

# **Restructuring of Firms under Transition: The Czech case**

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Second draft: April 1995\*

## Abstract

The author stresses specific features of restructuring under transition of a post-communist economy. He presents a formal model comparing the restructuring of three different firms characterized by ownership under the assumption of imperfect capital and financial markets. The empirical evaluation more or less supports the theoretical results.

## Abstrakt

Článek na zaměřen na specifické rysy restrukturalizace v podmínkách transformace celé ekonomiky. Je prezentován model srovnávající restrukturalizaci ve firmách privatizovných třemi různými metodami za předpokladu nedokonale fungujícího kapitálového a finančního trhu. Empirická analýza v podstatě potvrzuje teoretické závěry.

Cosponsored by ACE grant "Obstacles to Restructuring in Eastern Europe."

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\* I gratefully acknowledge the help of Yanis Katsoulacos and Jan Hanousek with the theoretical and empirical parts of the paper, respectively. Useful comments to the first draft were provided by M. Singer, M. Vošvrda, A. Zemplerová and K. Žigić.

## 1. Introduction

The Czech Republic is known as a quickly transforming economy with excellent achievements in macroeconomic stabilization. It often serves as the example for other post-communist transforming economies, especially because of the rapid privatization program. The liberal government believes that the macro stabilization, together with the setting up of the general system rules, is the best policy for transformation towards a market economy. It tries to limit its direct influence to the micro-sphere to the lowest possible extent.

Does this policy work? Would it not be better if the state would conduct the restructuring and privatize subsequently? To be able to answer these questions we first need to understand what is really going on in the micro-sphere now.

According to our knowledge, with the exception of a few case studies in a small number of selected firms, no serious empirical study on the restructuring of Czech firms exists yet. Even theoretical economists' intuition is very limited. Serious microeconomic models of firms in transition have not been created so far. All available literature connected with the topic is based on Western economies' experience with privatization. The reflection of specific features of economies in transition is very insufficient.

Since the most extended privatization in the West was realized in Great Britain, the majority of studies refer to the British experience. An excellent overview of related theories is provided by Vickers and Yarrow (1988). Even quite recent articles like Green and Price (1993) and Christodoulakis and Katsoulacos (1993), claiming to be linked directly to transitional economies, do not overcome the close connection to the British case. For example, all available theoretical papers adopt the assumption that it is the public firm (welfare maximizing) which is somehow privatized or restructured. But post-communist state-owned firms have nothing to do with society welfare maximization. In fact, they are anything but public firms in the standard sense.

In this paper we present both a theoretical model and empirical work reflecting some of the specific features of the transition economic reality. The model examines separately three privatization methods under the assumptions of imperfect capital and financial markets. The empirical part utilizes a special data sample of Czech firms. The aim is to capture certain aspects of restructuring and link them to the main individual characteristics of firms, particularly, to the method of privatization.

In section 2 we stress the specific features of privatization under the transition of an economy as a whole, formulate the firm's decision model and examine its basic properties. The confrontation of theoretical results with the data is presented in section 3. Section 4 concludes.

## 2. The Model

As already mentioned, there are several differences between privatization in developed economies and privatization under the general transition from command to market economies. We consider the most important differences to be:

scale. Great Britain, as the country with the largest privatization program in the West, privatized firms contributing to GDP by about 4%; Czech privatization includes firms producing a major part of GDP;

government objectives. Privatization in the West is often promoted in order to improve the budget. This implies that the aim of the government is to maximize the selling price of assets. In Eastern Europe, governments wish to transform a centralized economy into a market-oriented one, and privatization is viewed as the mechanism creating appropriate incentives for efficient economic decisions, rather than as the tool of extraordinary budget incomes;

macroeconomic environment. Eastern European countries do not have sound capital markets. Banking is the subject of transformation, as well as other institutions necessary for a well-functioning economy. The relative prices of goods do not yet fully reflect costs and demand/supply relations and are still more or less influenced by the former bureaucratic price-setting mechanisms;

state-owned firm's inefficiency. State-owned firms do not behave as welfare maximizers. Their managers operate by placing importance on personal relationships established under the old regime. Their incentives are hidden, but they probably deviate far from standard incentive mechanisms such as welfare maximization, revenue maximization or profit maximization;

continuity with previous actions. The current economic structures in post-communist countries were built according to non-economic decisions reflecting personal relationships and partial interests within the communist party and the needs of the command economy. These structures deviate greatly from those which would be developed under the market system.

In our model we reflect a few of the above facts. We do not specify any objective function of the firm before privatization. An imperfect capital market is assumed to imply the different prices of capacities to be bought and sold. Considering three privatization methods, we assume that the firm is owned

either by a foreign owner (F), by a domestic owner (D), or by dispersed domestic owners resulting from a give-away privatization (G).

While searching for a definition of restructuring, we realized that it differs significantly from one publication to another. The closest to our point of view we found is: "To restructure the organization means to change the way it is organized so that it has a different structure, usually in order to make it work more effectively."<sup>2</sup>

The words "to restructure" are very often used in theory as well as in the press, but really an exact definition has not been found. Authors use it for personal changes in management, dividing or merging firms, changes in the structure of internal organization, changes in the firm's attitude towards R&D, marketing or advertising, or exclusively for financial restructuring. Since the definition is vague, its meaning for the purposes of a formal model should be specified.

Our model choice variables are quantity of production  $Q_i$  and investment in restructuring  $R_i$ . The assumed effect of the investment in restructuring is the reduction of labor necessary for the production of one unit of output (unit labor requirements). Thus for the purpose of our model, we define restructuring as the reduction of unit labor requirements which require the lump sum cost  $R_i$ . Despite this, restructuring in only a specific sense, it is often argued that low productivity and artificial overemployment are the main barriers faced by firms in post-communist countries. It would not change the analysis much to introduce into the model restructuring as a reduction of the unit capacity requirements.

Although the objective function is formalized as the same one for all three cases (the profit maximization), G-type firm is assumed to restructure less effectively. The underlying impression is that dispersed ownership causes less effective control over the management. G-type management incentives differ in part from those of the owners; that is, managers do not like to fire employees.

The Czech experience with firms arising from the give-away privatization suggests that the salaries of managers are not based as much on the firm's performance, while their public reputation is determined by the ability to conserve jobs. Rather than building a good reputation with respect to owners, managers are concerned with short-term goals; this leads us to assume that they prefer good relations with workers and believe in the limited control of dispersed owners.

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<sup>2</sup> See the English Language Dictionary. London: Harper Collins Publishers, 1993.

The objective (profit) function consists of the following expressions (subscript  $i$  always refers to F-type, D-type and G-type firms, respectively):

*revenue*  $P(Q_i)Q_i$   
 where  $P(Q_i)$  is a downward sloping demand function (price function) and  $Q_i$  is the output

*rental cost of labor*  $wl(R_i)Q_i$   
 where  $w$  is wage and  $l(R_i)$  is the labor required for the production of one unit of output which depends on the restructuring investment  $R_i$

*rental cost of capacity*  $\delta \rho m Q_i$   
 where  $\delta$  is the depreciation rate,  $\rho$  is the price of one unit of capacity, and  $m$  is the capacity required for the production of one unit of output (in other words,  $mQ_i$  is the required capacity,  $\rho m Q_i$  is the price of a whole capacity and  $\delta$  translates it into the current costs of operating with the capacity);

<i>costs of restructuring</i>	$R_i$	
<i>costs of capacity adjustment</i>	0	if $mQ_i = M_0$
	$-\rho_r(M_0 - mQ_i)$	if $mQ_i < M_0$
	$\rho_i(mQ_i - M_0)$	if $mQ_i > M_0$

where  $\rho_r$  is the price of one unit of redundant capacity,  $\rho_i$  is the price of one unit of new capacity which is lower for the F-type firm, and  $M_0$  stands for the initial capacity.

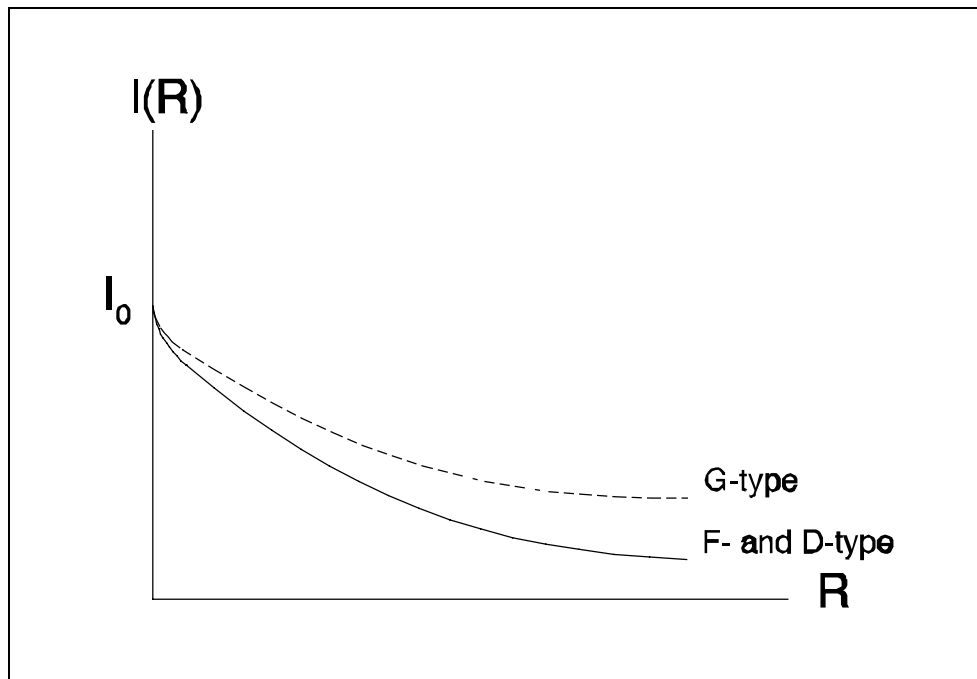
There are two market imperfections of transitional economies reflected. The imperfect domestic capital market causes low prices for redundant capacities. The buying price of a capacity  $\rho_i$  is higher than the selling price  $\rho_r$ . All three types of firm sell their redundant capacities in the imperfect domestic capital market.

The second market imperfection is the discrimination of domestic investors (G-type and D-type) on the access to credits. We can call this the financial market imperfection. Because of the scarcity of money, inefficiencies in banking, etc., it is more costly in transitional economies to obtain a credit. Despite the fact that in some post-communist economies the interest rates are not distorted much, other barriers to obtain a credit contribute to a higher price of money compared to Western markets. Since in transitional economies the buying of additional capacities is financed almost exclusively by credits, we suppose a lower price of additional capacities for the F-type firm. The F-type firm is the single one which has access to cheaper foreign money ( $\rho_F < \rho_D = \rho_G$ ).

Since the objective function is too difficult to deal with in the general form, we make several simplifying assumptions. We assume a linear inverse demand function with the unit slope ( $P(Q_i) = p_0 - Q_i$ ) and the diminishing effect of restructuring investment in unit labor requirements ( $l(R_i) = l_0 - l_i R_i^{1/2}$ ). Remember that the G-type firm is assumed to restructure less efficiently ( $l_G < l_D = l_F$ ). Other assumptions are: one unit of output is produced by just one unit of capacity ( $m = 1$ ) and no importance is given to depreciation ( $\delta = 0$ ). Ignoring depreciation, we do not take into account the rental costs of capacity. Parameters  $p_0$  and  $l_0$  are the initial points, where  $p_0$  is the upper bound for price and  $l_0$  is the upper bound for the unit labor requirement (or the unit labor requirement before restructuring).

Because the investment in restructuring is incorporated into the functional form of  $l(R_i)$  with the power one half, the unit labor requirements fall rapidly for low  $R_i$  and slowly for large  $R_i$ . The initial crown investments in restructuring have a greater effect than subsequent investments. Parameter  $l_i$  reflects the assumption of lower efficiency of restructuring investment in the G-type firm (see *Figure 1*).

**Figure 1:** The effect of restructuring investment on unit labor requirements ( $l(R_i) = l_0 - l_i R_i^{1/2}$ , where  $l(R_i)$  is the unit labor requirement,  $l_0$  is the unit labor requirement before restructuring,  $l_G < l_D = l_F$  are parameters of efficiency of restructuring investment and  $R_i$  is the restructuring investment).



Finally, the firms' maximization problems can be written as:

$$\max_{Q_i, R_i} \Pi_i = \max[(p_0 - Q_i) * Q_i - w * (l_0 - l_i R_i^{1/2}) Q_i - R_i + \rho_r * (M_0 - Q_i)] \quad \text{for } Q_i \leq M_0$$

$$= \max[(p_0 - Q_i) * Q_i - w * (l_0 - l_i R_i^{1/2}) Q_i - R_i - \rho_i * (Q_i - M_0)] \quad \text{for } Q_i > M_0$$

where  $i = F, D, G$ , respectively,  $\Pi_i$  stands for the profit,  $\rho_r < \rho_F < \rho_D = \rho_G$  and  $l_G < l_F = l_D$ . All values of the parameters and variables are restricted to being positive.

Using the first order conditions<sup>3</sup> and solving for optimal levels of output and investment in restructuring, we reached:

$$Q_i^* = \frac{2(p_0 - w l_0 - \rho_r)}{w l_i * (p_0 - w l_0 - \rho_r)^2} \quad \text{for } Q_i \leq M_0$$

Because the price of capacity is the highest for D- and G-type firms, using subscript D we ensure Condition 1 to hold for lower prices of capacity. Similarly, the efficiency of restructuring is highest for D- and F-type firms. Thus, once Condition 2 holds for D-type, it holds for all three types. Henceforth we restrict the analysis to the range of parameters satisfying both these conditions.

While looking for the maximum we should check the second order conditions for concavity.<sup>5</sup> The second order conditions for the maximum are satisfied if **Condition 3:**  $3w l_i Q_i R_i^{1/2} < 8Q_i^2$ . The positivity of output, the first order condition for restructuring investment and Condition 2 imply that Condition 3 is always satisfied.<sup>6</sup>

Analysing the solution of the maximization problem, we examine the effects of parameters. As  $p_0$  (the upper bound of output price) grows, both restructuring investment and the quantity of output rise. The increase in  $p_0$  is the upward shift of demand and the growth of output is a natural response of firms. More surprising is the increase of restructuring as a response to higher demand.

As the price of capacity ( $\rho_r$  or  $\rho_i$ ) and unit labor requirements before restructuring ( $l_0$ ) grow, both values of choice variables decrease. Higher prices of inputs cause lower output and restructuring investment. The effect of the wage rate ( $w$ ) is ambiguous; it depends on particular parameter values.

Since the model is quite general, it enables the capture of various situations by the appropriate choice of parameters. We analyze some of the interesting cases by means of the following propositions. Proofs of these propositions are presented in Appendix 1.

**Proposition 1:** If all three firms sell out some redundant capacities, then  $Q_F^* = Q_D^* > Q_G^*$  and  $R_F^* = R_D^* > R_G^*$ .

The meaning of Proposition 1 is that if privatization leads to the redundancy of the previous capacities, D-type and F-type firms behave similarly, while the G-type firm produces and restructures less. If new owners find high reserves in

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<sup>5</sup> The solution found by first order conditions is maximum only if the matrix of the second derivatives (Hessian matrix) is negative semidefinite. Otherwise the solution corresponds either to the minimum or to the inflex point. By straightforward manipulations we reach Condition 3 as the condition for negative semidefiniteness of the Hessian matrix.

<sup>6</sup> Substituting for  $R_i^{1/2} = w l_i Q_i / 2$  and omitting  $Q_i^2$  on both sides of Condition 3 we reach  $16/3 > w^2 l_i^2$ . This condition holds under Condition 2.



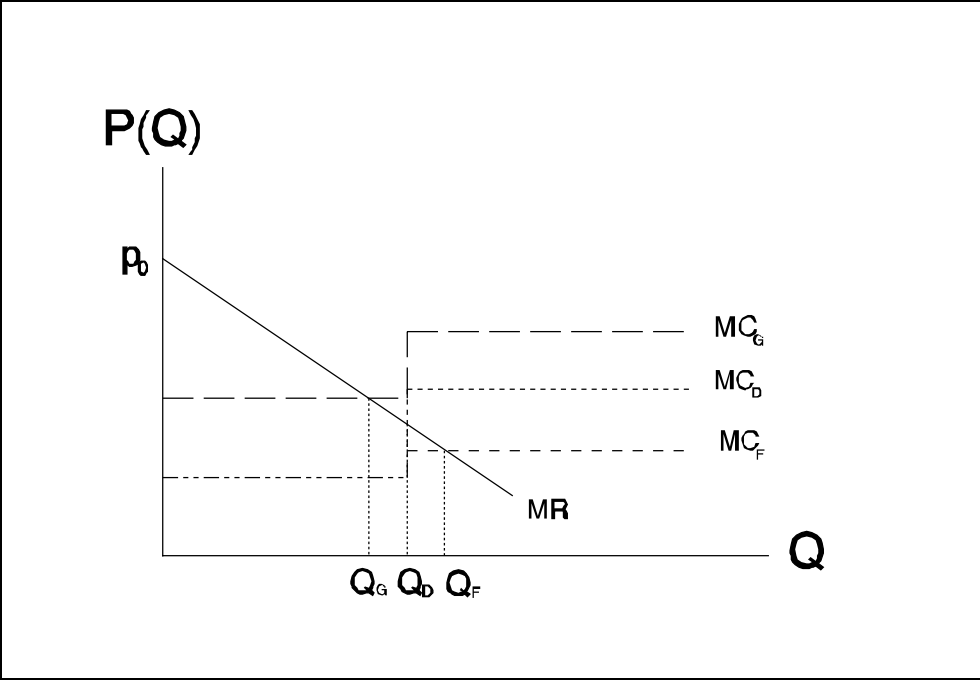
capacities, the foreign owners do not utilize their advantage on the financial market. Only dispersed owners have worse results because of their lower efficiency of restructuring.

**Proposition 2:** If all three firms hire new capacities, then  $Q_F^* > Q_D^* > Q_G^*$  and  $R_F^* > R_D^* > R_G^*$ .

In Proposition 2 we analyze the opposite extreme to Proposition 1. Here the privatization results in such a rapid increase in output that additional capacities are hired by all three types of firms. The F-type firm utilizes its easier access to credit on the foreign financial market and it produces and restructures more than the other two types. The G-type is again the subject of less efficient restructuring.

**Proposition 3:** There exist such parameters that  $Q_F^* > Q_D^* = M_0^* > Q_G^*$ . Such a situation is depicted in *Figure 2*.

*Figure 2:* The case stated by Proposition 3.



Notation: MR - marginal revenue (in our case it is the function  $P(Q_i) = p_0 - 2Q_i$ ),  $MC_i$  -marginal costs (for  $Q_D < M_0$  holds that  $Q_D = Q_F$ ),  $Q_i$  optimal output determined by intersection of marginal revenue and marginal costs, i - refers to F, D and G-type firms.

By Proposition 3 we capture one of the most interesting cases. While the G-type firm sells off some redundant capacities, the F-type firm hires additional capacities. The D-type firm in this particular case utilizes just all the original capacities. Investments in restructuring correspond to the output level ordering. Combining and rearranging the necessary conditions in order for this case to exist, we reached Condition 4.

**Note:** A necessary condition for Proposition 3 to hold is **Condition 4:**

$$p_0 - wl_0 - \frac{4 - w^2 l_G^2}{2} M_0 < \rho_r < \rho_F < p_0 - wl_0 - \frac{4 - w^2 l_D^2}{2} M_0$$

Although the adopted framework is very simple, the model allows us to analyze the employment implications. By the choice of output and restructuring investment, the firm chooses indirectly the number of job positions. The amount of labor ( $L_0$ ) demanded by the firm before restructuring was  $L_0 = l_0 M_0$ . After restructuring it changes to:

$$L_i^* = (l_0 - l_i R_i^{*1/2}) Q_i^* = (l_0 - \frac{wl_i^2}{2} Q_i^*) Q_i^*$$

From the above equation it follows that employment increases with optimum output only in a certain range of parameters. Namely, employment rises with output only if **Condition 5:**  $Q_i^* < l_0/(wl_i^2)$ .<sup>7</sup> We restrict ourselves to this reasonable condition.

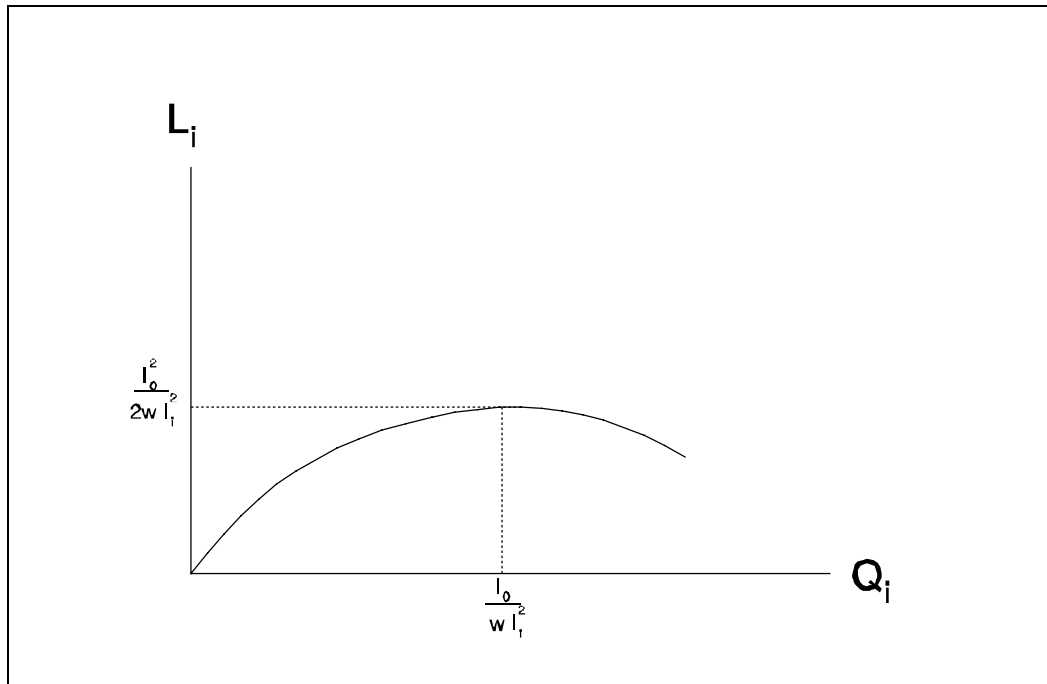
Interestingly, the model allows for the increase of employment after privatization and restructuring. The intuitive background for this case is that the negative effect of restructuring investment on employment is dominated by the need of additional employees for production of rather higher output.

Under Condition 5, the demanded labor after privatization can exceed employment before privatization only if **Condition 6:**  $M_0 < l_0^2/(2wl_i^2)$ . A graphical explanation is provided by *Figure 3*. If both conditions hold, the initial employment  $L_0$  lies below the horizontal line  $L_i = l_0^2/(2wl_i^2)$  and the optimal output below the vertical line  $Q_i = l_0/(wl_i^2)$ . Additional labor is hired if both conditions hold and output after privatization exceeds  $M_0$ .

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<sup>7</sup> Since there is a value of output which maximizes employment ( $\max(L_i^*) = l_0^2/(wl_i^2)$ ) which is reached for  $Q_i^* = l_0/(wl_i^2)$ , Condition 5 says that the optimum output should be below the employment maximizing output.

**Figure 3:** Output-labor dependence under optimal restructuring investment.



Notation:  $L_i$  - optimum labor demand,  $Q_i$  optimum output,  $i$  - refers to F, D and G-type firms.

**Proposition 4:** There exist such parameters that  $Q_F^* > Q_D^* = M_0^* > Q_G^*$  and  $L_0 = L_F^*$ .

In Proposition 4 the interesting case from Proposition 3 is extended by an additional requirement on the employment impacts of privatization. The F-type firm produces and restructures most, maintains the employment level and hires some new capacities. The D-type firm keeps the original capacity and produces on the original output level, and the G-type firm produces and restructures less than others and reduces capacities.

### 3. Empirical Evaluation of the Model

In this section we test the model implications on the data. For this purpose we utilize interesting data collected within the ACE project "Obstacles to Restructuring in Eastern Europe,"<sup>8</sup> which consists of 257 Czech firms with 25 or more employees operating in manufacturing. Information was gathered with the aid of questionnaires, which were mailed to more than one thousand firms.

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<sup>8</sup> For a more detailed description of the sample, evaluation of its representativeness and descriptive data analysis see Katsoulacos, Laštovička and Zemplerová (1994).

Addresses were randomly selected using more than three thousand manufacturing firms registered at the Czech Statistical Office. The respondents were allowed to reply anonymously.

The questions were related to the firms' past performance, the environment and the position on the market, barriers of growth, the firms' identification (industry, legal form, ownership structure, method of privatization) and the outlook for the future. Although it records the basic "hard" data (profits, investment, sales, debts, employees, and so forth) particular emphasis was on the "soft" data - the ideas, feelings and judgements of managers.

Unfortunately, the evidence does not include identical firms privatized by the three privatization methods. We cannot exclude the possibility of a biased selection of privatization methods - the reflection of a firm's potential in the choice of privatization method. It is very likely that firms with good perspectives were attractive to direct investors, while others were left to be privatized by give-away methods.

Additionally, we have no exact evidence of the firms' restructuring investment in the sense of the model. We discard data regarding investment, but not data concerning investment in the reduction of unit output requirements.

An indirect way of measuring restructuring is presented in Green and Price (1993). They believe in the efficiency of capital markets. The restructuring, in their sense, is any firm's activity leading to the significant growth of the market value of the firm, therefore directly observable on the stock market.

Despite general problems with the efficiency of capital markets, we criticize Green's and Price's approach from a different angle. Restructuring increases uncertainty of the firm's future development. It can lead to better perspectives and also the costs of restructuring could not be covered by improvements in a firm's position. Risk aversion exists even in the efficient markets. The market value of a firm could decrease only because of a risk accompanying its restructuring.

Since the capital market in the Czech Republic was only recently established, it is very volatile and thus inefficient.<sup>9</sup> Additionally, the impossibility of the application of their approach is caused by the fact that only firms privatized in the first wave of voucher privatization are tradable on the stock market. These firms are a minor part of our respondents.

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<sup>9</sup> For analysis of the Czech capital market see Laštovička (1994).

Another approach is adopted in Laštovička, Marcinčin and Zemplerová (1994). Utilizing the same data used here, they define exactly what they understand by restructuring. They measure it according to several attributes indicated in the data, and they analyze a dependence of restructuring (in their sense) on three sets of characteristics: the firm's size, dominant owner and industry. In the paper they also refer to whole group of analyses made on the data. Some of their results can be used as very indirect evidence for and against our model.

They conclude that foreign ownership is not a strong characteristic of firms' performance. In other words, foreign ownership does not greatly distinguish firms in their behavior. Although this does not correspond to our model, empirical results coincide better with the model's suggestions about G-type and D-type firms. One of their conclusions is that the D-type firm's main characteristic is more intensive organizational change than for the other privatization methods.

Since the investment in organizational structure aims to achieve better organization of work, some working force is saved. This means that more intensive organizational changes can be viewed as a higher investment in the reduction of unit labor requirements in D-type firms with respect to G-type firms. On the other hand, one of the main characteristics of G-type firm is the rapid fall of output. The data supports the implication of our model; G-type firms are the most likely to reduce output.

Looking for more direct testing of the model, we realized that the first order condition for the restructuring investment can be tested. Once we logarithmize it, we translate the equation to relative measures, which excludes some problems of different starting conditions of particular firms. The logarithmized first order condition has the following form:

$$\frac{1}{2}\log R_i = -\log \frac{1}{4} + 2\log w + 2\log l_i + \log Q_i$$

The data includes wages and outputs in 1993. However, the labor market is not explicitly introduced into the model and wages are assumed to remain sticky, irrespective of the type of firm.<sup>10</sup> Thus wages enter into the constant term for estimation purposes. A tricky approach should be used for the incorporation of  $l_i$ . The value of the efficiency of restructuring investment is unknown, but, the model says, it differs according to the type of firm. Since we dispose with the information about privatization methods and ownership structures of firms, we

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<sup>10</sup> The assumption of constant wages is examined at the end of this section.

can identify their type (F, D or G).

The F-type firms are defined as those of which foreign investors own more than 50% of the equity. The D-type firms are such with more than 50% dominance of either managers (management buy-outs), or direct domestic investors (including restitutes). We understand the G-type firms to be those dominated by either by individual investors from voucher privatization or voucher privatization funds, or employees.<sup>11</sup>

Introducing dummies for the type of firm into the regression, we would estimate the values of  $l_i$  separately for  $i = F, D$  and  $G$ . Unfortunately, there is a so-called "dummy variables trap."<sup>12</sup> In other words, we cannot estimate the constant term under the full list of dummies. Such a specification would lead to perfect multicollinearity. We should either drop the constant term or take one of dummies as the reference point for others. Both approaches enable us to test directly the model assumptions  $l_F = l_D > l_G$ , despite the impossibility to estimate the values of  $l_F$ ,  $l_D$  and  $l_G$ .

As we already mentioned, we have no direct information about the investment in the reduction of the unit labor requirements. But we dispose with several indicators of restructuring investment, which are heavily correlated with it. First, we know the total investment made within the years 1991 and 1993. Second, we know the productivity of labor separately for the years 1991 and 1993. We assume that in 1991 firms had not yet undergone restructuring and that in 1993 they operated fully on their respective optimal levels.<sup>13</sup> Reasonable measure of the change in unit labor requirements is therefore the change in productivity of labor.

Finally, we know several indicators of restructuring which have the dummy character. Respondents were asked whether they improved firm's organization structure, organization of production and training activities. These three items again refer to the intensity of restructuring in the sense of the model.

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<sup>11</sup> Firms with more than 50% of equity in hand of employees are practically only transformed cooperatives. Employees were given the ownership according to several criteria with a major role in the number of years employed in a cooperative.

<sup>12</sup> See Greene (1993) or other standard econometrics textbooks.

<sup>13</sup> Without the questionable assumption of the already finished transformation of firms in 1993, we would not be able to test anything. Since the common view is that the micro transformation is just beginning and that a lot remains to be done in the future, we in fact test whether the real changes in Czech firms follow the directions proposed by the model.

The appropriate method of estimation in this case is the instrumental variable

To conclude, the estimation of the first order condition for restructuring investment supports the model assumption  $l_G < l_D = l_F$ . However, the support is not strong enough to exclude the possibility of no impact of the firm's type on the efficiency of restructuring investment.

Another result of the model could be directly tested - the expression for labor demand after restructuring. Dividing both sides by  $Q_i$  we reach:

$$\frac{L_i}{Q_i} = l_0 - \frac{wl_i^2}{2}Q_i$$

Since we dispose with the data concerning employment and outputs, the unknown parameters are only  $l_0$  and  $l_i$  for  $i = F, D$  and  $G$ . Using the same trick as in the previous estimation, we estimate parameters of equilibrium labor demand in the form:

$$\frac{L}{Q} = C - \beta_1 * F * Q - \beta_2 * D * Q + \varepsilon$$

where  $L$  stands for the number of employees in 1993 and the rest of the notation is the same as in the previous test. The estimated constant  $C$  incorporates the effects of  $l_0$  and the  $G$ -type firm specific effect. The  $G$ -type firm is again taken as the reference point.  $\beta_1$  and  $\beta_2$  stands for the relative effects of  $F$ - and  $D$ -types with respect to the  $G$ -type. There is no need for a complicated method of estimation, thus we use the standard OLS.

Before running the estimation we again checked for high correlations between explanatory variables. Because only one of them could be activated (a firm is only of one type), the correlation is negative and very low. Even the correlations between the type of firm and  $Q$  are not too great.<sup>18</sup>

However, the model has a very low explanatory power in this form. The adjusted R-squared is only 0.037, suggesting some problems of the model (for basic statistics see Table 2, Appendix 2). This is obviously oversimplified - some explanatory variables are omitted. In other words, the inverse labor productivity ( $L/Q$ ) cannot be explained only by the firm's type and output. Moreover, no adjustment is made for the different starting conditions of firms.

Once again, we are in difficulty with not having in the data identical firms before privatization as the model assumes. The estimation should be adjusted by

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<sup>18</sup> The highest in absolute value is the correlation between  $D$  and  $Q$ , which is -0.207.



characteristics of the different starting conditions. But what are the relevant initial characteristics of a firm influencing productivity? One immediately comes to mind - industry. It is well known that the productivity (consequently L/Q) varies a lot over industries. We hope that the introduction of industrial dummies captures the most important differences between the starting conditions of firms.

There is a technical problem with the incorporation of industrial dummies. We register altogether 14 industries. Incorporating such a large number of additional explanatory variables under only 150 valid observations would lead to a significant loss of degrees of freedom. This is also the reason why we cannot use the whole group of indicators of initial differences between firms featuring in our data.<sup>19</sup> The selection of a lower number of "important" industries is necessary.

For the selection of industries with higher or lower labor productivity we use outside information. We arrange industries according to productivity of labor in 1991 computed on the basis of information provided by the Czech Statistical Office. Then we select three industries with the highest L/Q and three industries with the lowest L/Q and incorporate them into the estimation equation.<sup>20</sup>

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<sup>19</sup> In the data, we dispose with the following information about the starting conditions of firms: on which markets they operated (6 territorial dummies), the biggest problems they faced (13 dummies), the most important directions of investment (6 dummies), the various measures of the initial size of a firm (equity, sales, employees workers in 1991), the share of exports on sales in 1991, etc. The reader may ask why we use just industries, not one particular characteristic or another. It is a matter of choice. We believe that the industries capture the comprehensive information about the starting conditions.

An alternative approach to the selection of particular variables is to apply some summarization method like, for instance, principal components. However, there are always problems with a clear interpretation of summarized variables. For reference see Hanousek, Laštovička (1995).

<sup>20</sup> Although the Statistical Yearbook does not contain information about production in 1991 in the necessary industrial grouping, it does provide data about the number of employees and the share of industries in the total manufacturing production. Thus instead of computing L/Q as the number of employees producing a given unit of output, we compute the number of employees in 1991 over the share of industry in the total manufacturing production in 1991. The number of employees producing 1% of manufacturing production for respective industries is as follows:

FOOD 6.6	TEXTILE 31.2	LEATHER 28.3	WOODEN G. 21.5	PAPER 13.8	CHEMICALS 11.9
PLASTICS 17.5	CERAMICS 27.6	METAL 11.2	MACHINERY 24.2	EL. DEVIC. 24.3	TRANSPORT 16.4

The two remaining industrial groups are fuel production, for which we have no firm in our subsample, and the remaining, unlisted manufacturing production.

The six selected industries are: food processing (FOOD), textile and clothing (TEXTILE), production of leather goods (LEATHER), chemicals and fibres (CHEMICALS), ceramic products (CERAMICS) and metal tools and products (METAL). We introduce them into the estimation equation with the parameters  $\gamma_1$  to  $\gamma_6$ , respectively. For results of the estimation see Table 3 in Appendix 2.

By allowing for industry-specific effects, the explanatory power of regression rises to values acceptable for the micro data (adjusted R-squared = 0.14). We now test again the theoretical assumption  $l_G < l_D = l_F$ .

Looking to the estimated values of  $\beta_1$  and  $\beta_2$  we observe that they deviate from the G-type in the right direction (suggesting  $l_G < l_D$  and  $l_G < l_F$ ). The equality  $l_D = l_F$  we test as the equality of parameters  $\beta_1$  and  $\beta_2$ . The test shows that the hypothesis cannot be rejected even on the 10% significance level.<sup>21</sup> On the other hand, the hypothesis of the equality of all three parameters of restructuring efficiency can be rejected even on the 5% significance level.<sup>22</sup> There is no empirical evidence against the assumption  $l_G < l_D = l_F$  arising from the analysis of labor demand.

Finally, we provide the test of one of the basic assumptions we have used up to now - the independence of wages on the type of firm. We regress wages in 1993 to the three dummies F, D and G, omitting the constant term to avoid the "dummy variable trap". Then we test the joint equality of parameters. Unfortunately, we should fully reject the hypothesis that wages do not depend on the firm's type.<sup>23</sup>

Although the previous test might be considered as direct empirical evidence against the theoretical model, there are possible alternative explanations. The differences in post-privatization wage rates might not be a product of the method of privatization, but a consequence of the position of firms before privatization, biased selection of privatization method or some other firm's characteristic, such as its location.

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<sup>21</sup> Wald test for the hypothesis that  $\beta_1 = \beta_2$ :  
CHI-SQUARED = 2.1787604 WITH 1 DEGREE OF FREEDOM P-VALUE = 0.13992717.

<sup>22</sup> Wald test for the hypothesis that  $\beta_1 = \beta_2 = 0$ :  
CHI-SQUARED = 6.6051624 WITH 2 DEGREES OF FREEDOM P-VALUE = 0.03678808.

<sup>23</sup> First we estimate by OLS the following equation:  $w = a_1 * F + a_2 * D + a_3 * G + \epsilon$ . The Wald test for the hypothesis that  $a_1 = a_2 = a_3$ :  
CHI-SQUARED = 21.918090 WITH 2 DEGREES OF FREEDOM P-VALUE = 0.00000000.

In order to exclude the possible initial differentiation of wages, we regress not the wage in 1993, but the change of wages between 1991 and 1993 on the three dummies of the type of firms. The same test as in the previous case now has a different meaning. We do not ask whether wages depend on the firm's type, but if they adjust according to the type. Testing for the equality of parameters of all three types shows that on the 5% significance level we again reject the hypothesis.<sup>24</sup> Thus we conclude that the empirical evidence of wage rates contradicts the theoretical assumption of sticky wages.

## 4. Conclusions

Although the applied methodology is very simple, we have found several interesting theoretical and empirical results. We succeeded in introducing restructuring decisions into the firm's objective functions. The restructuring in our particular sense as a reduction of labor needed for the production of one unit of output may serve for the modelling of organizational changes, training activities, investment in working conditions and environment, or any other type of investment in "people."

Additionally, the model reflects the specific features of Eastern European transitional economies; namely, there are assumed capital and financial market imperfections in transforming countries. No doubt, it would be useless to analyze transition under the assumptions valid for well-functioning market economies. We believe the theory of transition should incorporate these important market imperfections.

The developed model aims to contribute to discussions concerning the advantages and disadvantages of particular methods of privatization. Despite obvious political and other advantages of voucher privatization (as the speed of widespread ownership change), it reflects the disadvantages arising from dispersed ownership. On the other hand, it shows the advantages of foreign investors implied by their presence on foreign developed financial markets.

Our simple model suggests that from the point of view of the firm and its restructuring, it is best to be owned by a foreign direct investor and worst to be owned by dispersed owners. Firms owned by direct domestic owners lie

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<sup>24</sup> First we estimate by OLS the following equation:  $dw = a_1 * F + a_2 * D + a_3 * G + \epsilon$ , where  $dw$  stands for wages in 1993 over wages in 1991. The Wald test for the hypothesis that  $a_1 = a_2 = a_3$ :

CHI-SQUARED = 8.7194353 WITH 2 DEGREES OF FREEDOM P-VALUE = 0.01278199.

somewhere in between. However, under special circumstances the differences between the behavior of firms owned by different types of owners might vanish.

Empirical evaluations are based on an interesting data sample of Czech firms. The data confirms the theoretical result of the dependence of restructuring investment and output on the privatization method applied to a firm. Empirical evidence also supports the theoretical relationship between labor demand, output and the method of privatization. There is no evidence against the assumption of lower efficiency of restructuring in firms privatized by give-aways.

Since the model does not explicitly capture the labor market, wages are assumed not to depend on the method of privatization. This assumption contradicts the empirical evidence. The model is oversimplified in this respect. However, the overall empirical evaluation is quite satisfactory, considering the fact that the model touches new problems in recently developing economics of transition.

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## APPENDIX 1

**Proof of Proposition 1:** Redundant capacities exist if  $Q_i^* < M_0$ . In this interval the single difference between optimal quantities is included in  $l_G < l_F = l_D$ . This leads directly to the inequality of optimal outputs in the proposition. The proof for optimal restructuring investments is analogical.

**Proof of Proposition 2:** New capacities are hired if  $Q_i^* > M_0$ . In this interval, the difference between optimal quantities is caused both by  $l_G < l_F = l_D$  and  $\rho_F < \rho_D = \rho_G$ . This leads to the inequality in the proposition. The proof for optimal restructuring investments is analogical.

**Proof of Proposition 3:** Because Proposition 3 is the statement of existence, it is enough to present such parameters under which it holds. Such parameters are presented in the proof of Proposition 4.

**Proof of Proposition 4:** Here are such parameters (numerical example):  $w = 2$ ,  $l_0 = 100$ ,  $l_F = l_D = 1/2^{1/2}$ ,  $l_G = 1/4^{1/2}$ ,  $M_0 = 30$ ,  $p_0 = 270$ ,  $\rho_F = 28$ ,  $\rho_D = \rho_G = 42$ ,  $\rho_F = 33.2455$ . Optimization under these parameters results in

$$\begin{array}{lll} Q_F^* = 36.7545 & Q_D^* = 30 = M_0 & Q_G^* = 28 \\ R_F^* = 675.4437 & R_D^* = 450 & R_G^* = 196 \\ L_F^* = 3000 = L_0 & L_D^* = 2550 & L_G^* = 2604 \end{array}$$

**Note:** These values of parameters satisfy all conditions from Condition 1 to Condition 5.

## APPENDIX 2

**Table 1:** Estimation results of rearranged logarithmized first order condition for the restructuring investment.

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TWO STAGE LEAST SQUARES

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Dependent variable:  $\log(Q)$   
 Instruments:  $C \log(\Delta P)$  OS OP TA F D  
 Explanatory variables:  $\log(R)$  F D

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Parameter	Estimate	Standard error	t-statistic
C	9.51633	.447668	21.2575
$\alpha_1$	.801064	.138435	5.78657
$\alpha_2$	.291453	.339125	.859425
$\alpha_3$	.035218	.274802	.128158

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R-squared = .735780  
 Adjusted R-squared = .727932

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**Table 2:** Estimation of rearranged labor demand equation in simple form.

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ORDINARY LEAST SQUARES

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Dependent variable: L/Q  
Explanatory variables: F\*Q D\*Q

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Parameter	Estimate	Standard error	t-statistic
C	.300174E-02	.185411E-03	16.1897
$\beta_1$	.877303E-09	.432714E-09	2.02744
$\beta_2$	.457275E-08	.220342E-08	2.07530

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R-squared = .050103  
Adjusted R-squared = .037267

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**Table 3:** Estimation of rearranged labor demand equation in simple form.

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ORDINARY LEAST SQUARES

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Dependent variable: L/Q  
Explanatory variables: F\*Q D\*Q FOOD TEXTILE LEATHER CHEMICAL  
CERAMICS METAL

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Parameter	Estimate	Standard error	t-statistic
C	.293499E-02	.235816E-03	12.4461
$\beta_1$	.822345E-09	.414361E-09	1.98461
$\beta_2$	.467145E-08	.260885E-08	1.79061
$\gamma_1$	-.882993E-03	.605291E-03	-1.45879
$\gamma_2$	.211467E-02	.587213E-03	3.60119
$\gamma_3$	.236411E-02	.140017E-02	1.68844
$\gamma_4$	-.105870E-02	.914136E-03	-1.15814
$\gamma_5$	-.418968E-03	.632487E-03	-.662414
$\gamma_6$	-.137908E-03	.436397E-03	-.316015

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R-squared = .185832  
Adjusted R-squared = .139638

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