INTERNATIONAL POLICY CENTER
Gerald R. Ford School of Public Policy
University of Michigan

IPC Working Paper Series Number 27

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May 2006

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First verions: May 2006

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Key Words: transition, R&D investment, firms in transition, employee ownership and control, institutions, openness

Prašnikar's and Domadenik's research on this paper was in part supported by the Slovenian Ministry of Science and Technology grant no. 3411-97-25-7863 and by Phare ACE grant no. P97-8172-R. Svejnar's research was in part supported by NSF grant no. SES 0111783 and NCEER contract no. 812-32. The authors are indebted to numerous Slovenian enterprises for providing them with the data used in this paper. The usual caveat applies.

Abstract:

Paper addresses the recent initiatives of EU Lisbon Agenda to increase level of R&D expenses in EU Member States by studying firm-level panel data in most advanced transition economy, Slovenia. Previous empirical literature - mainly cross-sectional - has tested the demand-pull hypothesis and found in overall that R&D expenses may be driven by output. Using a panel of over 150 Slovene firms over the 1996-2000 period, and checking for fixed effects, time, industrial and size dummies and for the path-dependent nature of R&D, we also find a significant role of sales in inducing R&D expenditures. Besides that data also confirm that internal funds and (un)successful bargaining for higher wages present significant variables for higher R&D expenses. However, at the micro level, the demand-pull, internal funds and bargaining effects play a varying role for the different sub-samples of firms. In particular, exporting firms, those which are liquidity-constrained, those not receiving public subsidies and those not heading a business group, seem to be particularly sensitive in deciding their R&D expenditures. R&D behavior at the firm level is modeled as error-correction model and estimated in system GMM specification.

JEL: C33, D01, L2, 031, P2,

1. Introduction

"We need more research and development, with more efficiency and better coordination. We need to work together on the European scale to ensure that research is translated into innovative products and services, which feeds into growth and jobs," the head of EU Commission J.M.Barroso said when the annual progress report (2006) on "Growth and Jobs" strategy was published. This is likely different language that European politicians use in the present time compare to well known Lisbon strategy (2000) with its popular phrase of Europe becoming the most competitive economy by 2010. However, the new language doesn't diminish the very fact on smaller R&D expenditures of most European countries compare to USA and Japan. Although some European countries achieved a much higher share of R&D expenditure in GDP (Finland 3.48%, Sweden 3.86% in 2005) than the USA (2.67% in 2004) and Japan (3.2% in 2003), the EU-25 average in 2005 was 1.85%.

Transition countries are due to the historical reasons even much more behind. Being among the most developed transition countries, and one of the most prepared to carry out the Lisbon goals (Murray, Wanlin, 2005), Slovenia declared a goal to increase public R&D expenditure from the current 0.55% to 1% of GDP by 2008 and private expenditure from the current 0.90% to 2% of GDP by 2010.[1] This is quite an ambitious goal, especially when we look on private sector increase. Since other countries set similar goals, in this paper we intend to show the mechanisms behind the processes of R&D accumulation in the private sector and feasibility of such goals.

Our study is of interest for four principal reasons. First, we provide empirical evidence on R&D activity at the firm level in transition economy in the sound analytical framework. Second, our study examines systematically the effect on R&D-related performance of different types of privatization and subsequent ownership, an issue that has not received any

[1] This is in accordance with the Barcelona meeting (March 2002) on the implementation of Lisbon strategy,.

attention in the literature so far. Third, we analyze the effect of specific institutional structure, characterized by employee representation on the Supervisory Boards of firms and underdeveloped financial markets, and provide a test of its effects on R&D expenses.[2] Finally, we are able to assess whether a firm's exposure to foreign versus only domestic markets affects its R&D investment. If the barriers between domestic and export markets are low, the relationship between export orientation and R&D performance should be weak or nonexistent because both types of firms are exposed to world competition. The transition economy context hence provides a fruitful setting in which to examine the hypothesis that countries that expose their firms to world competition induce similar economic behavior on all firms, irrespective of their structural and institutional differences.

Our results indicate that firms plan R&D activities in the strategic (long-term) nature, while short run effects are almost non existing. Long run elasticity of R&D investment was found to be significant with respect to current sale (accelerator effect) and cash flow. Accelerator effect proves that firms treat future profits as motives for R&D expenditures. Cash-flow effect is smaller but significant, indicating that Slovene firms finance the prevalent part of R&D expenditures from retained profits and past accumulation. Capital markets are of minor importance in providing finance resources for R&D activities. Finally, the bargaining hypothesis was confirmed on the long run indicating the existence of trade-off between R&D investment and higher wages. Firms oriented more on domestic than foreign markets invest the same and the method of privatization or supervisory board structure also doesn't have any effect on subsequent R&D investment. Surprisingly, firms with higher proportion of insider owners invest significantly more in R&D activities. On the base of our research we conclude that in present institutional environment in Slovenia it is not likely to expect a substantial increase of R&D expenditures in the private sector of the economy.

[2] Both are important institutional features of a number of new twelve countries in the European Union (EU).

The paper is organized as follows. In Section 2 we present the theoretical framework of firm level R&D investment, the corresponding estimating equations and institutional setting of Slovene economy, while in Section 3 we describe the data and variables that we use. In the fourth section we present the methodology, followed by the section five where the results of our empirical tests are outlined. In Section 6 we draw our conclusions.

2. Theoretical and institutional settings

R&D activities in firms in transition economies are usually studies within the context of restructuring they faced after break down of old regime. (See, for example, Grosfeld and Roland (1997), Aghion, Blanchard and Carlin (1997) and Frydman, Gray, Hessel, and Rapaczynski (1999).) The importance of investment in fixed capital has been documented in the business and economics literatures. The literature on investment in soft capital, such as R&D, is more recent but equally important. In the conceptual framework R&D expenses are included in the framework of the production function if output is a homothetic function of physical capital and technology acquired through R&D (Mairesse, Sassenou, 1991) and one may replace output by sales revenue in the production function since part of R&D expenses represents the development of new products (Griliches, 1986). In order to capture these aspects of strategic restructuring empirically, we estimate an investment equation that incorporates firm's output demand (demand side), internal funds (supply side) and the bargaining about -- tradeoff between -- investment and wages (Fazzari et al., 1988, and Prasnikar and Svejnar, 2000). We first outline the theoretical framework that underlies our estimating equations.

2.1. Theoretical setting and estimating equations

Following the neoclassical model of static factor demand, the long-run desired level of the knowledge stock is specified as a log-linear function of output and the user cost of capital.

Letting g_t denote the natural log of the desired knowledge stock in period t, y_t denote the log of output and j_t denote the log of the user cost of capital, yields:

$$g_t = \alpha + y_t - \sigma j_t \tag{1}$$

In the absence of any adjustment costs or barriers to immediate adjustment, this would be the optimal quantity of R&D capital for a profit maximizing firm with constant returns to scale CES production function. This formulation nests the possibility of a fixed capital-output ratio ($\sigma = 0$) and a Cobb-Douglas production function ($\sigma = 1$). However, it is not realistic to assume that the employer's expectations about future factor and product prices are static. In reality it makes sense to assume that the best employers can do is to take account of the amount of product factors currently employed and the likely future path of demand for products they produce. As the adjustment process may be complex, the usual way to proceed is to nest expression (1) within a general autoregressive-distributed lag (ADL) dynamic regression model, and use a "general-to-specific" specification search to let the data determine the relevant dynamics within our samples.

If we assume that adjustment process follows second-degree auto-regressive distributed lag process, the specification can be rewritten as follows:

$$g_t = \alpha_0 + \alpha_1 g_{t-1} + \alpha_2 g_{t-2} + \alpha_3 y_t + \alpha_4 y_{t-1} + \alpha_5 y_{t-2} + \alpha_6 j_t + \alpha_7 j_{t-1} + \alpha_8 j_{t-2} \tag{2}$$

and re-parameterize the model in an error correction form:

$$\Delta g_t = \alpha_0 + (\alpha_1 - 1)\Delta g_{t-1} + \alpha_3 \Delta y_t + (\alpha_3 + \alpha_4)\Delta y_{t-1} + \alpha_6 \Delta j_t + (\alpha_6 + \alpha_7)\Delta j_{t-1} +$$

$$-(1-\alpha_1-\alpha_2)(g-y)_{t-2} + (\alpha_3 + \alpha_4 + \alpha_5 - (1-\alpha_1-\alpha_2))y_{t-2} + (\alpha_6 + \alpha_7 + \alpha_8) j_{t-2} + \varepsilon_t \tag{2'}$$

The main challenge in estimating R&D investment models is to estimate the value of intangibles that the firm is using in the production process. The error correction model avoids this problem because it does not require knowing the stock of soft capital. Following Hall

(1992), Bond et al. (2003) and Bond and Van Reenen (2002) for the case of R&D expenses, we assume that for a firm in a steady state the current level of R&D capital stock (G_t) is given by

$$G_t = (1+\upsilon)G_{t-1}, \tag{3}$$

where υ represents growth rate of R&D capital stock. Correspondingly, expenditures in R&D are given by

$$R\&D_t = (\delta+\upsilon)G_{t-1} = \left(\frac{\delta+\upsilon}{1+\upsilon}\right)G_t \tag{4}$$

or

$$r_t = \ln\left(\frac{\delta+\upsilon}{1+\upsilon}\right) + g_t \tag{5}$$

where r_t is the log of R&D capital expenditures, g_t is the log of R&D capital stock and δ is the firm-specific depreciation rate. If this steady state approximation is reasonable, unobservable g_t can be replaced in equation (2') by the observed r_t, incorporate the first term of (5) by a firm-specific intercept and assuming that the variation in the user cost of capital can be captured by additive year-specific (μ_t) and firm-specific (η_i) effects (Bond, Harhoff, Van Reenen, 2003), yielding[3]:

$$\left(\frac{R\&D_{it}}{G_{i,t-1}}\right) = \rho_0 + \rho_1\left(\frac{R\&D_{i,t-1}}{G_{i,t-2}}\right) + \rho_2\Delta y_{it} + \rho_3\Delta y_{i,t-1} + \rho_4(g-y)_{i,t-2} + \rho_5 y_{i,t-2} + \eta_i + \varepsilon_{it}, \tag{6}$$

where $\rho_1 = \alpha_1 - 1$, $\rho_2 = \alpha_3$, $\rho_3 = \alpha_3 + \alpha_4$, $\rho_4 = -(1-\alpha_1-\alpha_2)$ and $\rho_5 = (\alpha_3+\alpha_4+\alpha_5-(1-\alpha_1-\alpha_2))$.

[3] From capital accumulation constraint $R\&D_t = G_t - (1-\delta)G_{t-1}$ follows

$$\left(\frac{R\&D_t}{G_{t-1}}\right) - \delta = \frac{G_t - G_{t-1}}{G_{t-1}} \approx \Delta g_t, \tag{3'}$$

where δ is the firm-specific depreciation rate.

Equation (6) requires that $\rho_4 < 0$ to be consistent with error correcting behavior implying that R&D capital stock above its desired level is associated with lower future R&D investment.

Equation (6) implicitly assumes that the firm operates in a perfect capital market in that it may obtain as much external capital as it wants at the same rate as that at which it can lend its internal funds. However, the underdeveloped nature of the capital markets in the transition economies and the existence of informational asymmetries between banks and firms suggest that firms may face constraints on external financing (Meyendorff and Thakor, 2002). If this is the case, the amount of any given firm's investment will vary positively with the amount of funds that it can generate internally.[4] It is customary to test for this phenomenon by augmenting equation (6) with a proxy for these internal funds, such as profits (e.g., Lizal and Svejnar, 2002, Domadenik, Prasnikar, Svejnar, 2003).

Moreover, it is also important to assess the extent to which employee ownership and/or control affect the firm's investment. The literature on participatory and labor-managed firms has for a long time debated the existence and seriousness of the so called "under-investment problem," allegedly brought about by the short (less than infinite) time horizon of individual workers in these firms. The basic argument is that worker-insiders, unlike diversified capital owners (outsiders), prefer to distribute enterprise surplus as current labor income and fringe benefits rather than reinvesting it in the firm for future growth (e.g., Furubotn and Pejovich, 1970, and Vanek, 1970). More recently, Blanchard and Aghion (1995) have followed this thesis by arguing in the transition context that insider-dominated firms may not generate resources needed for restructuring activities such as R&D investment.[5] We hence use

[4] An alternative interpretation of the case when the firm's level of investment varies positively with internal funds – one that is consistent with perfectly functioning capital markets -- is that the firms can borrow investment funds at a constant market rate but that this rate exceeds the rate at which the firms can lend because of transaction costs (e.g., Fazzari et al. (1988), Kaplan and Zingales (1997) and Almeida and Campello (2002)).

[5] In the context of the transition to a market economy, the investment-wage issue is especially important. The lifting of central controls and insider privatization gave workers significant powers in enterprises in countries such as

explanatory variables that permit us to assess the extent to which (a) there is bargaining over the internally generated funds that the firm could use for investment versus expenditures on wages, salaries and bonus payments and (b) employee ownership and/or control affect negatively the firm's investment.

To tackle the issue of bargaining, we follow the method used by Domadenik, Prasnikar and Svejnar, 2003, and let profit π to be defined as revenues Q minus labor costs WL and all non-labor costs H: $\pi = Q - WL - H$. Moreover, let W^a be the reservation (best alternative) wage and $WL - W^aL$ be the difference between the actual and reservation level of wage bill (labor cost).[6] The extent to which employee-insiders earn more than their reservation income ($WL - W^aL > 0$) reflects their ability to appropriate what would otherwise be the firm's surplus. $WL - W^aL$ is hence an outcome of bargaining over the firm's internally generated funds. Since we analyze strategic decisions over labor cost as well as soft capital investment in several areas, we include expenditures on research and development I_{RD}, expenditures on marketing I_M and expenditures on training I_T in the internal funds that are subject to bargaining.[7] The measure of internal funds that we use is therefore given by

$$\pi^a = \pi + (WL - W^aL) + (I_{RD}+I_M+I_T) = Q - W^aL - H + I_{RD}+I_M+I_T$$

We include π^a as a proxy for the internal funds variable in an augmented form of equation (6) and interpret the estimated coefficient on π^a as a measure of the extent to which firms with more internal funds invest more than others, *ceteris paribus*.

To answer the question, whether employee ownership and control have a negative effect on firm's investment, we include as explanatory variables EXTPRIV, OWNERFUNDS, OWNERPIFS, OWNERFIRMS, OWNEROTHER, and EXTBOARD, defined above.

Russia, Ukraine and some other newly independent states (NIS). Moreover, with the inability of many firms in these economies to pay wages, the tradeoff between using the firm's value added for financing investment versus paying wages and fringe benefits has become particularly acute.

[6] The reservation wage is defined as the wage below which employees would be unwilling to work in the firm. For its derivation look in Domadenik, Prasnikar, Svejnar, 2003.

[7] I.e., we capture the fact that employees may try to appropriate as income some funds that could otherwise be used for investment in R&D, marketing and training. We also implicitly assume that the reservation level of these expenditures is zero, which is not unrealistic in the context of the transition economies.

As in Bond, Harhoff and Van Reenen (2003), the corresponding empirical specification of an augmented error correction model for capital demand is:

$$\frac{R\&D_{it}}{G_{i,t-1}} = \rho_0 + \rho_1\left(\frac{R\&D_{i,t-1}}{G_{i,t-2}}\right) + \rho_2\Delta y_{it} + \rho_3\Delta y_{i,t-1} + \rho_4(r-y)_{i,t-2} + \rho_5 y_{i,t-2} +$$

$$+ \rho_6\left(\frac{C_{it}}{G_{i,t-1}}\right) + \rho_7{}^{R\&D}\left(\frac{C_{i,t-1}}{G_{i,t-2}}\right) + \rho_8{}^{R\&D}\left(\frac{C_{i,t-2}}{G_{i,t-3}}\right) + \rho_9{}^{R\&D}\left(\frac{(wL-w^aL)_{it}}{G_{i,t-1}}\right) +$$

$$+ \rho_{10}\left(\frac{(wL-w^aL)_{i,t-1}}{G_{i,t-2}}\right) + \rho_{11}\left(\frac{(wL-w^aL)_{i,t-2}}{g_{i,t-3}}\right) + \rho_{12}EXT_{it} + \rho_{13}OWNERFUNDS_{i,t-1} +$$

$$+ \rho_{14}OWNERPIFs_{i,t-1} + \rho_{15}OWNERFIRMS_{i,t-1} + \rho_{16}OWNEROTHER_{i,t-1} + \rho_{17}EXTBOARD_{i,t-1} +$$

$$+ \rho_{18}HOMEMKT_{it} + (\rho_{19})'INDUSTRY_i + (\rho_{20})'REGION_i + s_t + \alpha_i + \upsilon_{it} \qquad (7)^8$$

In equation (7), EXT is a dummy variable coded 1 if the firm was privatized primarily to external owners and 0 if it was privatized primarily to insiders (managers and workers). Variables *OWNERFUNDS*, *OWNERPIFS*, *OWNERFIRMS,* and *OWNEROTHER* measure the percentage of a given firm's shares that are owned by the state, privatization investment funds, other firms, and other (miscellaneous) owners, respectively. The miscellaneous owner category does not include the percentage of shares owned by insiders (workers, managers and retired workers) because this share of ownership is treated as the base, captured in the regression constant, against which the effects of other forms of ownership are being estimated. *EXTBOARD* measures the percentage of non-employee representatives on the Supervisory Board and *HOMEMKT* is the share of total sales going to the home (domestic)

[8] The long run properties of this specification can be calculated as $E_{R\&D/Y} = \rho_5/-\rho_1$, indicating long run elasticity of R&D investment with respect to sales; $E_{R\&D/C} = (\rho_6 + \rho_7)/(-\rho_1)$ for long run elasticity of R&D with respect to cash flow and $E_{R\&D/W} = (\rho_8 + \rho_9)/(-\rho_1)$ for long run elasticity of R&D with respect to excess wages.

market[9]. Finally, *INDUSTRY* and *REGION* are industry and region dummy variables that control for industry-specific and region-specific conditions, respectively, while s_t is an annual dummy variable that controls for macroeconomic shocks.

2.2. Institutional characteristics of Slovene economy in the nineties

During the 1990s, Slovenia has pursued a gradual transition approach, with the most important reforms being macro stabilization, liberalization of trade and increase of product market competition. Price stabilization was achieved through restrictive monetary and fiscal policies that brought down inflation from 21.5 percent per month in October 1991, when Slovenia launched its own currency, to an annual rate of 6-7 percent in the late 1990s. Slovenia also pursued a policy of managed flexible exchange rate and low import duties. This, together with an aggressive development of small and medium sized firms and government hardening of the budget constraints of the large socially-owned firms, has led to greater competition on the domestic market and improved competitive position on the western markets. Foreign capital has not played a significant part.

Compared to the aggressive pursuit of consistent macro policies, the government has placed relatively less emphasis on the development of efficient labor and capital markets. The financial system as a whole has remained underdeveloped and it represents a minute part of corporate financing, despite the extensive restructuring of banks and the founding of a stock exchange. Privatization of firms to insiders or outsiders took place in the early to mid 1990s, relying on a combination of voucher and manager-worker buy-out methods, and resulting in primarily insider (internal) or outsider (external) ownership.[10] The varying degrees of

[9] The inclusion of the variable capturing the share of firm's sales on the domestic market reflects the hypothesis that exporting firms that face greater competition and hence need to invest more than their domestically oriented counterparts in order to succeed in their restructuring activities.

[10] The 1992 Privatization Law allocated 20 percent of a firm's shares to insiders (workers), 20 percent to the Development Fund that auctioned shares to investment funds, 10 percent to the National Pension Fund, and 10 percent to the Restitution Fund. In addition, in each enterprise the workers' council or board of directors (if one

ownership of firms by investment privatization funds, state funds, other non-financial enterprises, employees, former employees, retirees, and other small shareholders makes Slovenia be an interesting laboratory for examining the effects of different forms of privatization and resulting patterns of ownership on restructuring and performance of firms.

A potentially important aspect of corporate governance is the German-style 1993 Law on Workers' Co-Determination that gives employees in companies with 500 to 1,000 (more than 1000) employees at least one-third (one-half) of seats on the Supervisory Boards of their firms. Since the Supervisory Board elects company management and also has other channels of influence, the employee-insiders potentially play an important role in the firms' decision making process (Prasnikar and Gregoric, 2002). The role of employees was eventually changed significantly with the new Law on Codetermination (2002). Employee influence is has also been reflected in collective bargaining, which has permitted wages to vary across firms and defied government attempts to reign in real wage growth.

3. Description of data and variables

The sample contains 1996-2000 annual data on 157 largest Slovenian firms that were privatized in the 1993-1995 period. We hence observe the firms in the immediate post-privatization period when they faced important decisions about investment in R&D. Most of these firms are registered as joint stock companies and in 2000 they generated 18 percent of total income and employed 9.8 percent of all employees among the firms registered in Slovenia. The data set is unique in that it provides information on a number of key variables, namely investment in R&D, marketing and training that are usually not available in balance sheets and income statements.

existed) was empowered to allocate the remaining 40 percent of company shares for sales to insiders (workers) or outsiders (through a public tender). Based on the decision on the allocation of this remaining 40 percent of shares, firms can be classified as being privatized to insiders (the internal method) or outsiders (the external method).

As may be seen from the summary statistics in Table 1, the variables display reasonable mean values and considerable variances. The average firm in the sample employs 558 workers, achieves a ratio of sales to tangible capital of 9.6 and sells 58 percent of the value of its products on the domestic market. Gross investment in fixed capital and marketing expenditures are each equivalent to about 15 percent of tangible capital, while investment in R&D and externally provided training equal to 6 and 1 percent of tangible capital, respectively. Sampled firms covered more than 90 percent of the total R&D expenses from internal funds, while the percentage of loans slightly decreased and funds provided by governmental institutions is showing weak but positive upward trend.[11] (See Table 2.) The majority of funds were spent on improvement of existing products and technologies (35.5 percent in 2000 and 34.3 percent in 1996) and introduction of new products (30.5 percent in 2000 and 32.6 percent in 1996). The share of basic research of new products and technologies exhibits downward trend indicating that firms are risk averse and spend their R&D funds on less risky projects. (See Table 3.)

Slightly more than one-half of the firms were privatized primarily to insiders, and the average share ownership is 31 percent by insiders, 34 percent by investment funds, 21 percent by other firms and 13 percent by other owners. Finally, the average share of non-employee representatives on the supervisory boards of firms is 51 percent, confirming that employees have a significant overrepresentation on these boards comparing to their ownership share.

The average intertemporal adjustments, not reported in a tabular form, include a decline in net employment of 4 and 2 percent in 1997 and 1998, respectively, followed by 1 and 3 percent increase in 1999 and 2000, respectively, a reduction in the relative differential between actual and reservation wages from 37 percent in 1996 to 32 percent in 2000, a 14.8

[11] Firms in manufacturing that report R&D activities in 1998 report that on average 92.7 percent of total R&D expenses was covered by internal funds, while the state contribution was 1.7%. The state contribution almost doubled in the period of 1996 till 1998 (increase by 90 percent) and amounted to 835 Mio tolars in 1998. (Statistical Yearbook of the Republic of Slovenia, 2001)

percent annual increase in the stock of R&D capital[12], a 5.2 percent annual increase in real sales per worker, and a 2 percent annual increase in labor costs. The average ownership share of insiders (employees, managers and retired employees) dropped significantly from 35 to 25.3 percent,[13] the share of investment funds from 37 to 31.2 percent,[14] and the share of others (small shareholders, state and banks) from 13.9 to 13.3 percent,[15] while the share of non-financial firms increased considerably from 13.7 to 30.3 percent in the 1996-2000 period. Investment in fixed capital relative to sales increased from 5.8 in 1996 to 7.9 percent in 2000. In contrast, investment in R&D relative to sales increased only by 0.88 percent points from 1.94 to 2.82 in the 1996-2000.

4. Methodology

By using micro-level panel data we are able to eliminate bias introduced by using aggregate investment data (Abel and Blanchard, 1986), reduce measurement error and take into account heterogeneity across firms and over time (e.g., Bond and Meghir, 1994). The most important problem in estimating equation (7) is the endogeneity of the contemporaneous right hand side variables with respect to current and past disturbances. Moreover, due to the

[12] We calculate the stock of intangible (knowledge) capital by using the permanent inventory method, originally proposed by Griliches (1979) for R&D capital. This method assumes that the current state of knowledge is the result of present and past expenditures in knowledge capital. In particular,

$G_{it}^{\ k} = (1-\delta^k)G_{it-1}^k + R_{it}^k$,

where R_{it} is the current level of soft capital spending, δ_i^k is the firm-specific rate at which the "knowledge" stock depreciates, while k denotes different forms of soft capital investments and G_{it} is the stock of knowledge capital. Substituting G_{it-1} by past expenditures on soft capital investment we obtain:

$G_{it}^{\ k} = R_{it}^k + (1-\delta^k)R_{it-1} + (1-\delta^k)^2 R_{it-2} + ...$ or $G_{it}^{\ k} = \sum_{\tau=0}^{\infty} 1-\delta^k)^{\tau} R_{it-\tau}$

Since our focus is on the sample of firms that underwent ownership transformation in the middle of the 1990s and were operating in a labor-management system before the process of transition that started in 1991, it make sense to assume that the process of investing started in 1992, with the initial level of knowledge capital being zero. As our data start in 1996, we assume that the value of investment in knowledge capital in each year is 5% smaller than in the following year. Finally, we assume a depreciation rate of 15%.

[13] The average share of employees fell from 23.5 to 16 percent, while the managers' share rose on average from 3 to 4 percent.

[14] Within this category, the average share of state funds declined from 23.4 to 13.2 percent, while the share of private investment funds increased from 13.6 to 18 percent.

[15] Within this category, the average share of small shareholders fell from 3.8 to 3 percent, whereas the average ownership shares of banks and state remained the same at 1.3 and 2 percent, respectively.

inclusion of lagged dependent variable as a regressor and its clear correlation with the error term, the estimation of the parameters of the model using Ordinary Least Squares (OLS) in levels will be inconsistent even if the errors are not serially correlated.

Since the work of Arellano and Bond (1991), the generalized method of moments (GMM) techniques has been widely used in the estimation of dynamic panel data models. However, subsequent estimation of the finite sample performance of the GMM estimator have shown that it is substantially biased. One source of the bias arises from "weak instruments problem" (Staiger and Stock, 1997), while the second source of the bias is the relative number of instruments to sample size - the so called "many instruments problem". Hahn and Hausman (2002), among others, have shown that the finite sample bias of 2SLS estimator is monotonically increasing in the number of instruments and leads to trade-off between the efficiency and the bias of the estimator. To overcome "weak instruments problem" Blundell and Bond (1998) proposed the system GMM estimator[16] that has been widely used in empirical studies since then. Hayakawa (2005) shows that although using more instruments than the first differencing and the level estimators, even in the case of fixed N and T, system GMM is less biased than both (the first differencing and the level) preceding GMM estimators.

Given the considerations above, we only present the system GMM estimates. We instrument Δy_{it}, π_t^a / G_{t-1} and $(wL - w^a L)_t / G_{t-1\,1}$ by using $y_{i,t-3}$, $y_{i,t-4}$, π_{t-3}^a / G_{t-4} and $(wL - w^a L)_{t-3} / G_{t-4}$ in the differenced equation, while Δy_{t-2}, Δy_{t-3}, $\Delta(\pi_t^a / G_{t-1})$,

[16] The system GMM estimator controls for the presence of unobserved firm-specific effects and for the endogeneity of the current-dated explanatory variables. It uses equations in first-differences, from which the firm-specific effects are eliminated by the transformation, and for which endogenous variables lagged two or more periods will be valid instruments provided there is no serial correlation in the time-varying component of the error terms. These differenced equations are combined with equations in levels, for which the instruments must be orthogonal to the firm-specific effects. Blundell and Bond (1998) show that in autoregressive-distributive lag models, first-differences of the series can be uncorrelated with the firm-specific effects provided that the series have stationary means. The validity of instruments is tested by using a Sargan test of over-identifying restrictions.

$\Delta(\pi^a_{t-1} / G_{t-2})$, $\Delta(\pi^a_{t-2} / G_{t-3})$, $\Delta(wL - w^a L)_t / G_{t-1}$, $\Delta(wL - w^a L)_{t-1} / G_{t-2}$ and $\Delta(wL - w^a L)_{t-2} / G_{t-3}$ were used as instruments in the levels equations.[17]

5. Empirical results

Looking at table 4 in appendix, error correction model of R&D investment fulfils all three underlying criteria: stability condition $|\rho_1| < 1$, error correction term being negative and long-run returns being constant. As IV estimation departs from all three underlying criteria (possibly due to its poor precision), we will focus only on System GMM results.

The error correction term is approximately equal to –0.221 indicating that a given output-capital gap is being closed via R&D investment at a rate of 22.1 percent per year[18]. Such high figure for adjustment of output-capital gap is probably a consequence of being in a transition period where firms had almost no R&D activities before 1994. Since data are showing high level of dependence from one year to another and I have relatively short time dimension of panel (5 years to estimate panel that includes two-year lags), the poor instruments resulted in very imprecise estimations with large standard errors.

The estimated regression coefficients indicate a strong accelerator effect of current sales particularly on the long run. Long run elasticity of R&D investment with respect to current sale was estimated at level 0.76 indicating that 1 percent sales growth in the long run induces 0.76 percent R&D investment growth. Cash-flow hypothesis is being confirmed by the result that a change in the availability of internal funds, for example, by 1 percent, led to increase in R&D investment by approximately 0.04 percent in the long run. However, the

[17] We are fortunate that our firm-level data come from two sources -- questionnaires that we administered to firms and the Slovenian Statistical Office. The questionnaire data relate to 1996-2000, but the Statistical Office data cover earlier years as well. We use the Statistical Office data for the lagged values of variables that we use as instruments and thus avoid the substantial loss of degrees of freedom that we would incur if we had to use 1996 data as instruments for 1997 values of variables.

[18] Hall et all, 2000, estimated the corresponding figure at a level of almost 14 percent for France and and 9 percent for US in the period of 1979-1993, while Bond et al, 1999, reports 16 percent for UK and 6.4 percent for Germany in the period of 1973-1993. All reported error correction terms are lower for R&D comparing to fixed capital investment.

effect is smaller than in the case of accelerator effect but statistically significant. Finally, the bargaining hypothesis was also confirmed on the long run indicating the existence of trade-off between R&D investment and higher wages. Firms where the average salaries exceeded the reservation level in a higher extent, ceteris paribus, invested less in the period under study.

The relevant studies on R&D investment in developed economies confirm very small or non-existent investment/cash flow sensitivity interpreting it as the fact that transitory cash flow movements are unlikely to have an important impact on a firm's R&D expenditures, which are largely committed someway in advance. (See Hall et al, 1999, Bond et al, 2003.) In the case of Slovenia, we can observe high dependence of R&D expenditures (high correlation between variables measuring R&D expenditures, percentage of cash flow, sales and excessive wages with respect to stock of R&D capital) that signals that those expenditures are planned on permanent basis. But, on the other hand, in the environment of underdeveloped financial system firms, where there are almost no possibilities to get finance for more risky R&D projects, face serious financing constraints. As reported by sample firms, they finance more than 90 percent of R&D activities from internal funds. (See table 2 for detailed description and representation by year).

Focusing on different subgroups of firms we find out that firms that had higher percentage of internal owners invest significantly more, *ceteris paribus*, comparing to those owned by other owners. The difference is the highest in the case of privatization investment funds (PIFs). The result is not surprising if we know that privatization investment funds enters in firms' ownership structure through different privatization channels in order to serve their clients with best possible dividends. Short run orientation of such practices drop R&D expenses. On other hand, we should be careful in promoting employees' ownership as being efficient for higher R&D investments. In the case of dispersed employees' ownership managers retain the control over the firms. Obviously, managers who bargain well for higher

R&D investments against excessive wages and dividends, display significant increase in R&D expenses. The latter is confirmed also by a positive but insignificant sign on external supervisory board members' composition usually being selected by managers. Interestingly, there are no statistically significant differences between firms that chose internal vs. external privatization method or between those earning more or less of their sales revenue on domestic market.

6. Conclusions

"We need more research and development, with more efficiency and better coordination. We need to work together on the European scale to ensure that research is translated into innovative products and services, which feeds into growth and jobs," the head of EU Commission J.M.Barroso said when the annual progress report (2006) on "Growth and Jobs" strategy was published. In the context of Lisbon strategy the presented paper deals with the topic that is in the centre of EU head officials. Moreover, as Slovenia being the most successful (former) transition economy usually presents the benchmark for late reformers the paper contributes to the literature on transition economies.

The study and data used in study confirms that transition economies lack funds that can be used for R&D activities. Underdeveloped financial system doesn't provide enough venture capital to support long-term R&D investments. Moreover, the model of collective bargaining at the state level and within particular firms are introducing bargaining over excessive cash flow desperately needed to finance R&D investments. Finally, the most worrisome fact is that firms either being privatized by state funds or privatization funds either being bought by other private investors, display significantly lower R&D activities comparing to firms that remained employees' owned. However, we should be aware that in the case of dispersed ownership managers gain the substantial control over the firms' operation. In the

context of R&D activities managerial ownership might provide an important growth inducing element.

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APPENDIX

TABLE 1: SUMMARY STATISTICS FOR VARIABLES USED IN ESTIMATING R&D INVESTMENT EQUATION

Variable	N	Mean	Standard deviation	Description
L_t	761	558.1	779.786	Number of employees
* $W_t = y_t/L_t$	761	2138.843	709.355	Labor costs per employee
* Q_t/L_t	761	10136.77	10218.48	Sales per employee
* $K_{RD,t}$	691	637623	2046896	Value of intangible R&D capital in 1996 prices
$I_{RD,t}/K_{RD,t-1}$	404	0.497	1.930	R&D Investment/ capital in $R\&D_{-1}$
$\pi^q_t/K_{RD,t-1}$	366	12.117	34.451	Value added less reservation labor costs plus R&D expenses, marketing expenses and training expenses/ $R\&D\ capital_{-1}$
$(WL - W^qL)_t/K_{RD,t-1}$	426	5.731	22.893	Labor costs less reservation labor costs/ $R\&D\ capital_{-1}$
lnQ_t	762	14.793	1.228	Logarithm of Sales revenue
lnKRD,t –lnQt	529	-2.753	1.222	Difference in Logarithms of R&D capital and sales revenue
OWNERINSIDERSt	738	0.318	0.229	Ownership share of managers, workers and former employees
OWNERFUNDSt	738	0.343	0.219	Ownership share of state funds and investment companies
OWNERFIRMSt	738	0.210	0.325	Ownership share of other firms
OWNEROTHERt	738	0.128	0.184	Ownership share of banks, small shareholders, state, unrealised internal buy-outs and other
EXTBOARDt	686	0.515	0.200	Share of non-employees' representatives on the Supervisory Board
HOMEMKTt	730	0.586	0.346	Sales on domestic market relative to total sales
EXTPRIV	780	0.488	0.500	Privatisation dummy (1=external; 0=internal)

* Variables are measured in 1000 SIT in 1996 prices.

TABLE 2: STRUCTURE OF EXPENSES FOR R&D CAPITAL INVESTMENT BY SOURCE OF FINANCING IN SAMPLED FIRMS IN PERIOD 1996-2000

Year	Internal funds	Loans	Funds of co-partners	Foreign firms	Domestic firms	Funds of scientific institutions	Ministry for Science funds	Fund for technology and development
1996	90.749	4.486	2.505	0.561	0.093	0.019	1.587	0.000
1997	92.997	2.421	1.463	0.421	0.158	0.074	2.467	0.000
1998	92.848	2.418	2.051	0.459	0.133	0.084	1.803	0.204
1999	94.480	1.837	0.435	1.000	0.217	0.246	1.205	0.109
2000	92.926	2.703	0.577	1.121	0.440	0.271	1.371	0.286

TABLE 3: STRUCTURE OF R&D EXPENSES IN SAMPLED FIRMS IN PERIOD 1996-2000

Year	Basic research of new products and technologies	Improvement of existing products and technologies	New products	New production methods	Laboratorial activities
1996	11.183	34.341	32.644	13.962	7.870
1997	8.978	29.907	36.945	14.868	9.302
1998	11.553	28.953	36.747	14.442	8.394
1999	9.689	36.319	27.080	18.085	8.927
2000	8.432	35.520	30.501	17.876	7.648

TABLE 4: INVESTMENT IN R&D (Standard errors are reported in parentheses.)

Dependent variable: $\frac{R\&D_t}{G_{t-1}}$	**Coefficient**	**Sys GMM**
$\frac{R\&D_{t-1}}{G_{t-2}}$	ρ_1	0.005 (0.017)
Δy_t	ρ_2	0.225 (0.161)
Δy_{t-1}	ρ_3	-0.089 (0.102)
$(r - y)_{t-2}$	ρ_4	**-0.221 [a] (0.062)**
y_{t-2}	ρ_5	-0.052 (0.050)
C_t/G_{t-1}	ρ_6	0.001 (0.005)
C_{t-1}/G_{t-2}	ρ_7	0.003 (0.003)
C_{t-2}/G_{t-3}	ρ_8	0.006 (0.004)
$(WL - W^aL)_t/G_{t-1}$	ρ_9	-0.017 (0.020)
$(WL - W^aL)_{t-1}/G_{t-2}$	ρ_{10}	0.001 (0.006)
$(WL - W^aL)_{t-2}/G_{t-3}$	ρ_{11}	-0.026 (0.019)
EXT	ρ_{12}	-0.004 (0.059)
$OWNERFUNDS_{t-1}$	ρ_{13}	-0.157 (0.194)
$OWNERPIFS_{t-1}$	ρ_{14}	**-0.381[b] (0.172)**
$OWNERFIRMS_{t-1}$	ρ_{15}	**-0.266[c] (0.154)**
$OWNEROTHER_{t-1}$	ρ_{16}	**0.345[b] (0.161)**
$EXTBOARD_{t-1}$	ρ_{17}	0.104 (0.116)
$HOMEMKT_t$	ρ_{18}	-0.105 (0.097)
Year dummies		Yes
Constant	ρ_0	0.556 (0.751)
Industry dummies	ρ_{19}	Yes
Regional dummies	ρ_{20}	Yes
Short-run Elast. of R&D to Y		0.225 (0.161)
Long-run Elast. of R&D to Y		**0.761[a] (0.228)**
Short-run Elast. of R&D to C		0.001 (0.005)
Long-run Elast. of R&D to C		**0.048[c] (0.027)**
Short-run Elast. of R&D to W		-0.017 (0.020)
Long-run Elast. of R&D to W		**-0.192[b] (0.074)**
Sargan p-value		0.65

Note:

1. a, b and c denote statistically significant values at 1%, 5% and 10% on a two tail test, respectively.

2. System GMM refers to Arellano – Bond two-step estimator for dynamic panel data with finite sample correction (Windmeijer, 2005).

3.. »Sargan« is a Sargan-Hansen test of the overidentifying restrictions (p-value reported).