firms with more senior (white collar) staff were more productive. However, in some circumstances, it can also happen that firms have a lower presence of senior staff just because, with some form of functional flexibility and job rotation, they have demoted senior staff to lower positions (Devereux, 2000).

It could also simply happen that managers fire certain employee instead of other employees because they try to maximize short term profits or minimize short term costs.

3. Hypotheses

Both models with specific human capital (Becker, 1962) and models assuming contracts with delayed payments (Lazear, 1979) or tournaments (Lazear and Rosen, 1981) imply that firms, when facing shocks try to retain those employees which have accumulated more experience and seniority in the firm. According to the model of contracts with delayed payment, firms would behave so in order to preserve their credibility with employees, while according the model of specific human capital firms would do it in order to preserve their specific human capital. Finally firms

employees can compete for certain ranks and if "winners" can enjoy their remuneration till their scheduled retirement.

could not only try to preserve their human capital, but also pursue short term profit maximization and cost minimization. “The cost-minimizing point will be characterized by a tangency condition: (…) the technical rate of substitution must be equal the factor price ratio” (Varian; 2006:354) and therefore:

$$\frac{\partial y / \partial white}{wage} = \frac{\partial y / \partial blue}{salary}$$

Where:

$$\partial y / \partial white = \varepsilon_{Ywhite} * y / white$$

$$\partial y / \partial blue = \varepsilon_{Y\,blue} * y / blue$$

Therefore, if we find that:

$$\frac{\partial y / \partial white}{wage} > \frac{\partial y / \partial blue}{salary} \qquad 1)$$

we can observe that firms are not in an optimal input combination.

In a neoclassical world the optimizing reaction of firms should be that of increasing the relative use of the input with the higher ratio, in this case, white collar labour.

Therefore if we found the inequality described above, we could conclude that not only firms behaved in order to preserve their specific human capital, when they fired relatively more blue collars than white collars, but also as profit maximisers; if we do not find such relation, we cannot invoke optimizing behavior, but if:

$$\partial y / \partial white > \partial y / \partial blue \qquad 2)$$

i.e. if the productivity of white collar workers were still higher than that of blue collar workers, we could still suggest that that white collar workers were embodying more human capital than blue collar workers.

Finally if also the inequality 2) above were found not true, it would be rather confirmed a hypothesis of contracts with delayed payments or generally speaking some institutional explanation. Firms retained white collars for some institutional reason, but not because they were more productive.

We therefore test the hypotheses that white collar workers had higher productivity/wage than blue collar workers.

This section has presented the hypotheses of this paper. They are summarized in Table 1.

Table 1 Summary of the hypotheses of this paper

	Effects within a company (panel data analysis)	Effects between companies (cross section analysis)
Specific human capital	A firm was able to increase its product more by increasing the presence of white collars than by increasing the presence of blue collar workers.	Firms having a higher relative presence of white collars were the ones with highest productivity, in the years when the average firm reduces the relative presence of blue collars. Vice versa in the other years.[3]
Profit Maximization	A firm was able to increase its average ratio of product per paid remuneration by increasing the relative presence of white collars.	Firms having a higher relative presence of white collars were the ones with highest ratio of product per paid remuneration in the years when the average firm reduces the relative presence of blue collars. Vice versa in the other years.[3]

4. Methodology

This section presents the production functions and the models which are used to test the hypotheses. We use both the Cobb Douglas (CD) production function and the Translog production function. The first is simpler and the second is very flexible and can well represent a wide variety of functions. In some cases the second can be re-conducted to the first; we test this hypothesis (the restriction). In the whole data set the two production functions are used with ordinary least squares (OLS), with least squares with dummy variables (panel) and with stochastic frontier analysis (SFA) both with a cross section and a panel specification. Following Wooldridge (2003:118-119) we have tested for the endogeneity of the explanatory variables; tests

[3] When we use pooled data, we should expect to find the same result that we expect with panel data, because there are more years when firms reduce the relative presence of blue collars.

confirm the presence of endogeneity. This leads us to use instrumental variables (Two Steps Least Squares – 2SLS).

So now we are going to describe the combinations of models and production function. They are presented in Table 2. Additionally all these combinations will be used both in a panel and in a cross section setting.

Table 2 Different combinations of models and production functions, which are used in this study. Each combination is used both in a panel and in a cross section setting.

		Model		
		Ordinary least square	**Stochastic Frontier Analysis**	**2 Steps Leas Squares**
Production Function	**Cobb Douglas**	C.D. with OLS	C.D. with SFA	C.D. with 2SLS
	Translog	Translog with OLS	Translog with SFA	Translog with 2SLS

In these tests the objective is the same:

- We investigate which labour input has higher productivity.

- We investigate if the ratio between marginal productivity of one type of labour (white collar labour) and its remuneration, is higher than that the same ratio for the other type of labour (blue collar labour).

Ordinary least squares (o.l.s.) - Cobb Douglas

$$\text{Ln } Y = \alpha_0 + \alpha_K \ln K + \alpha_{blue} \ln L_{blue} + \alpha_{white} \ln L_{white} + \varepsilon$$[4]

Y means output, K means capital, L_{blue} means blue collar labour[5], L_{white} means white collar labour, α_0 is a constant and ε an error normally distributed.

Results for this as for others models are affected by the degree of capacity utilization. With many firms using a limited amount of their capacity we can expect difficulties with the estimation of some parameter, in particular with that of capital, which is the worse measured factor[6]. Besides acknowledging the possible limitation that factor utilization brings to the results of this paper we have also tried to partially reduce this problem by presenting the results of separate annual cross-sections.

An initial test consists in estimating the function with OLS without dummy variables or fixed effects in the pooled data and in every single year from 1994 to 2000.

The model is also estimated with fixed and period effects:

$$\text{Ln } Y_{it} = \alpha_0 + \alpha_K \ln K + \alpha_{blue} \ln L_{blue} + \alpha_{white} \ln L_{white} + \alpha_i + \alpha_t + \varepsilon$$

Where α_i is a binary variable indicating the firm and α_t is a binary variable indicating the year. In both cases we also carry out the regressions using instrumental variables following Wooldridge (2003:83-105) i.e. the 2 Steps Least Squares (2SLS) estimator of LIMDEP by William Greene. The set of instrumental variables is made up by:

α_0, $\ln K_{t-1}$, $\ln L_{blue\ t-1}$, $\ln L_{white\ t-1}$.

Ordinary least squares (o.l.s.) - Translog Production function

$$\text{Ln}Y = \alpha_0 + \alpha_K \ln K + \alpha_{blue} \ln L_{blue} + \alpha_{white} \ln L_{white}$$

$$+ \tfrac{1}{2} \alpha_{KK} (\ln K)^2 + \tfrac{1}{2} \alpha_{blue\_blue} (\ln L_{blue})^2 + \tfrac{1}{2} \alpha_{white\_white} (\ln L_{white})^2$$

$$+ \alpha_{blue\_white} (\ln L_{blue} \ln L_{white}) + \alpha_{blue\_k} (\ln L_{blue} \ln K) + \alpha_{k\_white} (\ln K \ln L_{white}) + \varepsilon$$

[4] See Chiang (1984:416) for the marginal product of Cobb Douglas.

[5] For the actual Russian categories to describe the workforce see Appendix.

[6] Different authors bring “Strong empirical evidence that (...) capital accumulation cannot be considered a significant factor affecting production outcomes during transition in the 1990s” (Mickiewicz and Zalewska, 2002:12). In the sample of Angelucci et al. (2002), the majority of the capital stock of the average firm is more than 15 years old, and just over 8 percent is less than five years old. “The assets of industrial enterprises –especially installed more than ten years ago- are usually undervalued, and generally badly measured” (Angelucci et al, 2002:109).

This model (Greene, 2003:103 and before and more specifically Bernt and Christensen, 1974)) differs from the Cobb Douglas model because it relaxes the assumption of constant elasticities. First the function is estimated with OLS without dummy variables or fixed effects in the pooled data and in every single year from 1994 to 2000.

Then the same Translog function is estimated with fixed effects and period effects, here below:

$LnY_{it} = \alpha_0 + \alpha_k \ln K + \alpha_{blue} \ln L_{blue} + \alpha_{white} \ln L_{white}$

$+ ½ \alpha_{kk} (\ln K)^2 + ½ \alpha_{blue\_blue} (\ln L_{blue})^2 + ½ \alpha_{white\_white} (\ln L_{white})^2$

$+ \alpha_{blue\_white} (\ln L_{blue} \ln L_{white}) + \alpha_{blue\_k} (\ln L_{blue} \ln K) + \alpha_{k\_white} (\ln K \ln L_{white})$

$+ \alpha_i + \alpha_t + \varepsilon$

The restriction consists in imposing that:

$\alpha_{KK} = \alpha_{blue\_blue} = \alpha_{white\_white} = \alpha_{blue\_white} = \alpha_{blue\_K} = \alpha_{K\_white} = 0$

If the hypothesis is not rejected, the Translog becomes identical to the simpler Cobb Douglas. Therefore we shall test this restriction in order to choose between the two specifications. Using the Translog production function, the three elasticities are:

$\varepsilon_{YK} = \alpha_K + \alpha_{kk} \ln K + \alpha_{blue\_k} \ln L_{blue} + \alpha_{k\_white} \ln L_{white}$

$\varepsilon_{Y\,blue} = \alpha_{blue} + \alpha_{blue\_blue} \ln L_{blue} + \alpha_{blue\_white} \ln L_{white} + \alpha_{blue\_k} \ln K$

$\varepsilon_{Y\,white} = \alpha_{white} + \alpha_{white\_white} \ln L_{white} + \alpha_{blue\_white} \ln L_{blue} + \alpha_{k\_white} \ln K$

In 2SLS we use instrumental variables. The set of instrumental variables is made up by:

α_0, $\ln K_{t-1}$, $\ln L_{blue\,t-1}$, $\ln L_{white\,t-1}$, $(\ln K_{t-1})^2$, $(\ln L_{blue\,t-1})^2$, $(\ln L_{white\,t-1})^2$, $(\ln L_{blue\,t-1} \ln L_{white\,t-1})$, $(\ln L_{blue\,t-1} \ln K_{t-1})$, $(\ln K_{t-1} \ln L_{white\,t-1})$.

Stochastic Frontier Analysis[7] - Cobb Douglas

We use a cross section specification and a panel version. The cross section specification is:

$$\text{Ln } y_i = \alpha_0 + \alpha_k \ln K_i + \alpha_{blue} \ln L_{blue-i} + \alpha_{white} \ln L_{white-i} + \nu_i - u_i$$

In it ν_i represents statistical noise and u_i (>=0) represents technical inefficiency. Also in this case we do not assume invariant coefficients in the whole period and the cross section specification has been used both with the pooled data and separately with the data of each single year.

The version for panel data is:

$$\ln y_{it} = \alpha_0 + \alpha_k \ln K_{i\,t} + \alpha_{blue} \ln L_{blue\,i\,t} + \alpha_{white} \ln L_{white\,i\,t} + \nu_{it} - u_i$$

where $_{+}\nu_{it}$ represents statistical noise and u_i (>=0) represents technical inefficiency. $\lambda = \sigma_u/\sigma_v$ where σ_u is the standard error of the disturbance asymmetrically distributed and attributed to inefficiency and σ_v is the standard error of the disturbance symmetrically distributed and attributed to statistical noise. If $\lambda \to 0$, data do not indicate inefficiency; if $\lambda > 1$, the presence of inefficiency is confirmed.

Stochastic Frontier Analysis - Translog Production function

Also in the case of the SFA when we use the Translog production function, we use first a cross section version:

$$\text{Ln } y_i = \alpha_0 + \alpha_k \ln K_i + \alpha_{blue} \ln L_{blue\ i} + \alpha_{white} \ln L_{white\ i}$$
$$+ \tfrac{1}{2} \alpha_{kk} (\ln K_i)^2 + \tfrac{1}{2} \alpha_{blue\_blue} (\ln L_{blue\ i})^2 + \tfrac{1}{2} \alpha_{white\_white} (\ln L_{white\ i})^2$$
$$+ \alpha_{blue\_white} (\ln L_{blue\ i} \ln L_{white\ i}) + \alpha_{blue\_k} (\ln L_{blue\ i} \ln K_i)$$
$$+ \alpha_{k\_white} (\ln K_i \ln L_{white\ i}) + \nu_i - u_i$$

This cross section specification has been used both with the pooled data and separately with the data of each single year.

Then we also test using a panel data version:

$$\ln y_{it} = \alpha_0 + \alpha_K \ln K_{it} + \alpha_{blue} \ln L_{blue\ it} + \alpha_{white} \ln L_{white\ it}$$
$$+ \tfrac{1}{2} \alpha_{kk} (\ln K_{it})^2 + \tfrac{1}{2} \alpha_{blue\_blue} (\ln L_{blue\ it})^2 + \tfrac{1}{2} \alpha_{white\_white} (\ln L_{white\ it})^2$$
$$+ \alpha_{blue\_white} (\ln L_{blue\ it} \ln L_{white\ it}) + \alpha_{blue\_k} (\ln L_{blue\ it} \ln K_{it})$$

[7] The presentation of stochastic frontier models here follows Kumbhakar and Knox Lovell, 2000. A similar presentation can be found in Greene (1997). A synthesis is given by Greene (2003).

$+ \alpha_{k\_white} (\ln K_{it} \ln L_{white\ it}) + \nu_{it} - u_i$

Using the Translog production function we test for the hypothesis that the Translog function can be substituted by the Cobb Douglas production function as a better specification (the restriction).

Also here the restriction consists in imposing that:

$$\alpha_{kk} = \alpha_{blue\_blue} = \alpha_{white\_white} = \alpha_{blue\_white} = \alpha_{blue\_k} = \alpha_{k\_white} = 0$$

5. Data Presentation

The database of this paper is taken from Goskomstat[8]. Our data concern Russian footwear enterprises having the industry code 17371, i.e. enterprises manufacturing footwear for the market, but not those firms, which produce footwear, but have as main activity the production on order (tailor made production, code 17372) or the reparation of shoes and boots (code 17373). [9]

We use the same source of data of Brown and Earle (2000), who state that: "The data do not cover industrial enterprises with fewer than 100 employees and more than 75 percent owned by individuals or industrial divisions of non-industrial enterprises" (Brown and Earle, 2000:9)[10]. As a result the Registry of the Russian industry has a size-bias, because small firms are not included into it, if they have certain specific legal features. In the Russian light industry (table 2.9 in Goskomstat, 1999b:64 and Goskomstat,1999c:32) the share of employees in firms omitted by the Registry of the Russian industry was in the years 1996-1998, respectively, 20%, 23% and 22 %.

Here we use a subset of data concerning the years 1994-2000, where, before excluding missing records, there are 1698 observations. We opt to present results

[8] Goskomstat is the Russian federal statistical agency.

[9] Data about the production of footwear for the stocks to be sold on the market (code 17371) come together with those of the tailor made (on demand) production (code 17372) and with those of the footwear repairing firms (code 17373). One of the first operations of data cleaning consists in eliminating those observations which show an industry code equal to 17372 or 17373.

[10] A firm should be excluded from the database only if two conditions are fulfilled:
a) small size (less than 100 workers)
b) more than 75 percent owned by individuals or industrial divisions of non-industrial enterprises;
none of these conditions alone is sufficient to exclude a firm from the data base.

about 1994-2000 because on these years we have better followed every step of database construction, directly from the source. In the years 1994-2000, 332 observations have missing records, i.e. 21.19 % of the total; therefore we test on a maximum of 1235 observations. However when we use instrumental variables we reduce our data set to 1197 observations, because some records do not have a lagged value. The statistics concerning all the analyzed data about the years 1994-2000 are presented in Table 3. We can notice that the whole data-set includes both very large and very small firms.

Table 3 Descriptive statistics
(1235 observations)

	Mean	St. Dev	Min	Max	Unit
Output	229.63	470.16	0.03	5,010	Mln roubles 1992
White _L	64.23	72.15	1.00	696	Men/women
Blue _L	323.03	414.21	1.00	2,664	Men/women
Capital	127.01	235.87	0.00	2,721	Mln roubles 1992
Wage	0.19	0.13	0.00	1.35	Mln roubles 1992
Salary	0.05	0.04	0.00	0.54	Mln roubles 1992
LN_OUTPUT	4.03	1.94	-3.66	8.52	
LN_WHITE _L	3.67	1.04	-	6.55	
LN_BLUE _L	5.15	1.20	-	7.89	
LN_CAPITAL	3.61	1.90	-5.53	7.91	

6. Results using the whole data set[11]

The set of results includes the coefficient for the different variables and, in the case of Translog production functions, also the factor elasticities, calculated at the average values. In the case of the Cobb Douglas production function, factor elasticities and coefficients coincide.

In the case of the Translog production function results include elasticities for the three considered production factors (white collar labour, blue collar labour and capital).

Results also report the productivities of the two types of labour and the ratios given by these productivities divided by the remuneration of the respective type of labour, wages for white collars and salaries for blue collar workers.

Results also include λ, which for significant values above 1 indicates the presence of inefficiency.

A preliminary test consists in checking that the Translog production function can be reduced to a Cobb Douglas without a significant loss of likelihood (the restriction). However even when the use of Cobb Douglas can lead to some loss of log likelihood this production function can offer the advantage of offering elasticities with standard error calculated by LIMDEP.

Finally the probable presence of endogeneity induces us to give more importance to those tests which have been carried out with the use of instrumental variables (2SLS) and to use the others as complementary information, with the considerations that the O.L.S. are the most efficient estimates of the coefficients and the SFA provides the coefficients of best performing firms and the measure of slack among underperformers.

[11] The reader in a hurry can jump to the end of this section where a table summarises results.

Regressions on all years together

In Table 4 the hypothesis that the Translog production function can be transformed into a Cobb Douglas production function, without significant loss of likelihood, is rejected, because in all cases the restriction (Rst) is significantly rejected.

In the case of the whole data set the productivity of white collar workers is always higher than that of blue collars. In the case of panel data, the use of instrumental variables shows that a ruble spent in an additional unit of white collar labour brings more additional output than a ruble spent in an additional unit of blue collar labour; this could not be seen with the use of ordinary least squares and stochastic frontier analysis, which are however probably affected by endogeneity problems. In the case of the Cobb Douglas production function, all tests, but panel data with O.L.S., are consistent with 2SLS results and in most of cases we have clear evidence of the significance of the elasticity coefficients.

So far there is not only some evidence of more specific human capital embodied by white collar workers, but also of short term profit maximizing behavior. We could suppose that if white collars enjoyed any privilege (fewer dismissals and more recalls), it was maybe because they were more productive, even after considering their higher cost. The S.F.A. seems to suggest widespread presence of inefficiency; the parameter λ is significantly bigger than 1. Since the stability of this parameter in different years can be questioned, the consideration of annual cross sections can bring some additional light.

Annual cross sections[12]

Ordinary Least Squares (O.L.S.)

Annual cross sections are carried out at current prices, avoiding all those problems that deflations can generate, when the researchers use constant prices. Annual cross sections also eliminate the issues concerning the changing degree of capacity utilization in different years and the stability of parameters.

[12] Results about the whole data-set.

Table 4 Whole data set – Cross section with pooled data and panel data - Translog production function (1994-2000) constant prices

	Cross section									Panel data								
	O.L.S.			S.F.A.			2S.L.S.			O.L.S.			S.F.A.			2S.L.S.		
N. obs.	1235			1235			1197			1235			1235			1197		
	β	σ	ε	β	σ	ε	β	σ	ε	β	σ	ε	β	σ	ε	β	σ	ε
White	1.28	0.24	0.50	1.40	0.22	0.40	-1.75	1.50	0.75	0.05	0.30	0.39	1.40	0.22	0.43	-0.19	0.31	2.41
Blue	0.03	0.23	0.95	-0.04	0.16	0.88	0.38	0.55	0.61	1.15	0.27	0.84	-0.04	0.16	0.99	-0.46	0.54	0.04
K	0.06	0.12	-0.03	0.19	0.10	0.05	-1.45	1.81	-0.00	0.15	0.15	-0.05	0.19	0.10	-0.01	1.89	0.61	-1.75
WW	0.34	0.16		0.49	0.09		0.44	0.25		0.42	0.11		0.49	0.09		-0.02	0.06	
BB	0.47	0.06		0.58	0.06		0.02	0.07		0.06	0.10		0.58	0.06		-0.14	0.08	
KK	0.02	0.02		0.04	0.02		0.40	0.32		0.01	0.02		0.04	0.02		-0.95	0.22	
KW	-0.00	0.05		-0.02	0.04		-0.38	0.31		-0.07	0.05		-0.02	0.04		0.11	0.06	
KB	-0.03	0.04		-0.04	0.03		0.40	0.96		0.01	0.04		-0.04	0.03		-0.10	0.12	
BW	-0.39	0.09		-0.52	0.05		0.23	1.94		-0.18	0.07		-0.52	0.05		0.44	0.12	
Const.	-1.89	0.45		-0.65	0.34		2.54	1.13		-2.07	0.74		-0.65	0.34		-0.20	1.32	
λ				2.84	0.26								2.84	0.26				
∂y/∂white	1.80			1.43			2.70			1.41			1.54			8.63		
$\frac{\partial y / \partial white}{wage}$	9.56			7.63			14.41			7.48			8.21			46.06		
∂y/∂blue	0.67			0.62			0.44			0.60			0.70			0.03		
$\frac{\partial y / \partial blue}{salary}$	12.2			11.38			7.86			10.8			12.81			0.55		
Adj. R2	.62						.53			.85						.84		
Log likel.				-1902										-1722				
Rst	0			0			0.02			0.01			0			0.00		

Rst = p value of the restriction;

Table 5 Whole data set – pooled data cross section and panel - Cobb Douglas (1994-2000) constant prices

	Cross section						Panel					
N. Obs.	1235		1235		1197		1235		1235		1197	
	O.L.S.		S.F.A.		2s.l.s.		O.L.S.		S.F.A.		2s.l.s.	
	β	σ	β	σ	β	σ	β	σ	β	σ	β	σ
White	0.7	0.1	0.69	0.04	1.01	0.23	0.29	0.08	0.60	0.04	1.60	0.18
Blue	0.73	0.09	0.62	0.03	0.45	0.18	0.83	0.07	0.75	0.02	-0.13	0.14
K	-0.04	0.03	0.01	0.02	-0.05	0.04	-0.05	0.04	0.00	0.03	0.79	0.35
Const.	-2.18	0.18	-0.52	0.17	-1.82	0.24	-1.17	0.36	-0.73	0.13	-4.12	0.91
λ			2.18	0.19					2.01	0.18		
∂y/∂white	2.51		2.47		3.60		1.04		2.14		5.74	
$\frac{\partial y / \partial white}{wage}$	13.35		13.17		19.22		5.56		11.40		30.62	
∂y/∂blue	0.52		0.44		0.32		0.59		0.53		-0.09	
$\frac{\partial y / \partial blue}{salary}$	9.49		8.05		5.83		10.81		9.74		-1.63	
Adj. R2	0.60				.59		0.88				.84	
Log likel.			-1951							-1754		

Rst = p value of the restriction

Table 6 Whole data set - Annual cross-sections   Translog production function - ordinary least squares

	1994		1995		1996		1997		1998		1999		2000	
N. obs.	199		201		176		165		169		165		160	
	β	σ	β	σ	β	σ	β	σ	β	σ	β	σ.	β	σ
White	0.79	0.62	0.17	0.90	0.04	1.51	1.68	1.32	1.53	0.64	1.06	0.85	1.92	0.55
Blue	0.02	0.50	1.09	0.68	0.21	1.15	-0.05	1.03	-0.14	0.53	0.08	0.67	-0.06	0.53
K	-0.14	0.26	0.06	0.29	0.77	0.43	0.09	0.46	0.16	0.26	0.13	0.27	-0.51	0.32
WW	0.58	0.49	-0.18	0.59	-0.15	0.65	-0.03	0.24	0.95	0.33	0.33	0.39	0.52	0.36
BB	0.43	0.07	0.44	0.15	1.32	0.43	0.85	0.22	1.14	0.31	0.42	0.18	0.32	0.20
KK	0.04	0.04	-0.02	0.06	0.02	0.05	0.05	0.07	-0.04	0.04	0.04	0.05	0.05	0.05
KW	-0.08	0.16	0.35	0.19	0.46	0.24	0.08	0.19	0.04	0.12	-0.06	0.11	-0.14	0.08
KB	0.05	0.11	-0.23	0.16	-0.52	0.20	-0.19	0.14	-0.02	0.09	-0.05	0.09	0.11	0.08
BW	-0.43	0.22	-0.27	0.30	-0.51	0.38	-0.38	0.19	-1.06	0.25	-0.22	0.21	-0.42	0.28
Const.	2.37	1.35	1.09	1.23	0.63	1.69	1.47	2.01	1.30	0.74	2.52	1.14	4.50	1.11
ε_{white}	0.14		0.94		0.99		0.37		0.03		0.63		0.45	
ε_{blue}	1.04		0.51		0.48		1.15		1.57		0.90		1.02	
ε_{k}	0.12		0.01		-0.04		-0.14		-0.16		-0.02		-0.02	
$\partial y/\partial white$	7.25		121.83		131.51		61.83		5.20		268.13		260.78	
$\frac{\partial y / \partial white}{wage}$	3.16		21.22		16.15		6.11		0.44		14.51		9.82	
$\partial y/\partial blue$	10.04		12.73		12.90		37.97		64.38		82.13		120.49	
$\frac{\partial y / \partial blue}{salary}$	8.05		4.70		3.04		6.64		10.36		8.31		8.93	
Adj. R2	.71		.67		.52		.56		.64		.61		.61	
Rst	0.00		.13		.10		0.14		0.00		.33		.21	

Rst = p value of the restriction

Table 7 Whole data set - Annual cross-sections Cobb Douglas production function - 0rdinary least squares

	1994		1995		1996		1997		1998		1999		2000	
	β	σ	β	σ	β	σ	β	σ	β	σ	β	σ	β	σ
N. obs.	199		201		176		165		169		165		160	
White	0.71	0.30	1.16	0.21	1.14	0.32	0.68	0.22	0.35	0.22	0.73	0.21	0.54	0.21
Blue	0.51	0.29	0.29	0.18	0.33	0.28	0.80	0.23	1.17	0.21	0.75	0.15	0.91	0.18
K	0.10	0.06	-0.00	0.07	-0.05	0.09	-0.11	0.10	-0.10	0.06	-0.03	0.07	-0.07	0.06
Const.	0.85	0.50	1.86	0.41	2.24	0.62	2.25	0.57	1.62	0.45	2.60	0.39	3.13	0.41
$\partial y/\partial white$	37.82		151.1		151.4		111.7		63.14		310.4		315.3	
$\frac{\partial y / \partial white}{wage}$	16.50		26.32		18.59		11.04		5.30		16.80		11.87	
$\partial y/\partial blue$	4.89		7.15		8.93		26.53		47.79		68.26		108.5	
$\frac{\partial y / \partial blue}{salary}$	3.92		2.64		2.10		4.64		7.69		6.90		8.04	
Adj. R2	0.67		0.66		0.50		0.55		0.61		0.61		0.58	

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In Table 6 the restriction indicates that in almost all years the hypothesis that the Translog production function can be reduced into a Cobb Douglas cannot be rejected at a 5% significance level. Therefore in the O.L.S. context for most of the years a Cobb Douglas function (results in Table 7) can be considered a simpler and better option. The years 1994 and 1998 are the two exceptions. In almost all cases the productivity of white collars is higher than that of blue collars. The exceptions are the years 1994 and 1998 when we use Translog.

In almost all years the value of the ratio given by productivity divided by remuneration is higher for white collar labour than for blue collar labour. Again results about 1994 and 1998 constitute the exceptions.

Results may be affected by endogeneity. The use of instrumental variables can probably eliminate this limitation.

Stochastic frontier analysis (SFA)

The restriction (Table 8) indicates that for years 1994 and 1996 the use of a Cobb Douglas production function (Table 9) would not imply significant losses of likelihood. For all other years the Translog production function fits significantly better the available data. When we use the production function, which the restriction indicates, white collars always have higher productivity than blue collars.

In years 1994, 1995, 1996, 1997 and 1999 the ratio given by productivity divided by remuneration is higher for white collar labour than for blue collar labour. In the year 1998 the opposite is true and in the year 2000 there is a very small (2%) advantage for blue collars. In all years there is a significant presence of slack. The issue of potential endogeneity leads to consider 2SLS.

Two steps least squares (2SLS)

Using the Translog production function the restriction suggests that for every considered year there is not a significant loss of log-likelihood, if we use a simpler Cobb Douglas production function (Table 12). With this production function the productivity of white collars is always higher than that of blue collars. Every year, but in year 2000, the ratio of marginal productivity of white collar labour divided by a white collar wage is higher than the analogous ratio for blue collar labour.

Table 8 Whole data set - Annual cross-sections - Translog production function - stochastic frontier analysis (current prices)

	1994		1995		1996		1997		1998		1999		2000	
N. obs.	199		201		176		165		169		165		160	
	β	σ	β	σ	B	σ	β	σ	β	σ	β	σ.	β	σ
White	0.75	1.21	0.84	0.82	0.44	1.47	1.50	1.14	2.22	1.03	1.88	1.03	1.99	0.81
Blue	0.41	1.11	0.92	0.59	0.29	1.43	0.61	1.20	- 0.44	0.72	- 0.34	0.61	- 0.58	0.58
K	- 0.01	0.42	- 0.07	0.36	0.63	0.67	0.07	0.70	0.11	0.36	- 0.01	0.42	- 0.02	0.39
WW	0.58	0.55	0.06	0.48	0.29	0.82	0.20	0.25	0.94	0.35	0.61	0.36	0.32	0.34
BB	0.39	0.37	0.55	0.17	1.40	0.84	0.81	0.41	1.17	0.28	0.58	0.17	0.56	0.18
KK	0.02	0.09	- 0.02	0.07	0.00	0.10	0.02	0.11	- 0.02	0.06	0.07	0.05	0.08	0.07
KW	- 0.06	0.23	0.29	0.16	0.39	0.30	0.15	0.15	- 0.01	0.13	- 0.14	0.14	- 0.14	0.11
KB	0.04	0.17	- 0.16	0.14	- 0.40	0.24	- 0.16	0.19	0.01	0.12	0.00	0.11	- 0.02	0.08
BW	- 0.47	0.29	- 0.50	0.25	- 0.85	0.68	- 0.63	0.21	- 1.12	0.27	- 0.47	0.21	- 0.33	0.19
Const.	2.05	1.78	1.90	1.48	1.92	2.56	1.74	2.48	2.31	1.31	4.01	1.48	5.06	1.35
λ	4.53	1.53	2.82	0.75	3.56	1.11	3.84	1.31	2.81	0.98	3.39	1.24	5.26	2.07
ε_{white}	0.06		0.78		0.52		0.37		- 0.02		0.42		0.34	
ε_{blue}	1.01		0.62		0.76		1.01		1.42		0.88		0.87	
ε_{k}	0.16		0.03		- 0.03		- 0.05		- 0.05		0.11		0.12	
∂y/∂white	3.32		101.79		69.05		60.90		- 3.05		178.42		198.69	
$\frac{\partial y / \partial white}{wage}$	1.45		17.73		8.48		6.02		- 0.26		9.65		7.48	
∂y/∂blue	9.76		15.31		20.56		33.32		58.38		79.79		102.81	
$\frac{\partial y / \partial blue}{salary}$	7.83		5.64		4.84		5.82		9.39		8.07		7.62	
Log-likel.	-234.1		-276.55		-284.4		-259.4		-258.2		-256.8		-255.1	
Rst	0.83		0.02		0.62		0.02		0.00		0.02		0.02	

Rst = p value of the restriction

Table 9 Whole data set - Annual cross-sections - Cobb Douglas production function - stochastic frontier analysis (current prices)

	1994		1995		1996		1997		1998		1999		2000	
N. obs.	199		201		176		165		169		165		160	
	β	σ	β	σ	β	σ	β	σ	β	σ	β	σ.	β	σ
White	0.74	0.11	1.19	0.14	1.01	0.15	2.06	0.04	0.41	0.14	0.61	0.13	0.49	0.12
Blue	0.40	0.04	0.25	0.10	0.37	0.13	0.69	0.02	0.99	0.13	0.76	0.10	0.77	0.10
K	0.13	0.07	-0.02	0.06	-0.08	0.07	-0.26	0.01	-0.03	0.09	0.02	0.06	0.03	0.08
Const.	2.06	0.36	3.16	0.36	4.25	0.60	2.26	0.11	2.89	0.58	3.63	0.56	4.50	0.57
λ	2.06	0.40	2.54	0.59	2.94	0.74	14.90	0.98	1.88	0.59	1.76	0.56	2.57	0.68
$\partial y/\partial white$	39.45		154.91		134.56		339.81		73.82		257.34		284.51	
$\frac{\partial y / \partial white}{wage}$	17.20		26.98		16.52		33.58		6.20		13.92		10.71	
$\partial y/\partial blue$	3.89		6.23		10.10		22.84		40.75		69.65		91.67	
$\frac{\partial y / \partial blue}{salary}$	3.12		2.30		2.38		3.99		6.55		7.04		6.80	
Log-likel.	-257.7		-283.3		-293.6		-458		-271		-264		-264	

Rst = p value of the restriction

The elasticity of capital is sometimes positive, sometimes negative and just occasionally significant. This result should not be effect of of endogeneity or of differences in capacity utilization by the same firms in different years[13]. The absence of data about capacity utilization by different firms during the same year could however have influence on it. On the other hand, case studies show that some firms were burdened with real estates, which they were unable or slow to sell and which were generating costs in terms of property taxes to be paid.

Table 10 Results vs hypotheses in the case of the whole data-set

	Effects within a company (panel data analysis)	Effects between companies (cross section analysis)	
Specific human capital	A firm was able to increase its product more by increasing the presence of white collars than by increasing the presence of blue collar workers.	Firms having a higher relative presence of white collars were the ones with highest productivity, in the years when the average firm reduces the relative presence of blue collars. Vice versa in the other years.	
	Yes	Pooled data:[14] Yes always.	Annual data Always YES, But NO in : OLS 1994 OLS & SFA 1998
Profit Maximiza tion	A firm was able to increase its average ratio of product per paid remuneration by increasing the relative presence of white collars.	Firms having a higher relative presence of white collars were the ones with highest ratio of product per paid remuneration in the years when the average firm reduces the relative presence of blue collars. Vice versa in the other years.	
	Yes with SFA and 2SLS No with OLS.	Pooled data[14] No OLS YES SFA and 2SLS	Annual data Always YES, But NO in : OLS 1994 All 2000.

[13] However let us not forget that a “potential problem with applying 2SLS and other IV procedures is that the 2SLS standard errors have a tendency to be “large”. What is typically meant by this statement is either that 2SLS coefficients are statistically insignificant or that the 2SLS standard errors are much larger than OLS standard errors” (Woolridge, 2002: 102), even if under certain assumptions, “the 2SLS estimator is efficient in the class of all instrumental variables estimators ” (Woolridge, 2002: 96).

[14] In the case of pooled data we should expect that results about higher productivity and profitability of white collars should prevail, because this is the most frequent situation.

Synthesis of results about the whole data set

Table 13 shows that in almost every case the marginal productivity of white collars was higher than that of blue collars. Some doubts remain for years 1994 and 1998 when we use the Translog production function. Generally we find that white collar labour was more productive in the considered period and this could support the thesis that white collars were embodying more human capital and for this reason were more rarely dismissed. Table 14 seems to suggest that probably firms were also short term profit maximisers, because white collar labour in most of cases, especially using the Cobb Douglas production function and 2SLS, seem to have a higher ratio between their marginal product and their marginal cost. There is contrary evidence for 1994 and 1998 using O.L.S. For 2000 using 2SLS results suggest that productivity/wage in the case of white collars was less than productivity/salary in the case of blue collars. Also this finding would support the hypothesis that firms were profit maximisers. Actually in the year 2000 Russian footwear firms increased the share of blue collars in their workforce (see Figure 2).

Additionally from the use of SFA in Tables 3, 4, 7, and 8 we learn of the significant presence of slack among the firms in exam.

Table 11 Whole data set - Annual cross-sections Translog production function – 2 Steps Least Squares (current prices)

	1994		1995		1996		1997		1998		1999		2000	
N. obs.	192		186		175		164		165		158		157	
	β	σ	β	σ	β	σ	β	σ	β	σ	β	σ.	β	σ
White	3.66	15.61	-0.61	1.18	-10.37	136.5	-3.81	28.31	15.24	31.84	2.65	1.66	-2.49	11.35
Blue	1.41	4.92	0.05	1.37	23.33	453.1	3.48	16.66	-11.14	25.70	-1.08	1.30	1.98	6.22
K	-3.78	13.57	0.71	0.69	-5.47	153.5	3.08	7.04	-2.63	7.28	-0.17	0.51	-0.90	2.07
WW	2.97	15.38	-0.30	1.79	31.48	748.6	-0.51	12.68	-3.15	9.04	2.11	1.68	-9.00	19.29
BB	0.65	4.19	0.48	0.17	-7.52	175.0	1.05	1.27	2.99	5.65	0.89	0.57	-2.28	5.49
KK	1.60	4.72	-0.14	0.26	1.35	31.1	0.10	0.66	0.16	0.88	0.05	0.07	0.66	1.40
KW	-1.66	7.43	0.35	0.49	-8.34	208.2	0.41	4.99	0.26	2.48	-0.39	0.31	0.51	1.51
KB	-0.19	1.45	-0.16	0.34	5.00	131.5	-1.11	3.59	0.07	1.66	0.23	0.32	-1.36	3.16
BW	-0.60	5.55	-0.14	0.99	-6.90	174.4	0.54	5.67	-1.06	4.62	-1.24	0.91	6.18	13.68
Const.	4.59	9.38	2.58	2.82	-20.38	440.5	-10.71	22.39	16.27	34.17	3.43	2.39	9.66	10.46
ε_{white}	0.41		0.40		-3.34		0.85		1.17		0.51		1.05	
ε_{blue}	1.25		0.81		3.08		0.69		0.44		0.95		0.48	
ε_{k}	-0.12		0.09		1.54		-0.19		0.03		0.04		-0.07	
$\partial y/\partial white$	22.03		52.30		-443		140.0		211.2		216.2		614	
$\frac{\partial y / \partial white}{wage}$	9.57		9.10		-54.33		14.0		17.7		12.0		23.01	
$\partial y/\partial blue$	12.15		20.16		83.14		22.81		18.3		87.84		56.73	
$\frac{\partial y / \partial blue}{salary}$	9.77		7.18		19.53		3.98		2.93		8.82		4.17	
Adj. R2	0.08		0.63		-12		0.41		0.89		0.53		-2.02	
Rst	0.91		0.28		0.99		0.42		0.99		0.40		0.98	

Rst = p value of the restriction

Table 12 Whole data set - Annual cross-sections Cobb Douglas production function- 2 steps least squares (current prices)

	1994		1995		1996		1997		1998		1999		2000	
N. obs.	192		186		175		164		165		158		157	
	β	σ	β	σ	β	σ	β	σ	β	σ	β	σ.	β	σ
White	0.34	0.47	0.79	0.33	1.46	0.69	1.48	0.51	1.97	0.72	0.64	0.37	0.23	0.80
Blue	0.46	0.41	0.40	0.28	-0.37	0.57	0.10	0.31	0.17	0.50	0.74	0.32	1.19	0.62
K	0.40	0.21	0.14	0.10	0.17	0.15	-0.13	0.20	-0.42	0.16	0.03	0.09	-0.08	0.09
Const.	0.52	0.51	1.50	0.55	2.73	0.99	3.10	0.92	3.65	0.94	2.38	0.47	2.93	0.70
$\partial y/\partial white$	18.18		102.01		193.73		244.34		355.93		269.60		133.15	
$\frac{\partial y / \partial white}{wage}$	7.90		17.75		23.74		24.37		29.85		14.91		4.99	
$\partial y/\partial blue$	4.42		9.86		-9.91		3.43		6.90		68.45		141.60	
$\frac{\partial y / \partial blue}{salary}$	3.55		3.51		-2.33		0.60		1.11		6.87		10.42	
Adj. R2	0.65		0.63		0.47		0.50		0.41		0.61		0.59	

Table 13 The whole data base - Summary of answers to the question: do white collars have higher productivity than blue collars?

$$\frac{\partial y}{\partial white} > \frac{\partial y}{\partial blue} \quad \textbf{?}$$

	Panel		Pooled -data cross section		1994		1995		1996		1997		1998		1999		2000	
	C.D.	Trans log	C.D.	Trans log	C.D.	Trans log	C.D.	Trans log	C.D.	Trans log	C.D.	Trans log	C.D.	Trans log	C.D.	Trans log	C.D.	Trans log
Ols	Yes	Yes	Yes	Yes	Yes	**No**	Yes	Yes	Yes	Yes	Yes	Yes	Yes	**No**	Yes	Yes	Yes	Yes
SFA	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	**No**	Yes	Yes	Yes	Yes
2SLS	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The shaded cells indicate that the other production function fits significantly better the data with that model.

Table 14 Summary of answers to the question: do white collars have higher marginal productivity/cost than blue collars?

$$\frac{\partial y / \partial white}{wage} > \frac{\partial y / \partial blue}{salary} \;\; \textbf{?}$$

	Panel		Pooled -data cross section		1994		1995		1996		1997		1998		1999		2000	
	C.D.	Trans log	C.D.	Trans log	C.D.	Trans log	C.D.	Trans log	C.D.	Trans log	C.D.	Trans log	C.D.	Trans log	C.D.	Trans log	C.D.	Trans log
Ols	No	**No**	Yes	**No**	Yes	**No**	Yes	Yes	Yes	Yes	Yes	No	No	**No**	Yes	Yes	Yes	Yes
SFA	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	**No**	Yes	Yes	Yes	Yes
2SLS	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	**No**	Yes

The shaded cells indicate that the other production function fits significantly better the data with that model.

7. Results about medium-large firms

The full data set gives only partial coverage to small firms, but it appears to capture nearly all medium-large firms, those with more than 100 employees. The Goskomstat rules require that all of these should be included in this database, while only small firms with certain legal characteristics are included. With a specific test on medium large firms we should be able to obtain a relatively objective picture about them. Tables 15-22 report results of tests, tables 23 and 24 summarise results and table 25 considers results against hypotheses.

In the case of the whole data set tests using a Translog production function show that there is some advantage in using Translog with O.L.S. and S.F.A. For annual cross-sections only in the case of SFA in 1998 Translog fits significantly better the data, therefore usually a Cobb Douglas production function is to be preferred.

Productivity

In most of results it is confirmed that white collar labour was more productive than blue collar labor, however some important exceptions must be considered. The cross section of the whole data base rejects the hypothesis using O.L.S. and S.F.A., even if we can argue that cross-section of pooled data probably is not the best way to study the issue. In the case of panel data, only in the case of SFA the hypothesis is rejected. The results of 2SLS, which should not be affected by endogeneity, always confirm that labour productivity is higher for white collars than for blue collars.

Also in the case of annual cross-sections it is usually true that in medium-large firms white collars were more productive than blue collars. However some doubts can be raised about year 1994 (O.L.S. and S.F.A.), in the case of 1998 (SFA), 1999(2.S.L.S.) and 2000 (O.L.S. and 2.S.L.S.). It is worth reminding that in the years 1999 and 2000 medium-large firms increased the share of blue collar workers, which would be perfectly consistent with higher productivity of blue collar workers.

Table 15 Medium Large Firms - Cross section with pooled data and panel data - Translog production function (1994-2000) constant prices

	Cross section									Panel data								
	O.L.S.			S.F.A.			2S.L.S.			O.L.S.			S.F.A.			2S.L.S.		
N.	981			981			961			981			981			961		
	β	σ	ε	β	σ	ε	β	σ	ε	β	σ	ε	β	σ	ε	β	σ	ε
White	2.07	0.57	0.09	2.83	0.87	-0.02	3.72	2.22	0.66	2.36	0.79	0.39	2.50	0.77	0.06	0.33	0.61	1.66
Blue	-1.42	0.62	0.86	-1.20	0.99	0.85	-6.51	3.32	0.32	0.22	0.85	0.92	-0.60	0.83	0.74	1.29	1.09	0.57
K	-0.51	0.21	0.28	-0.57	0.22	0.34	-0.43	0.71	0.02	-0.04	0.24	-0.09	-0.21	0.18	0.30	0.25	0.72	-1.49
WW	0.27	0.23		0.34	0.14		-3.43	3.20		0.31	0.12		0.20	0.10		-0.00	0.08	
BB	0.85	0.14		0.85	0.20		0.72	0.74		0.41	0.19		0.60	0.16		-0.28	0.16	
KK	0.03	0.03		0.08	0.02		-0.02	0.18		-0.00	0.02		0.06	0.01		-0.26	0.41	
KW	0.08	0.07		0.00	0.06		0.73	0.58		-0.06	0.06		-0.02	0.05		-0.03	0.08	
KB	0.03	0.06		0.04	0.06		-0.43	0.48		0.04	0.06		0.02	0.05		-0.05	0.16	
BW	-0.68	0.15		-0.76	0.12		1.25	1.78		-0.48	0.12		-0.54	0.09		0.27	0.27	
Const.	6.51	1.82		6.03	2.35		14.03	6.43		0.35	2.76		3.92	2.08		-2.88	3.33	
λ				2.29	0.26								2.26	0.26				
∂y/∂white	19.06			-3.62			2.42			79.72			12.93			6.13		
$\frac{\partial y / \partial white}{wage}$	1.67			-0.32			12.83			6.97			1.13			32.56		
∂y/∂blue	34.78			34.43			0.23			37.13			29.65			0.41		
$\frac{\partial y / \partial blue}{salary}$	5.86			5.80			2.33			6.25			4.99			4.19		
Adj.R2	0.40						0.10			0.87						0.85		
Log-likelihood				-1658									-1470					
Rst	0.00			0.00			0.13			0.00			0.00			0.25		

Rst = p value of the restriction

Table 16 Medium Large Firms Cobb Douglas (1994-2000) constant prices

	Cross section						Panel					
N. Obs.	981		981		961		981		981		961	
	O.L.S.		S.F.A.		2s.l.s.		O.L.S.		S.F.A.		2s.l.s.	
	β	σ	β	σ	β	σ	β	σ	β	σ	β	σ
White	0.33	0.12	0.27	0.07	0.78	0.31	0.44	0.10	0.24	0.06	1.42	0.25
Blue	0.68	0.11	0.65	0.06	0.63	0.26	0.70	0.10	0.48	0.04	0.13	0.19
K	0.23	0.04	0.25	0.02	-0.05	0.06	-0.07	0.05	0.24	0.02	-0.04	0.16
Const.	1.19	0.32	2.83	0.34	-1.85	0.44	3.39	0.65	4.29	0.32	-1.70	0.86
λ			1.81	0.21					2.41	0.28		
∂y/∂white	68.56		56.72		2.86		91.82		49.74		5.24	
$\frac{\partial y / \partial white}{wage}$	6.00		4.96		15.20		8.03		4.35		27.85	
∂y/∂blue	27.61		26.19		0.46		28.10		19.42		0.10	
$\frac{\partial y / \partial blue}{salary}$	4.65		4.41		4.63		4.73		3.27		0.97	
Adj. R2	0.37				0.46		0.82				0.79	
Log likel.			-1695						-1492			

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Table17 Medium Large firms – Annual cross sections Translog production function-ordinary least squares

	1994		1995		1996		1997		1998		1999		2000	
N.obs.	173		160		143		129		130		124		122	
	β	σ	β	σ	β	σ	β	σ	β	σ	β	σ.	β	σ
White	-0.45	1.85	1.77	1.09	-0.69	2.00	2.51	2.22	1.32	1.34	2.16	1.41	2.50	1.57
Blue	1.68	1.81	-2.35	1.37	-0.57	1.62	-2.99	2.25	-0.87	1.64	-1.93	1.36	0.18	1.61
K	0.03	0.59	0.29	0.48	1.28	1.12	0.48	1.06	-0.06	0.40	-0.08	0.57	-1.86	0.65
WW	0.39	0.68	-0.66	0.76	0.10	0.94	-0.08	0.22	0.74	0.40	-0.42	0.63	0.79	0.36
BB	0.18	0.48	1.48	0.30	1.70	0.47	1.06	0.41	1.19	0.50	0.89	0.29	0.07	0.36
KK	0.03	0.06	0.05	0.10	0.02	0.07	-0.04	0.14	-0.03	0.05	-0.01	0.07	0.04	0.07
KW	0.05	0.30	0.47	0.20	0.47	0.31	-0.01	0.24	0.09	0.18	0.16	0.21	-0.13	0.11
KB	-0.06	0.25	-0.45	0.19	-0.62	0.33	-0.03	0.23	-0.04	0.08	-0.09	0.14	0.38	0.15
BW	-0.27	0.46	-0.40	0.37	-0.60	0.52	-0.33	0.30	-0.93	0.35	-0.26	0.29	-0.75	0.36
Const.	-0.73	3.79	6.52	3.64	1.84	6.00	6.39	5.69	4.72	4.19	6.71	3.82	8.77	5.15
ε_{white}	0.04		0.81		0.80		0.24		0.02		0.66		0.28	
ε_{blue}	1.19		0.55		0.64		0.99		1.61		1.01		1.16	
ε_{k}	0.15		0.04		-0.06		-0.07		-0.18		-0.07		0.03	
$\partial y/\partial white$	1.65		82.63		95.80		37.01		3.17		265.75		177.05	
$\frac{\partial y/\partial white}{wage}$	0.77		17.47		13.31		3.65		0.29		17.97		6.58	
$\partial y/\partial blue$	8.86		12.92		19.64		34.67		59.13		79.81		121.75	
$\frac{\partial y/\partial blue}{salary}$	7.23		5.05		3.79		5.17		9.02		7.85		8.09	
Adj.R2	.66		.61		.39		0.38		.48		.47		.44	
Rst	.86		0.08		.13		.45		.08		.33		.96	

Rst = p value of the restriction

Table18 Medium-Large firms- Annual cross-sections Cobb Douglas production function - 0rdinary least squares

	1994		1995		1996		1997		1998		1999		2000	
N.obs.	173		160		143		129		130		124		122	
	β	σ	β	σ	β	σ	β	σ	β	σ	β	σ	β	σ
White	1.23	0.31	1.23	0.31	1.20	0.40	0.53	0.24	0.35	0.26	0.87	0.25	0.33	0.26
Blue	0.21	0.28	0.21	0.28	0.35	0.34	0.93	0.27	1.30	0.27	0.95	0.21	1.15	0.23
K	0.02	0.09	0.02	0.09	-0.12	0.11	-0.13	0.12	-0.15	0.06	-0.12	0.09	-0.01	0.09
Const.	1.81	0.67	1.81	0.67	2.53	0.82	2.37	0.82	1.32	0.65	1.74	0.66	2.07	0.72
∂y/∂white	2.53		125.43		144.34		82.26		63.30		352.23		204.46	
$\frac{\partial y / \partial white}{wage}$	1.18		26.51		20.05		8.11		5.84		23.82		7.60	
∂y/∂blue	9.08		4.97		10.88		32.54		47.85		74.76		120.02	
$\frac{\partial y / \partial blue}{salary}$	7.40		1.95		2.10		4.85		7.30		7.35		7.97	
Adj.R2	.67		.57		.38		.38		.46		.46		.40	

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Table19 Medium-Large firms –Annual cross - sections-Translog production function – stochastic frontier analysis (currentprices)

	1994		1995		1996		1997		1998		1999	
N.obs.	173		160		143		129		130		124	
	β	σ	β	σ	B	σ	B	σ	β	σ	β	σ.
White	-0.46	1.42	1.71	2.32	-0.33	3.68	3.71	3.30	2.16	1.96	3.41	3.32
Blue	1.38	1.37	-1.30	2.39	0.70	4.14	-2.82	3.53	-1.72	2.17	-1.81	2.82
K	-0.05	0.69	0.37	0.83	1.50	1.27	0.94	1.70	0.39	1.06	0.35	1.28
WW	0.66	0.69	-0.41	1.36	-0.03	1.69	-0.13	0.48	1.00	0.48	0.03	0.51
BB	0.04	0.50	1.26	0.96	1.62	1.16	1.07	0.58	1.29	0.44	0.96	0.47
KK	0.02	0.10	0.05	0.11	-0.00	0.21	-0.07	0.20	-0.00	0.09	0.05	0.11
KW	-0.10	0.31	0.38	0.22	0.49	0.45	-0.04	0.32	-0.10	0.17	-0.09	0.21
KB	0.08	0.26	-0.39	0.27	-0.63	0.42	-0.03	0.39	-0.00	0.18	-0.06	0.24
BW	-0.27	0.38	-0.47	1.07	-0.70	1.12	-0.47	0.35	-0.97	0.37	-0.44	0.37
Const.	1.94	2.61	4.46	4.20	-1.96	9.27	2.92	8.34	4.49	6.53	3.16	7.37
λ	4.85	1.85	3.28	0.94	3.87	1.32	4.08	1.56	2.85	1.11	4.17	1.64
ε_{white}	-0.04		0.64		0.30		0.24		-0.10		0.32	
ε_{blue}	1.08		0.63		0.99		0.99		1.48		1.06	
ε_{k}	0.17		0.08		-0.04		-0.07		-0.04		0.12	
∂y/∂white	-1.83		64.74		36.07		37.01		-17.75		129.68	
$\frac{\partial y / \partial white}{wage}$	-0.85		13.68		5.01		3.65		-1.64		8.77	
∂y/∂blue	8.04		14.64		30.36		34.67		54.32		83.65	
$\frac{\partial y / \partial blue}{salary}$	6.56		5.73		5.85		5.17		8.28		8.23	
Log-likel.	-207.51		-219.17		-225.7		-202.64		-195.51		191.63	
Rst	.95		.47		.60		.38		0.00		.32	

Rst = p value of the restriction

Table20 Medium-Large firms –Annual cross-sections-Cobb Douglas production function-stochastic frontieranalysis(curren tprices)

	1994		1995		1996		1997		1998		1999		2000	
N.obs.	173		160		143				130		124			
	β	σ	β	σ	β	σ	β	σ	β	σ	β	σ.	β	σ
White	-0.11	0.12	1.20	0.16	1.12	0.19	0.64	0.21	0.35	0.14	0.59	0.16	0.19	0.09
Blue	1.19	0.11	0.16	0.12	0.25	0.14	0.62	0.18	1.12	0.19	0.86	0.14	0.96	0.14
K	0.15	0.07	0.03	0.08	-0.11	0.08	-0.01	0.17	-0.06	0.13	0.03	0.09	0.08	0.06
Const.	0.97	0.40	3.28	0.49	4.87	0.72	3.86	1.13	2.65	1.17	3.29	1.12	4.37	0.82
λ	4.39	1.50	2.97	0.84	3.65	1.46	2.85	1.04	1.84	0.67	2.89	1.10	4.73	1.96
$\partial y/\partial white$	-4.85		122.26		134.47		99.24		63.43		240.43		122.16	
$\frac{\partial y / \partial white}{wage}$	-2.26		25.84		18.68		9.79		5.85		16.26		4.54	
$\partial y/\partial blue$	8.85		3.71		7.66		21.86		41.28		68.30		100.24	
$\frac{\partial y / \partial blue}{salary}$	7.22		1.45		1.48		3.26		6.29		6.72		6.66	
Log-likel.	-209.44		-226.66		-234.95		-208.6		-203.1		-197.84		- 195.34	

Table21 Medium-Large firms –Annual cross - sections-Translog production function – 2 steps least squares (current prices)

	1994		1995		1996		1997		1998		1999		2000	
	β	σ	β	σ	B	σ	B	σ	β	σ	β	σ.	β	σ.
White	66.04	967.41	18.43	241.00	11.87	47.18	-0.14	20.14	-50.02	80.99	1.53	2.24	9.45	21.20
Blue	11.96	197.01	-9.40	98.34	-25.14	77.59	-3.95	10.26	-54.90	93.58	-1.83	2.80	-1.17	9.47
K	-48.73	729.72	-5.12	76.96	1.00	6.92	2.90	6.98	-10.11	23.34	-0.96	0.78	-2.15	5.35
WW	37.06	528.38	9.20	130.92	-13.26	46.67	-4.10	7.39	-30.52	68.84	2.02	1.99	-6.53	9.48
BB	-4.30	111.18	6.64	76.05	3.32	6.62	3.42	2.66	3.86	8.82	0.57	0.79	-0.82	3.08
KK	7.81	105.50	-1.72	21.72	-0.41	1.55	0.04	0.89	-1.71	3.59	0.17	0.12	0.79	1.28
KW	-16.74	254.73	1.57	15.86	2.25	6.77	1.45	4.22	10.63	21.33	-0.54	0.42	-0.26	1.24
KB	10.19	169.72	2.47	36.02	-1.17	3.57	-1.67	2.98	-3.23	7.26	0.30	0.43	-0.79	1.35
BW	-15.32	202.74	-12.11	159.64	4.07	16.19	0.49	1.92	14.01	25.45	-0.75	1.20	3.57	4.97
Const.	7.00	68.39	15.66	116.62	49.97	127.96	3.86	20.52	324.48	520.74	10.91	6.68	0.64	33.14
ε_{white}	7.55		0.57		2.02		0.17		6.78		0.19		1.22	
ε_{blue}	-2.06		0.21		-1.10		0.87		-9.80		1.19		0.89	
ε_{k}	-1.30		0.55		-0.29		-0.18		-2.23		0.12		-0.15	
$\partial y/\partial white$	337.79		58.54		242.08		26.58		1,224.02		73.53		767.59	
$\frac{\partial y / \partial white}{wage}$	157.39		12.43		33.63		2.62		113.17		4.06		28.51	
$\partial y/\partial blue$	-15.46		5.09		-33.88		30.39		-361.44		95.69		93.66	
$\frac{\partial y / \partial blue}{salary}$	-12.58		1.93		-6.53		4.53		-54.99		9.10		6.22	
R	-24.29		-1.87		.60		-1.11		-34.99		.32		-2.42	
Rst	.99		.99		.74		.82		.99		.73		.89	

Rst = p value of the restriction

Table 22 Medium Large Firms- Cobb Douglas production function – 2 steps least squares (current prices)

	1994		1995		1996		1997		1998		1999		2000	
N.	168		153		143		129		127		120		121	
	β	σ	β	σ	β	σ	β	σ	β	σ	β	σ.	β	σ
White	0.17	0.49	0.43	0.49	1.59	0.68	1.34	0.75	1.70	0.77	0.14	0.50	-0.36	1.22
Blue	0.61	0.38	0.90	0.46	-0.47	0.60	0.19	0.45	0.26	0.62	1.35	0.51	1.64	1.01
K	0.46	0.23	0.07	0.12	0.08	0.20	-0.17	0.27	-0.47	0.19	0.03	0.12	0.06	0.17
Const.	-0.19	0.70	0.69	0.86	3.57	1.38	3.60	1.34	4.74	1.71	0.98	1.01	1.42	1.73
$\partial y/\partial white$	9.50		58.11		215.31		227.63		318.17		61.43		- 220.95	
$\frac{\partial y / \partial white}{wage}$	4.08		9.91		25.94		21.38		25.86		3.31		-7.78	
$\partial y/\partial blue$	5.92		22.81		-12.73		6.50		10.90		127.32		198.92	
$\frac{\partial y / \partial blue}{salary}$	4.80		7.82		-2.87		1.08		1.77		12.89		13.94	
Adj.R2	0.61		0.53		0.33		0.31		0.25		0.41		0.35	

Table 23 Medium-large firms: Summary of answers to the question: do white collars have higher productivity than blue collars?

$$\partial y / \partial white > \partial y / \partial blue \quad \textbf{?}$$

	Panel		Pooled -data cross section		1994		1995		1996		1997		1998		1999		2000	
	C.D.	Trans log	C.D.	Trans log	C.D.	Trans log	C.D.	Trans log	C.D.	Trans log	C.D.	Trans log	C.D.	Trans log	C.D.	Trans log	C.D.	Trans log
Ols	Yes	Yes	Yes	**No**	**No**	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	**No**	Yes
SFA	Yes	**No**	Yes	**No**	**No**	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	**No**	Yes	Yes	Yes	N.A.
2SLS	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	**No**	No	**No**	Yes

The shaded cells indicate that the other production function fits significantly better the data with that model.

Table 24 Medium-large firms- Summary of answers to the question: do white collars have higher marginal productivity/cost than blue collars?

$$\frac{\partial y / \partial white}{wage} > \frac{\partial y / \partial blue}{salary} \quad \textbf{?}$$

	Panel		Pooled -data cross section		1994		1995		1996		1997		1998		1999		2000	
	C.D.	Trans log	C.D.	Trans log	C.D.	Trans log	C.D.	Trans log	C.D.	Trans log	C.D.	Trans log	C.D.	Trans log	C.D.	Trans log	C.D.	Trans log
Ols	Yes	**No**	Yes	**No**	**No**	No	Yes	Yes	Yes	Yes	Yes	No	**No**	No	Yes	Yes	**No**	No
SFA	Yes	**No**	Yes	Yes	**No**	No	Yes	Yes	Yes	No	Yes	No	No	**No**	Yes	Yes	No	N.A.
2SLS	Yes	Yes	Yes	Yes	**No**	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	**No**	No	**No**	Yes

The shaded cells indicate that the other production function fits significantly better the data with that model.

Table 25 Results vs hypotheses in the case of medium-large firms

	Effects within a company (panel data analysis)	Effects between companies (cross section analysis)	
Specific human capital	A firm was able to increase its product more by increasing the presence of white collars than by increasing the presence of blue collar workers.	Firms having a higher relative presence of white collars were the ones with highest productivity, in the years when the average firm reduces the relative presence of blue collars. Vice versa in the other years.	
	Yes OLS and 2SLS NO SFA	Pooled data:[15] YES 2SLS NO OLS and SFA	Annual data Always YES, But NO in : OLS and SFA 1994 SFA 1998 OLS, SFA 1999 SFA 2000.
Profit Maximization	A firm was able to increase its average ratio of product per paid remuneration by increasing the relative presence of white collars.	Firms having a higher relative presence of white collars were the ones with highest ratio of product per paid remuneration in the years when the average firm reduces the relative presence of blue collars. Vice versa in the other years.	
	Yes 2SLS No OLS and SFA.	Pooled data[15] No OLS YES SFA and 2SLS	Annual data Always YES, But NO in : ALL 1994 OLS and SFA 1998 OLS and SFA 1999

Productivity/wage (productivity/salary)

Here the results are mixed. Most of the tests indicate that white collars had higher productivity/remuneration than blue collars had. However the opposite is true in the panel model (O.L.S. and S.F.A.) and in the pooled data with O.L.S. Additionally is not true in the year 1994 and in the years 1999 and 2000, with doubt to be raised in 1998.

In the years 1999 and 2000 the situation:

$$\frac{\partial y / \partial \text{white}}{wage} < \frac{\partial y / \partial \text{b}lue}{salary}$$

[15] In the case of pooled data we should expect that should prevail results about higher productivity and profitability of white collars, because this is the most frequent situation.

would also support the hypothesis that firms were profit maximisers, because in those years medium-large firms started re-balancing their workforce in favor of blue collar labor. We observe at the same time that when blue collar labour becomes more profitable than white collar labor, firms start to use more of it.

It should be added that the elasticity coefficients are not always significant and this of course affects the significance of the values of productivities, therefore these values require some caution.

8. Conclusion

During the transition years Russian footwear firms downsized their workforce between 1992 and 1998 and slightly increased it between 1999 (1998 in the case of medium-large firms) and 2000 but the cuts were not uniformly distributed across categories of employee. The number of white collars fell less than proportionally in the years between 1992 and 1998 and increased less than proportionally between 1999 (1998 in the case of medium-large firms) and 2000. Three explanations (which need not be mutually exclusive) have been suggested:

- Firms behaved in a profit maximizing way, increasing the share of that type of labour which at that moment contributed more to profits (or to reducing losses);
- Firms acted as they did in order to preserve their human capital, protecting more productive workers;
- Firms gave privileges to white collars, not because they were more productive, but instead for institutional reasons (internal labour markets, implicit contract, etc.).

Results for the whole data set mostly support the first and the second explanation and usually make the third explanation redundant.

Results for the smaller (but better documented) set of medium and large firms usually do not reject the hypothesis that these firms were profit maximisers.

In these firms the share of blue collars ceased to fall earlier (see figure 2) and there were fewer years when the use of blue collar labour was less profitable than the use of white collar labour.

Subject to the qualifications, which this paper has explained (low significance of some coefficients and absent measurement of capacity utilization by different firms during the same year, see section 4) the results would appear to support the broad conclusion that in the very peculiar transitional period from socialist planning to market-based competition, Russian footwear firms managed their redundancies in ways consistent with principles of profit maximization.

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