Does a Soft Macroeconomic Environment Induce Restructuring on the Microeconomic Level during the Transition Period? Evidence from Investment Behavior of Czech Enterprises

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Abstract/Non-technical Summary

The paper analyzes investment behavior of industrial enterprises in the period immediately following price and foreign trade liberalization in the Czech Republic. It also focuses on the effect of "soft" macroeconomic environment on the microeconomic decisions. A dynamic investment function with symmetric adjustment cost function based on the Euler equation has been estimated. The derived and estimated investment function accounts for export sales in order to determine whether firms evaluate production for domestic and foreign markets differently, i.e, use the advantage of an undervalued currency. The estimation was conducted on two-year firm-level panel data from 1992 and 1993. The first major result of the empirical analysis suggests that there is no evidence that firms treat domestic sales and exports differently in the context of the adjustment cost function. The second remarkable finding contradicts the common view that firms in the transitional environment have short-term horizons. Both these findings could be interpreted as strong evidence against the idea of economic policy helping firms within a temporary soft macroeconomic environment. No evidence was found against the applicability of the constant returns to scale assumption on the Cobb-Douglas production function within the analyzed framework.

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JEL Classification: D21, D24, D92, E22, E61, F19, G31, P21

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I. Introduction

Studies dealing with investment play an important role in economic analysis since investment directly influences one of the two essential production factors — the capital. There is a significant lack of applied investment studies using a theoretically well-justified model which do not suffer from oversimplification by severe assumptions made to justify data aggregation (Gordon (1992)). However, combined empirical-theoretical works in a standard investment framework on firm-level data have started to appear recently, the most notable being Hayashi and Inoue (1991), Blundell et al. (1992) and Bond and Meghir (1994). Panel data on a micro-level allows for eliminating bias introduced by aggregation at the industry level; almost all variables are better defined at the firm level; and, in addition, heterogeneity of the sample across firms and time can be taken into account. One can even depart from the oversimplifying notion of a representative firm and investigate cross-differences in the population thoroughly.

A study attempting to be significant should offer not only an empirical study based on a dynamic structural model, but also implications for policy analysis. The results of this paper should answer questions about the effect of a "soft" macroeconomic environment (Kornai (1986)) on level of investment rate from the starting point of adjustment cost minimization; estimate the magnitude of the firm's internal discount factor; and finally, investigate the influence of exports on a firm's investment behavior. Hence, we should be able to judge which of these factors play a significant role, if any, and toward which governmental policy each should be oriented.

According to the neoclassical theory of capital, a firm's plan to maximize its utility (i.e., the net value of the firm) over time leads to optimal capital accumulation. This neoclassical theory, which is more than seven decades old if we count from Irving Fisher's publications, has been experiencing a renaissance in the last few decades as a cornerstone of recent studies. A well-known exhaustive survey of classical investment literature can be found in Jorgenson (1971). Nickell (1977), Sargent (1980) and Arthus and Muet (1990) also provide interesting insights and more recent summaries of this subject. Recent developments in the investment literature are building on this classical fundament.

When we focus on the transition economies, there is no doubt that the speed of restructuralization depends crucially upon the ability to replace inefficient, economically or technologically obsolete capital stock (EBRD (1995)). A high level of investment seems to be a necessity on the transitional economy's road to a competitive market economy on a micro level. Thus with level of investment as a reference point, we can study the effect of a "soft" macroeconomic environment in the early stages of transition in the Czech Republic. The main focus is on the effect of a fixed exchange rate policy after a large devaluation and on temporary "soft" budgeting through large governmental spending, i.e., the effect of governmentally pulled growth.

The first basic assumption adopted in this paper reflects the situation in the early stage of transition. We assume that firms switched from being regulated to having the freedom to pursue their own goals. The situation at the beginning of transformation is taken as the starting point of the process of adjustment. At that time, firms suddenly obtained a free hand to adjust themselves to the new situation.

A firm's management presumably makes an appropriate adjustment for "growth" and "production" strategies. Moreover, each adjustment is costly for a firm not only in terms of the price of the new inventories, but also in terms of possible unrealized immediate revenues which are sacrificed for the future higher ones. This is the background for the introduction of the adjustment cost function in addition to known real resources spent on investment. However, the government may select such temporary policies to reduce these costs, which could be viewed as a "soft budget constraint" as defined by Kornai (1980). In economic theory, each economic agent-firm should face the same situation in an ideal market. However, such an equal opportunity environment seems to be completely unrealistic especially in a transitional economy. During transition, firms may have to overcome different types of obstacles, for example, in lending or in placing their product on the market. These discriminative factors could depend on a firm's size, ownership, location, brand of product, international environment or any similar characteristics which are evaluated by financial institutions or other interacting economic agents. Different adjustment costs may thus emerge for different firms and such costs should also reflect the "softness" of a particular firm's environment. With the exception of made-up setups, it is improbable that the right form of adjustment costs can be assigned or determined and this is why a suitable approximation is commonly used.

We can assess the firms' planning horizon by their discount factor. If it is close to 1 ("zero interest rate"), then the firms are long-term forward looking. If it is close to 0 (high interest rate), the firms are aware of unstable, or temporary, economic conditions. Policymakers have learned that economic policies which do not respect world economic equilibria are not sustainable for a long time. Therefore, rational individuals would be aware that "soft" macroeconomic conditions are only temporary and will be changed. Indeed, the environment in the Czech Republic has changed: the fixed exchange rate was abandoned after a run on the currency in 1997 and public budgets have been subject to major cuts since 1997 and are still running huge deficits.

The estimates provided in this paper are carried out on uniquely large sample of firms: almost the entire firm population of a small, open, transition economy — the Czech Republic[1] — censored only at the very end of one tail of the distribution. A strictly structural approach is used with no ad hoc descriptive generalization. The estimation is conducted on 1992 and 1993 data. At that time the firms were still formally owned by the state in general but large and small scale privatization schemes had already peaked. Therefore there was certainty that the old times would soon be gone and "hard" times were close ahead.

I.1. Motivation for Export Extensions

This work aims not only to estimate the relationship between the production and

[1] Only firms located in the Czech Republic in 1993 are considered; Slovak firms are excluded from the 1992 sample.

investment functions of an average firm in a transition economy but also takes into account a firm's direct exports, which could help to answer questions on the effectiveness of exchange rate policy. The undervaluation of the Czech (Czechoslovak in 1992) currency was meant as a "soft cushion" to enterprises to overcome the loss of CMEA markets and establish themselves on the western ones by means of price advantage. If specific patterns of investment with respect to international trade exist, and the parameters of the investment cost function associated with these factors can be identified, they could help to formulate government policy to a) accelerate the speed of restructuralization on the microeconomic level; b) reduce the costs of the transformation; c) correct the exchange rate under pegged or fixed rate policies to ease the burden of loss of particular world markets; and, mainly, d) justify such policy.

Moreover, restructuring foreign trade is one of the principal conditions for the development of Eastern European countries. In cases where domestic demand is contracted, exporting allows unemployment to be maintained at a sustainable level and thus helps to keep the social costs of transition below a critical level. In order to maintain positions on the world market, or to penetrate this most competitive environment, it is necessary to introduce new technologies as soon as possible. This short list serves as the usual governmental justification for the pros of the soft-exporting environment.

The focus on a firm's investment behavior with respect to exporting capabilities is a natural first step. The most interesting question is whether the devaluated currency really affected the ability of the firms to overcome the loss of CMEA markets and helped them to restructure: in particular, whether the exports affect adjustment cost function. The results, which we will present later, suggest that it is not the case and hence there is no evidence in either direction of the link between investment and export abilities in the analyzed period.

I.2. Investment and Approaches to Modeling

Historically the majority of studies can be classified into two main groups. The first group could be called stock-oriented and infers the demand for investment from derived capital stock adjustment (the leading example being Jorgenson (1963)). The structurality of the model is its main feature. Also, the model appeals to the production function and demand for output. Rental costs of capital are used to determine the capital stock. The expectations are usually not explicitly dealt with but, implicitly, they can be taken into account by means of lags in the case of the estimation of distributed lag functional forms. The second group is the so-called flow-oriented approach, which attempts to directly explain investment by using the increasing marginal costs of investment. The level of investment is determined by the stock market value of capital, without accounting for the production function and the demand for output. They rely on the ability of the stock market to form, from all expectations, asset prices and thus determine the appropriate shadow price of capital. The representative and almost exhaustive survey of recent investment literature and applications on panel data can be found in Mátyás and Severstre (1992).

Both listed approaches could be successfully combined in order to avoid criticism either for neglecting the structural form of the problem or for omitting the principal equality of marginal costs and benefits. This was pioneered by Abel (1980). For a recent application of U.K. data see Bond and Meghir (1994). Other interesting articles are Chirinko and Schaller (1995), Hubbard et al. (1995), Johnson (1994), Oliner and Rudebusch (1992), Oliner et al. (1996), Petersen and Rajan (1994) and Whited (1992). The findings in these articles form the cornerstone of our approach which is, in essence, the flow model, since the investment rate is determined by equating the marginal costs of investment to the shadow price of capital. However, we do not use the stock market to infer the shadow price of capital; the shadow price is determined by the structural form. This is in keeping with the spirit of the capital stock approach.

In addition to the two main groups of stock- and flow-orientation, there is also literature on investment which does not exploit the assumption of profit maximization. These studies are considered to be more appropriate for the mixed and socialist type of centrally planned economies. They mainly use the framework of labor managed firms (LMF), the leading examples being studies on the former Yugoslavia. The most common finding is that the rate of investment is lower than in a classical setup. For an example of this, see Conte and Ye (1995) or Vanek (1975). The reasoning behind this result is that LMFs are not indifferent to present and future profits and they favor immediate payments, as recently indicated by a study on Slovenian firms by Prasnikar and Svejnar (1999). A separate problem is the investment regulation of firms in monopolized industries: see Lyon and Mayo (1996).

II. Baseline Model

II.1. Theoretical Framework with Structural Outcome

First, the analysis of a firm in the transitional economies should attempt to develop an underlying model which allows for testing different definitions of an objective function in order to compare competing hypotheses. The classical approach deals with profit goals; however, a "self-managed firm" framework utilizing other objectives (for example, see Pejovich (1969) or Estrin and Svejnar (1993)) might be more appropriate for transition economies. Therefore, we have used an approach allowing for the general functional form of the objective function. The LMF modification can be found in Prasnikar and Svejnar (1999). However, we use the classical profit orientation in the following analysis, which seems to be the most appropriate for the Czech Republic (Basu et al. (1994)).

Consider a firm which maximizes its objective function, say V_t, which is the total sum of expected discounted "profits" (denoted as Π, which could not only be the profit from the classical point of view, but also profit per worker, income per worker, value added or any other objective which the firm's managers consider to be the desirable goal to maximize) from the present time up to an infinite time horizon. This is formally written as

$$V_t = E\left[\sum_{j=0}^{\infty} \xi_{t+j}\, \Pi_{t+j} | \Omega_t\right] \quad , \tag{1}$$

$$\xi_{t+j} = \prod_{n=0}^{j-1} \frac{1}{1+r_{t+n}} \quad \forall \quad j > 0 \quad ,$$
$$= 1 \qquad\qquad j = 0 \quad . \tag{2}$$

Here $E[.|\Omega_t]$ denotes the expectation, conditional on all information available at time t; Π_{t+j} is the expected profit at time t+j, given information in time t in the classical setup; ξ_{t+j} is a discount rate between period t and t+j (defined by **(2)**, supposing that all payments are made in the beginning of each period); and Ω_t is the set of all available information at time t. In the classical setup which is used, the profit (or, to be more rigorous, cash-flow) in a given period is defined as the difference between total revenues (represented by the term p*Y(.,.)) and total (input and other internal[2]) costs (all other terms in **(3)**). Since profit Π_t at time t is supposed to be a function of capital stock at time t (K_t), labor force (L_t) and investment (I_t), one can write more explicitly (with p_t, p^I_t and w_t denoting the price of goods, investment goods and labor respectively):

$$\Pi_t = \Pi(K_t,L_t,I_t) = p_t \; Y(K_t,L_t,I_t) - w_t L_t - p_t^I I_t \quad ,$$
$$Y(K_t,L_t,I_t) = F(K_t,L_t) - G(K_t,I_t) \quad . \tag{3}$$

Note that in the classical setup the total revenues of a firm should be the production generated by the appropriate production function F(.,.) reduced by an adjustment investment cost function G(.,.), i.e., the production and the adjustment costs functions should be additively separable. The function G(.,.) should be strictly convex in all arguments.[3] Finally, the function F(.,.) should be strictly concave in order to have the profit function Π be, in turn, strictly concave, since then the first order conditions (see **(5)**-**(7)**) are sufficient for the existence of a unique maximum — the solution.

The term $p^I_t I_t$ is used instead of the usual "capital rent," since the current capital stock was already paid for and causes no costs at time t, while the new capital (i.e., investment) has to be paid for in full immediately. In addition, there is another reason why capital rent is not explicitly used as the second major input cost. Suppose that the value of the firm's capital (K_t) is higher than the V_t. Then the best action is to sell the capital and shut down the firm, assuming zero closing costs. Therefore, we implicitly assume that production is always expected to be more profitable than the liquidation of the firm. This assumption is not restrictive since there were no bankruptcies during the analyzed period.[4]

[2] The firm cannot only use real internal costs but the management can also evaluate some costless actions as costly for the optimization solution.

[3] If the costs of adjustment depend also on labor, then G=G(K,L,I), the cost adjustment function, has to be convex in the labor dimension as well.

[4] The legal system allowed for bankruptcy but the law extremely favored debtors over creditors. Even today after ten modifications of the bankruptcy law the procedure is extremely lengthy and costly for creditors. This legal bottleneck is a major reason why bankruptcy procedures are still not used as often as they should be. There is a considerable amount of anecdotal evidence of hopeless creditors waiting for bankruptcy to be declared in the newspapers.

(continued...)

There are two reasons for distinguishing between the price levels of goods and investment goods. Both have similar formal effects, and in the setup we are using, the distinction between prices of goods and investment goods causes no formal change in our estimated formulae; only interpretation of coefficients differs slightly. The first natural question to ask when analyzing **(3)** is, What about variable costs? The revenue part should at least look like $s*F-c*F$, where s and c are output and input prices per one unit of output, respectively.[5] We can argue that the VAT could be captured in a similar way and the corporate tax (see, for example, Whited (1992)) as well. We will refer to these factors as scaling factors.

The second reason for distinguishing between the prices is that, allowing for imperfect competition,[6] the price term looks like $(1-1/elasticity)*price$ after the first differentiation. Thus we can always look at $p=(s-c)(1-1/elasticity)*(tax\ correction)*p^I$. However, without additional assumptions we are not able to distinguish among these effects in the given formal specification. Since such a distinction is not the purpose of this paper, no additional assumption is imposed and we control for both effects without distinguishing between them.

The capital stock changes according to capital accumulation constraint $K_t = (1-\delta)K_{t-1} + I_t$, where δ is the depreciation rate. The firm's optimal investment problem can be rewritten as a dynamic programming problem with a single state variable K_t (capital can be changed only via investment) and single control variable I_t (investment made in the current period; the decision regarding the level is made at the beginning of each period). We can substitute the capital accumulation constraint into the dynamic specification:

$$V_t(K_{t-1}) = \max_{K_t,I_t,L_t} \left\{ \Pi\big((1-\delta)K_{t-1}+I_t,I_t,L_t\big) + E\left[\xi_{t+1}V_{t+1}((1-\delta)K_{t-1}+I_t)|\Omega_t\right] \right\} \quad . \tag{4}$$

By differentiating, with respect to all choice variables K_t, L_t and I_t (suppose labor to be subject to immediate costless adjustment, i.e., variable input; a costless assumption may be relaxed with no influence on the core of further derivation[7]), one can obtain first order necessary conditions **(5)** through **(7)**:

$$(1-\delta)\lambda_t = \frac{\partial V_t}{\partial K_{t-1}} = (1-\delta)\frac{\partial \Pi_t}{\partial K_t} + (1-\delta)E\left[\xi_{t+1}\frac{\partial V_{t+1}}{\partial K_t}|\Omega_t\right] \tag{5}$$

$$\frac{\partial V_t}{\partial I_t} = 0 = \frac{\partial \Pi_t}{\partial K_t} + \frac{\partial \Pi_t}{\partial I_t} + E\left[\xi_{t+1}\frac{\partial V_{t+1}}{\partial K_t}|\Omega_t\right] \tag{6}$$

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[4](...continued)
In any case, this is another feature which can be viewed as a temporary "softness" in the analyzed period.

[5] The existing literature rarely deals with the variable costs.

[6] See Bond and Meghir (1994); they use this approach to control for imperfect competition.

[7] Estrin and Svejnar (1993) estimate a similar model with adjustment costs for both capital and labor.

$$\frac{\partial V_t}{\partial L_t} = 0 = \frac{\partial \Pi_t}{\partial L_t} \quad . \tag{7}$$

Condition **(5)** is the Euler equation that characterizes the evolution of the shadow price λ_t of capital along the optimal path (one marginal unit of capital at time t-1 worth (1-δ) of one unit of capital at time t; that is why the shadow price is multiplied by the term involving depreciation). Condition **(6)** says that the value of a marginal unit of capital should be equal to the marginal costs of this unit, and **(7)** characterizes the optimal level of the labor factor (input). The Euler equation can be rewritten as

$$\lambda_t = \frac{\partial \Pi_t}{\partial K_t} + (1-\delta)E\left[\xi_{t+1}\lambda_{t+1}|\Omega_t\right] \quad . \tag{8}$$

Substituting forward for λ_{t+1}, λ_{t+2}, etc., one will receive a solution for λ_t:

$$\lambda_t = E\left[\sum_{j=0}^{\infty}\left(\xi_{t+j}\ (1-\delta)^j\ \frac{\partial \Pi_{t+j}}{\partial K_{t+j}}\ |\Omega_t\right)\right] \quad . \tag{9}$$

This equation states that the shadow price of one unit of capital should be equal to the infinite sum of marginal profits from this one additional unit of capital discounted by the discount factor (interest rate) and speed of depreciation of the capital, given all available information.

There are various ways how to proceed further. The mainstream literature follows the "Tobins - q" type solution. These models of investment use stock market information to measure the shadow price of capital. In this case, it is further necessary to impose a condition of linear homogeneity on the profit function in order to proceed to an estimable form (for example, see Matyas and Severstre (1992) for the full derivation and discussion of the q-model). A brief summarization of the sufficient conditions for the derivation of the result follows: perfectly competitive markets, linear homogeneity of costs of adjustment, constant returns to scale of production, and the firm is a price taker. Then (as was first accomplished by Hayashi (1982)) the intuitive result can be shown, namely, that the unobserved value of a marginal unit of investment (shadow price) is equal to the average valuation of existing capital.

Moreover, there is an additional, necessary condition that the stock market valuation of a company correctly reveals the net present value of the firm as specified in **(1)** for the classical setup. If this extra condition is invalid, then the shadow value of capital is measured with a systematic error and no obvious instruments are available to correct this problem (see Blanchard, Rhee, Summers (1990)) in the q-approach. The Czech capital market is infamous for its nontransparency and lack of proper regulation.[8] If the objective of the firm's management is not

[8] In November 1997 the governor of the Czech National Bank announced that as much as 30 percent of the loan portfolio of the largest commercial bank was composed of substandard loans. The reliance on bank credit is also evident from the fact that no firms decided to raise capital on the already existing stock exchange in previous years.

to maximize the net present value of the firm,[9] or if the firm has non-traded or partially traded assets, then this q-method cannot be used. Most of the investment models in the recent literature dealing with adjustment costs are based upon the q-approach (e.g., Abel and Blanchard (1986) or van Ees and Garretsen (1994) among others), which is unusable in the Czech case.

The shadow value of capital can also be estimated by forecasted marginal revenues of capital, according to **(9)**. However, then we have to specify the formation of expectations, which is not implied by the structural investment model. Thus, the Lucas (1976) critique may apply if changes in the economic environment affect the formation of the expectation. This is also a crucial problem of studies of adjustment costs based on the cost-minimization problem since none of the authors provide any justification why the lagrangian should be constant over time (i.e., shadow price is the same for all periods; see Singer et al. (1998)). Moreover, assumptions on a particular formation of expectations are much harder to justify if they are not derived directly from the underlying structural model.

An alternative is to eliminate λ in terms of observable variables. The derivation utilizes the fact that expectations must hold not only for t but also for t+1 given Ω_t. Following Bond and Meghir (1994) we can get a specification of the Euler equation in terms of the observables which also controls for the expectations without stating how they are formed (defined in a similar way by Abel (1980) and Shapiro (1986)). This derived formula **(10)** is at the core of our underlying baseline specification:

$$\frac{\partial \Pi_t}{\partial K_t} = -\frac{\partial \Pi_t}{\partial I_t} + (1-\delta)E\left[\xi_{t+1}\frac{\partial \Pi_{t+1}}{\partial I_{t+1}}|\Omega_t\right] \quad . \tag{10}$$

Now the anticipated result when the expectations are formed with error should be defined. Define the prediction error as the difference between the actual value at time t+1 and the predicted value for time t+1 at time t given the information set Ω_t (i.e., the rational expectation hypothesis):

$$\varepsilon_{t+1} = (1-\delta)\xi_{t+1}\frac{\partial \Pi_{t+1}}{\partial I_{t+1}} - (1-\delta)E\left[\xi_{t+1}\frac{\partial \Pi_{t+1}}{\partial I_{t+1}}|\Omega_t\right] \quad . \tag{11}$$

Then, by substituting prediction error from **(11)** in **(10)**, we get

$$(1-\delta)\xi_{t+1}\frac{\partial \Pi_{t+1}}{\partial I_{t+1}} = \frac{\partial \Pi_t}{\partial K_t} + \frac{\partial \Pi_t}{\partial I_t} + \varepsilon_{t+1} \quad . \tag{12}$$

The two derived equations **(7)** and **(12)** are used further on. The former, **(7)**, represents the necessary condition for optimum level of adjustable input (labor). We will use this equation in the form of equality of marginal product of labor to wage. The latter equation, **(12)**, represents the baseline specification of the firm's investment problem with generally acceptable conditions on the objective function — strict concavity of Π — in a quite general setup. Also, the condition of

[9] Lizal et al.(1995, 1997) show that the managers of Czechoslovak firms in the 1990-1992 period were likely to pursue different goals.

rationality of expectations used for the solution of the shadow price is common, natural, and widely used. There is no assumption of perfect competition nor of constant returns to scale, as is necessary for the q-approach. In addition, no stock market data are necessary to estimate the shadow value of capital, which may be a crucial obstacle for the analysis of firms with non-traded assets.[10] Finally, the most appealing fact is that there was no auxiliary assumption imposed to measure the shadow value of capital. Also, note for the future, that this specification implies heteroskedasticity if we are not willing to assume that both the depreciation rate and discount rate are equal for all firms.[11]

If the firm's expectations satisfy only a weak rationality condition, then the stochastic disturbances ε_{t+1} are serially uncorrelated and also orthogonal to Ω_t. However, if the observation period does not coincide with the firm's decision period, then this fact may introduce a low-order moving average error process. This provides a background for the assumption of a limited serial correlation in ε_{t+1}. However, nothing can guarantee non-measurement errors of the shadow value of capital, i.e., a firm-specific bias of prediction could exist, which would depend on the "predicting capabilities of the particular management" or other unobservable variables. This means that the expected value of the error is different from zero for a particular firm — systematic error of the firm's management. Therefore, the regressors on the right-hand side are likely to be correlated with error and OLS estimates cannot be used due to their inconsistency. The obvious remedy is to use any method based on the instrumental variable technique (IV) ranging from simple instrumenting to sophisticated generalized methods of moments (GMM).

Matyas and Severstre (1992) also mention a problem of measurement error of some of the regressors. The shadow value of capital being measured with error implies that the marginal profit of capital is not exactly known. This means that even if we are able to measure all the observable variables exactly, we are actually measuring variables which are only *proxies* for the optimal levels. The justification is that since we observe true, realized values defined by the prediction capabilities of management, we have values different from the ideal ones (perfect foresight of the management and no restrictions on the firm's actions). Thus, we might face the measurement error in the variables problem, especially in investment and capital.

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[10] During the transition period we usually face an emerging (or even absent) capital market which cannot be considered perfect, not only due to existing regulations and/or lack of liquidity, but also because of partial or complete lack of convertibility of the domestic currency restricting foreign participation on the stock exchange. Thus, the observed stock prices could be distorted enough to make all estimations of the shadow value of the capital not only highly volatile, but also biased, and could cause unreasonable or unusable predictions.

[11] For example, in the Czech Republic, there was by law a prescribed depreciation rate according to the nature of capital (e.g., real estate depreciates by 2%, computers by 25% a year) and a firm was not allowed to choose any different scheme. Hence, the Fisher and McGowan (1983) and Fisher (1987) problem of tax distortion and overdepreciation of capital does not apply to the Czech data in the analyzed period.

II.2. Adjustment Cost Function

The adjustment cost function for investment G(.,.) can be defined in many different ways. There is a huge amount of literature dealing with the definition of the cost adjustment function in a labor demand framework (for example, see Hamermesh (1989)[12]). There is no difference between the arguments used in the labor demand studies and those in the investment framework. We use the most common symmetric quadratic form (note that this function is homogeneous of degree 1, i.e., it exhibits constant returns to scale, in investment and capital), introduced by L. Summers (1981):

$$G(K_t,I_t) = \frac{a}{2}\left(\frac{I_t}{K_t} - b\right)^2 K_t \quad , \qquad a,b \geq 0 \quad . \tag{13}$$

Parameter **a** controls the magnitude of the costs, while parameter **b** indicates the optimal Investment/Capital ratio based on the adjustment costs; in this case "optimal" means the point where the adjustment costs are minimal. This cost-optimal value is generally different from the growth-optimal ratio or profit-optimal or cash-flow-optimal ratio. There is no theoretical judgment for the magnitude of **a** or **b**, but it would be beneficial for the firms if **b** is close to the overall Investment/Capital average.[13] The judgement for the quadratic form is based on the fact that higher deviations from the equilibrium are likely to be more costly than just a small oscillation around the optimal level. The symmetricity of quadratic costs is the major feature of criticism, which objects that the same deviations to different sides of the optimum point are likely to cause different costs. However, the overwhelming advantage of the specification used is its agreeable form: differentiation everywhere, and linear homogeneity. Apart from its analytiçal simplicity, this form is supposed to be a good approximation of the true unknown adjustment cost function.[14]

The adjustment costs could be thought of not only as installation / dismantling / replacement costs or losses of output due to disruptions caused by capital exchange / installation, but also as losses due to interest market imperfections causing not entirely optimal choices to be

[12] Hamermesh and Pfann (1996) provide a discussion of the problems associated with the selection of the proper shape of the adjustment cost function. A more general specification like $C(\Delta X) = \frac{1}{2}b(\Delta X)^2 - c\Delta X + e^{c\Delta X} - 1$ does not lead to a closed form solution and requires a nonlinear method of estimation. Pfann and Verspagen (1989) examine adjustment costs in the Dutch manufacturing industry. Various cost-adjustment specifications were used by Singer et al. (1998) on Czech data; they found no evidence against symmetricity of cost of adjustment.

[13] Bond and Meghir (1994) estimate a similar model by the GMM technique with a correction for the correlation of lagged dependent variables and firm-specific variables on the RHS of their equation. By simple calculation, it can be shown that their estimation yields significantly negative value of the structural parameter **b** from the cost adjustment function (omitting the covariance of coefficients since they naturally report only standard errors of coefficients), which is not consistent with the assumption of positive value of **b**. Although the purpose of their paper was not to estimate these structural parameters, such inconsistency with assumptions makes their results and conclusions dubious.

[14] Singer et al. (1998) experiment with various forms of adjustment cost functions in labor and capital on Czech enterprise data from 1993-1995: they find no evidence for asymmetric costs.

made.[15] A verbal illustration might consist of the following examples: trade unions within the firm may force the management to underinvest by demanding wage increases beyond the firm's financial abilities; higher uncertainty in future developments may cause intertemporal preferences to vary greatly and result in an unreasonably high interest rate; legislation on collateral could influence bank behavior and credibility of firms. Any discrimination in the lending policy of financial institutions causes distortions. The EBRD's and World Bank's loans can also be seen as a "soft" instrument to reduce adjustment costs. The interest in export influence can also be justified by the higher credibility of directly exporting firms (i.e., firms which do not use intermediaries). The above mentioned examples illustrate why the parameters **a** and **b** approximate quite a complex underlying structure which usually cannot be even partly identified without additional, sometimes severely restricting, assumptions.

II.3. No Specific Production Function vs. Cobb-Douglas Function

Finally, the production function F(.,.) has to be specified. Assuming that the production function F(.,.) is homogeneous of degree 1 in labor and capital, then after a little bit of manipulation we get

$$\frac{\partial \Pi_t}{\partial K_t} = p_t \left[\frac{F(K_t,L_t) - G(K_t,I_t)}{K_t} - \frac{\partial F}{\partial L} * \frac{L_t}{K_t} + a \left(\frac{I_t}{K_t} \right)^2 - ab \frac{I_t}{K_t} \right] \quad . \tag{14}$$

For the partial derivative of the production function with respect to labor, we can substitute wage w_t from the first order condition **(7)**. The benefit of the strong assumption of the production function's linear homogeneity means that we do not have to specify the production function literally. However, linear homogeneity directly implies constant returns to scale of production. Thus, once the production of analyzed firms does not exhibit constant returns to scale, this major simplification is not feasible.[16]

A similar result can be obtained assuming a Cobb-Douglas production function which gives a competing model. Let the Cobb-Douglas production be formally

$$F(K_t,L_t) = A K_t^{\alpha} L_t^{\beta} \quad , \qquad A>0 \;\; \& \;\; 0 \le \alpha \le 1 \;\; \& \;\; 0 \le \beta \le 1 \quad . \tag{15}$$

We should assume that $\alpha+\beta$ is not equal to unity; otherwise we can use the procedure based on the assumption of constant returns to scale, where no additional requirements regarding the shape or form of the production function itself are required. The first order condition for labor input by evaluating **(7)** is, for the Cobb-Douglas case, $w_t = \frac{\beta F(K_t,L_t)}{L_t}$. Equation **(14)** then becomes

$$\frac{\partial \Pi_t}{\partial K_t} = p_t \left[\frac{F(K_t,L_t) - G(K_t,I_t)}{K_t} - \frac{1-\alpha}{\beta} w_t \frac{L_t}{K_t} + a \left(\frac{I_t}{K_t} \right)^2 - ab \frac{I_t}{K_t} \right] \quad . \tag{16}$$

[15] The transition itself can be characterized as the process of creating more or less perfect markets.

[16] Singer et al. (1998) estimate the Cobb-Douglas revenue function and their estimates of returns to scale are around 0.78. They do not analyze the production function at all.

Substitution for partial derivatives in **(12)** gives the following estimable equation we use later on:

$$\frac{I_{t+1}}{K_{t+1}} = \gamma_0 + \gamma_1 \frac{Y_t}{K_t} + \gamma_2 w_t \frac{L_t}{K_t} + \gamma_3 \left(\frac{I_t}{K_t}\right)^2 + \gamma_4 \frac{I_t}{K_t} + \eta_t \, ,$$

$$\begin{aligned}
\textit{where:} \qquad \gamma_0 &= b - \frac{1}{a}\frac{p^I_{t+1}}{p_{t+1}} - \frac{b}{\pi_t} + \frac{1}{a\pi_t}\frac{p^I_t}{p_t} \\
\gamma_1 &= -\frac{1}{a\pi_t} \\
\gamma_2 &= \frac{1-\alpha}{\beta}\frac{1}{a\pi_t} \\
\gamma_3 &= -\frac{1}{\pi_t} \\
\gamma_4 &= \frac{b+1}{\pi_t} \\
\eta_t &= -\frac{\varepsilon_{t+1}}{a\pi_t p_t} \\
\pi_t &= \frac{(1-\delta)p_{t+1}\xi_{t+1}}{p_t} \, .
\end{aligned} \qquad \textbf{(17)}$$

Note that Y_t stands for the observed production, $Y_t = Y(.,.,.) = F(.,.) - G(.,.)$, which is, in comparison to the theoretical production frontier F(.,.) and adjustment costs G(.,.), directly observable. We could have set $\mathbf{p}_t=1$ (numeraire); this would have meant that $\mathbf{p}_{t+1}$ is nothing but a one-period price index, a one-period inflation from period t to t+1. The intuitive meaning of π_t, defined as $\pi_t=(1-\delta)\mathbf{p}_{t+1}\xi_{t+1}/\mathbf{p}_t$, would be the "firm specific discount rate on new investment," consisting of an overall non-depreciated fraction of capital stock $(1-\delta)$, inflation $\mathbf{p}_{t+1}/\mathbf{p}_t$ and the firm's internal (own) discount rate ξ_{t+1}, which could naturally differ from the overall market real interest rate.

One can easily verify that if the Cobb-Douglas production function exhibits constant returns to scale, then $\gamma_1 = -\gamma_2$ since $1 - \alpha = \beta$. If $-\gamma_1 < \gamma_2$, then we have decreasing returns to scale. If the opposite inequality holds, the firm is using technology with increasing returns to scale.

II.4. Introducing Export

The first approach explaining the existence of a mixture of domestic and export production is based on the concept of the multiproduct firm (or product differentiation) where the products for domestic and foreign markets are different. This product difference according to the sales destination can be almost taken for granted in a command economy. On the other hand, the European Union is a natural counterexample to the concept of the multiproduct firm. Not only the member states of the EU, but also firms which trade with EU members, are coordinating their legal and international standards; then the final products differ only in the language of the instructions for use (if there is even that difference).

II.4.i. Multiproduct-Firm Concept

There are plausible concepts explaining the existence of production for both domestic and foreign market simultaneously rather than only for the most profitable. One is the hypothesis of volatile and different prices on the domestic and foreign markets; the prices move randomly and independently (or at least without a high positive correlation). Then the producer concentrates on the market with a higher mean price and uses the second market only as insurance (mainly if there is a negative correlation between prices) and as an additional dimension for optimization of profit via production quantity. Another argument supporting the presence of firms on more markets under different prices utilizes the concept of (fixed) entry costs. In order to enter the market with a new product, a firm must incur fixed entry costs which might be higher if the firm was not present on the market for a long time period. In this case, the firm does not distinguish between the production (products) for domestic and foreign markets, and optimizes the whole production no matter what the final destination of the product is.

To test whether the firm follows the multiproduct concept (i.e., we observe different structural parameters) or not we can use the following theoretical construction: Suppose that the whole production can be written as an addition of the domestic and export production ($F = f_D + f_E$) and both these functions are linearly homogeneous. Also, suppose that the adjustment cost function G consists of two similar functions ($G = g_D + g_E$) of form **(13)** with parameters $\mathbf{a}_D$, $\mathbf{a}_E$, $\mathbf{b}_D = \mathbf{b}_E = \mathbf{b}$ (since we cannot observe investment and capital for domestic and export production separately, the optimal rate of investment b has to be assumed to be the same; in practice it would probably be a weighted average of the two). Subscripts D and E denote domestic sales and exports respectively. Suppose further constant returns to scale so we can collect terms with γ_1 and $-\gamma_2$, and denote $\gamma_{12} = \gamma_1 = -\gamma_2$. Note that if the firm cannot distinguish between the capital, investment and labor used for domestic and/or export production ($\mathbf{a}_D = \mathbf{a}_E = \mathbf{a}$), then in

$$\frac{I_{t+1}}{K_{t+1}} = \gamma_0 + \gamma_{12}\left[\frac{Y_t}{K_t} - w_t\frac{L_t}{K_t}\right] + \gamma_{12E}\left[\frac{E_t}{K_t} - w_t\frac{L_t}{K_t}\right] + \gamma_3\left(\frac{I_t}{K_t}\right)^2 + \gamma_4\frac{I_t}{K_t} + \eta_t \ , \qquad \textbf{(18)}$$

where E_t stands for real export production (i.e., $E_t = f_E - g_E$, directly observable), the coefficient γ_{12E} associated with the additional term controlling for the exports is not significantly different from zero. The rest of the γ's have the same interpretation as in **(17)**. Note also that Y_t stands for total sales, including exports. The assumptions imposed on parameters are strong, but they are given by the nature of the data (only sales destination is available). Therefore, the conclusion which can be reached without additional binding assumptions is that different values of the adjustment cost function for domestic and foreign sales strongly support the multiproduct concept.

II.4.ii. Cash-Flow Concept

One can view the revenues from exports as a financial ease (given domestic demand constraint) or as a source of additional (extra) revenue when the realization prices of the product on a foreign market are higher than those on the domestic one. This extra revenue is available mainly in the early transition stage, when domestic currency is usually undervalued as a standard "soft" macroeconomic policy. Then, following the cash-flow literature, exports or the share of exports in the total production should be considered as an important part of the cash-flow sources of the firm. Using an approach similar to that found in the recent literature, for example Kaplan and Zingales (1997) or Galeotti et al. (1994), the exports per capital or export share could be considered as a part of the general cash-flow controlling variables; or one can even assume that the export share plays a role in the decision process of the lender (direct modification of the Bond and Meghir (1994) specification) and therefore enters the firm's objective function via debt dependency as a factor (linearly) modifying the debt constraint. In the latter case the term involving exports enters the investment demand equation in the second power. Depending upon the assumption of formation of the lending constraint and on the cash-flow influence of exports on investment, one can arrive at different specifications for how to include the export term in the estimated equation.

III. Data Description

The major source of the data is the CSO. Unfortunately, data on exports on the firm level was collected only in the early stages of transition; therefore the econometric analysis is carried out on the 1992-1993 sample. The data set used for estimation consists of several parts. The first data files used are monthly panel data on Czech industrial firms from 1992-1993. The sample ought to contain all industrial firms having more than 25 employees in 1992 and 1993. (In 1994 the CSO changed its methodology and since then has systematically monitored firms with 100 employees or more. Moreover, export sales were not collected later on.) These 1992-1993 files supply information on output (production), total sales, export sales, wage bills, labor, as well as the previous year's values of these variables. In addition, they contain the enterprise identifier (scrambled), district, ownership, industrial classification and other information (a detailed description is available upon request). Since the CSO has changed its method of data collection (since the split of Czechoslovakia), the prospect that previous-year values could be less reliable — especially if an enterprise underwent some organizational changes — is neglected. The 1992 values reported in 1993 are used for further analysis, namely because of the split of Czechoslovakia in 1993. This approach also has a hidden advantage: after reorganization, the firm should report the previous (last year) values adjusted to its current size (see Lizal et al.(1995, 1997)). From these data sets, quarterly ones were constructed by combining the appropriate three months.

The second part of the data files are the quarterly 1992-1993 panel data, containing data on acquired investment and sold investment property in the given quarter, as well as these values from the previous year. There is also other data, interesting to us, indicating capital stock and depreciation. All these latter variables are for the beginning and end of the given quarter. Note the difference in this data: it states the level on a certain date (i.e., on January 1, April 1, July 1, October 1) unlike the data on investments and all the other monthly data. Thus, there is no information on the previous-year values for capital. This data is available for firms which have a turnover larger than a certain critical value.[17] Firms are identified by the same scrambled identifier used in the monthly data sets.

The last panel which was used for the purpose of this analysis is quarterly data on capital from 1992. However, there was a slight change in the accounting method between 1992 and 1993, so this data is not fully comparable with capital data from the 1993 quarterly panel. Since an estimation using both 1992 and 1993 capital data would probably involve the measurement error in variables in a system which is not linear in this variable, a more complex econometric problem would need to be solved, and this is beyond the scope of this paper. Therefore, we have used two different data sets to address this issue:

1) short panel, just 1993 variables on capital, N large, T=4 and;

2) long panel, 1992 and 1993 variables on capital, assuming no difference in the capital measurement, N smaller, T=8;

and that is why two different sets of results are presented. Note that the longer panel will be twice as long in time span as the shorter one, but will contain a substantially smaller number of firms (approximately 70% of the initial set).

While the CSO was careful in collecting the data, the data set contains a number of errors and inconsistencies. Moreover, when coding data the CSO does not distinguish between missing values and zeroes. In an attempt to assemble a reliable data set, we have used a set of consistency checks to clear the samples. Then a combined quarterly panel, from all the data which did not fail these consistency checks, was constructed by merging firms according to the scrambled identifier. The included graphs and tables describe the constructed quarterly panel files and the overall economic situation.

Now we should mention the weakness of these data sets. The firms are required by law to fill out the statistical forms. The CSO has the right to fine — again according to the law — a firm which does not turn in the forms on time. However, there is no penalty for providing false information. The high percentage of observations failing the consistency checks could be due to such an absence of legal penalty. The CSO itself is able to detect only typographical errors through its verification procedure, since it checks only cross-check sums and does not use any other verification. Since a large portion of the data was discarded, a sample selection problem can arise. Unfortunately, the usual two-step correction for a sample selection problem (Maddala (1994)) is not available,[18] but as was pointed out by Lizal (1998) these gaps are random and do not cause a sample selection problem.

Table 1 describes the main variables used for estimation, i.e., the unbalanced quarterly

[17] A recent definition (for 1994 and 1995) states that firms with a turnover of more than 1 million Kc have to report, and certain types of firms also have to report regardless of their turnover. The final decision of whether the firm is obliged to report is made by the local branches of the CSO according to the relative importance of the enterprise. The law allows the CSO to require certain information from any enterprise regardless of its size.

[18] The data eliminated because of its inconsistency cannot be used in the probit part.

panel. Note that the one-year consumer price index was 12.7% in 1992 and 18.2% in 1993. The producer price index for the same periods was 9.6% and 11.4% respectively for these years. All figures are in current Kc (Kcs in 1992).

Table 2 contains the 1992 and 1993 comparison based on monthly averages. Figure 1 shows price evolvement with the administrative peak on January 1st. Figures 2 and 3 show the time development of the monthly data in 1992 and 1993. Note that this data set was constructed only from monthly data, a monthly panel, and this monthly panel was balanced in order to eliminate the variance caused by different samples. For this purpose, firms with missing and/or unreliable values for investment and/or capital were left in the sample if they did not fail the consistency checks on reported monthly values since these descriptions do not involve the capital.

Tables 1 and 2, together with Figures 1, 2 and 3, should give an overall view of the monthly time trends of the main indicators over the two years. Let us briefly comment on remarkable features. Approximately 20-30% of the observations per period failed the consistency checks for monthly data; however, as was shown by Lizal (1998) or Lizal and Svejnar (1998), the fails of Czech enterprise data are random and there is no evidence for a sample selection bias. Lizal and Svejnar (1998) provide more detailed analysis of the evolvement of Czech enterprises over a longer time period with distinction among different types of ownership. We should also point out a "strange" feature: average sales exceed average production. This may be caused either by inflation (sales take place later than production) or by the sale of stocks from the previous years. In 1990-1991, when the average production was almost twice as high as sales, one can find particular firms with production more than three times as high as sales; see Basu et al. (1994).

Figure 2 contains a graph that relates the average total and export sales. Average export sales are approximately 25% of average total sales; hence, we can conclude that there is a significant share of directly exporting enterprises. The line that expresses the ratio of average export to average total sales shows some seasonality in monthly changes as well as a jump at the beginning of 1993 due to the split of Czechoslovakia.

A well-known feature is the substantial increase in average monthly sales at the end of the year. These jumps in sales in December probably reflect effects of tax regulation.[19] Notice, in addition, a continuous decrease in the size of an average firm in terms of total labor in Figure 3; a more detailed description of the labor changes in the Czech Republic in the same period of time can be found in Singer (1996). An average firm had more than 700 employees in January 1992 and ended with about 550 in December 1993. Note that this comparison does not include de novo

[19] Higher sales during the last month of the year are caused partly by "government" spending, as there is a tendency on the part of each government-financed organization to spend the whole budget; otherwise, the budget for next year might be cut. The Ministry of Finance also allows state financed organizations to spend less than the proportional amount of the budget in the first three quarters of the year (approx. 10% cut), and gives permission to spend the rest during the last quarter. In this way, the Ministry insures itself against a deficit. Another probable source of higher sales is the intention of firms to complete all contracts by the end of the year and start the new year with a clean slate.

firms. The average wage line is steadily upward-sloping and shows that average wage approximately follows the consumer price index: wage regulation is still in effect; ceilings are defined by means of CPI.

The exporting abilities of any firm depend not only on the firm's internal situation, but also on external influences, for example, the tax and duty policies of the home country and importing countries and also antidumping cases against the Czech Republic. These effects are important for an evaluation of the "softness" of the environment.

The tax and duty policies of the Czech government are quite stable. Therefore, there should be no industry, regional, or even firm-specific effects in the analyzed period since the government has conducted a liberal policy. The pegged exchange rate during 1993 did not allow for any uncertainty caused by exchange rate volatility. Therefore, all firms faced the same situation and thus, there is no need to control these effects in the regression. In 1996 the fluctuation band of the currency was widened to ±7.5% from the central parity (pegged to the basket), and in 1997 after the currency crisis the float regime was introduced. Since these major changes occurred well after the analyzed period, they need not be directly accounted for in this analysis. The average interest rate, used as an instrument in estimation, is computed and reported by the Czech National Bank and was also used as an instrument. Czech National Bank monetary policy was also stable during the whole period.

However, one should pay attention to EC importing policy. In the first five years of transition, 1989-1994, there were 560 antidumping cases. Of these, only 14 were against Czech exporters (it is worth mentioning that all these cases were started against a group of countries, not only against the Czech Republic) and 12 of the 14 had already been closed by 1992. Therefore, since 1992 there were only two cases against the Czech Republic, one in 1992 concerning iron pipes and one in 1994 concerning steel products. So far, no significant constraint due to dumping cases has been reported by Czech (or Slovak) firms during the analyzed period. Therefore, there is no need for any control of such cases in the regression. Besides, we use industrial dummies to control for industry-specific effect in the econometric analysis.

IV. Estimation Results

IV.1. Instrument Sets

Since the methods based on instrumental variable technique (simple IV or GMM) are necessary to obtain consistent estimates, let us briefly discuss the instruments we have used in our estimation procedures. The selection of valid instruments depends crucially upon the assumptions behind the nature of the error process and whether we suspect an error of measurement problem or we believe that exogenous variables are correlated with individual effects.

Let us suppose that disturbances are i.i.d. and serially uncorrelated. Also suppose that all regressors on the RHS of the regression equation are uncorrelated with an individual specific effect and are also serially uncorrelated. As noted in the econometric literature, even under these assumptions the estimation of dynamic models on panel data with a finite time dimension by the least squares dummy variable method (LSDV or within) produces an inconsistent result. This result is not influenced even if the cross-section size of the sample might be considered infinite. Valid instruments are all the RHS variables and their lagged values. In addition, lagged value(s) of the LHS is/are also valid instruments (Balestra and Nerlowe (1986)). And, of course, any first differences of any variable are also valid instruments (Matyas and Severstre (1992)).

If the RHS variable(s) is/are correlated with individual effect (error terms still uncorrelated), then any first differences and lagged RHS variables are valid instruments. However, if the error follows the moving average process of a finite order, then having the RHS correlated with individual effect means that only sufficiently lagged values of the RHS variable are valid instruments (lagged more than the order of MA). Arellano and Bover (1995) suggest additional valid instruments which could be obtained by transformations of RHS variables.

We present several sets of results depending upon the assumptions on correlation with individual effect and the error process. For the short (4 quarters) and/or long panels (8 quarters) we have assumed the error process to be i.i.d. with no or low order of correlation (MA 0, 1 or 2) and (MA 0, 1 or 4), respectively. We have assumed capital to be either correlated with individual effect or uncorrelated (i.e., capital might not or might be present in our instrument set). Investment is assumed to be correlated with individual effect as well as with the investment/capital ratio (implied by the nature of dynamic panel models with finite time dimension and individual effects). All other variables are supposed to be uncorrelated with individual effect. All computation was done in TSP v. 4.3.

In the case of all regressions, we have assumed that there is no measurement error problem, with the exception of the estimation of capital constraint. For this, we have assumed both investment and capital to be correlated with individual effect and possibly with the measurement error.

Unfortunately, eight periods are not a good basis for an exhaustive panel estimation, which would allow all coefficients to differ across both firms and time. We have addressed this possibility of differences by including cross-section and time dummies. Moreover, the error process is likely to be at least a two-year moving average since a significant portion of projects take a couple of years to complete. Therefore, a panel having more than 8 periods is necessary to proceed to the most detailed analysis and to be able to perform tests of the validity of particular instruments (Godfrey (1991)) and hence select the best estimation method.

IV.2. Capital Accumulation Constraint

As the very first step, we estimated the depreciation factor δ from capital accumulation constraint $\mathbf{K_t = (1 - \delta) * K_{t-1} + I_t}$ by IV technique. The reason is that this estimation gives a good consistency check of the capital and investment. The estimation conducted on a short panel (1993) resulted in δ = 1.37% per quarter, t-statistic = 10.6, R-squared = 0.998 and number of observations = 4148. As instruments we have used one-year lagged values (labor/sales, wage, wage bill/sales, export/sales, production/sales ratios and squared and interacted ratios of labor/sales, export/sales and production/sales) and current dummy variables indicating the main 2-digit industry, ownership and the legal form of the enterprise.

Long panel (1992-1993) estimation results were $\delta = 2.63\%$ per quarter, t-statistic = 3.68, R-squared = 0.991 and number of observations = 9987. As instruments we used one quarter lagged values (labor/sales, wage, wage bill/sales, export/sales, production/sales ratios and squared and interacted ratios of labor/sales, export/sales and production/sales) and current dummy variables indicating main 2-digit industry, ownership and legal form of the enterprise.

These very significant results coincide with the theoretical boundaries defined by the legal system of the Czech Republic. The implied one-year depreciation rate is 5.37% (±0.52%) from a short-panel estimation and 10.11% (±2.86%) from a long-panel estimation.[20] However, the results based on the short panel are very close to results obtained in a detailed study of depreciation in the Czech Republic by Lizal (1998), and therefore the further results based on a long panel should be considered less reliable. On the other hand, one can argue that the results from a long panel suffer much less from extraordinary time variance in a short time span apart from the change in definition of capital variable. This feature is probably reflected by a much lower t-statistic of the estimated depreciation rate. Note that the technique used is consistent in the presence of the measurement error in the capital and investment variables.

IV.3. Investment Equation

The general estimated investment equation, which covers **(17)** and **(18)**, was of the form

$$\frac{I_{i,t+1}}{K_{i,t+1}} = \gamma_0 + \gamma_1 \frac{Y_{i,t}}{K_{i,t}} + \gamma_2 w_{i,t} \frac{L_{i,t}}{K_{i,t}} + \gamma_3 \left(\frac{I_{i,t}}{K_{i,t}} \right)^2 + \gamma_4 \frac{I_{i,t}}{K_{i,t}} + \gamma_E \frac{E_{i,t}}{K_{i,t}} + \beta^T D_{i,t} + \eta_{i,t} \quad ,$$

where $\mathbf{Y}_{i,t}$ stands for total production (or total sales), $\mathbf{E}_{i,t}$ for exports, $\mathbf{I}_{i,t}$ for investment, $\mathbf{K}_{i,t}$ for capital, $\mathbf{L}_{i,t}$ for labor input, $\mathbf{w}_{i,t}$ for wage, $\mathbf{D}_{i,t}$ are industrial and time dummies, **i** is individual (firm) subscript, **t** is time subscript. The equation was estimated twice, once imposing constant returns to scale on arbitrary production function ($\gamma_1 = - \gamma_2$) and once imposing the Cobb-Douglas production function with arbitrary returns to scale; and the validity of the constant returns to scale constraint was tested. Estimated parameter γ_E was used to calculate the value of underlying parameter $\mathbf{a}_E$ of the adjustment cost function associated with the export sales in the same way as γ_1 was used to calculate the overall adjustment cost function parameter **a**; e.g., see the easiest formula **(17)** for exactly how the parameter **a** enters the estimated function parameters. Standard errors of all underlying parameters **a**, $\mathbf{a}_E$, **b** and π were obtained by means of the classical delta-method with analytic first derivatives. Estimation was carried out using TSP 4.3; asymptotic standard errors were computed using the delta method (analytic first derivatives).

[20] The delta method was always used to compute asymptotic standard errors.

IV.3.i. Long Panel

(1) Capital Is Assumed to Be Correlated with Individual Effect:

In this case, no instruments should contain the capital variable since then the estimates would be inconsistent. Instruments were similar to those in the estimation of the capital constraint described in the previous chapter. In particular, we have used lagged values and combinations of RHS variables (labor/sales, wage, wage bill/sales, export/sales, production/sales ratios, all of them also squared, and interacted ratios of labor/sales, export/sales and production/sales) and current dummy variables indicating the main 2-digit industry, ownership and legal form of the enterprise. The panel was estimated by GMM with MA process of order 1 and 4 (i.e., one-quarter MA, one-year) and by simple IV with assumption of i.i.d., uncorrelated error process. As can be seen from the top of Table 3, the discount factor π is always significantly positive and, surprisingly, slightly (although insignificantly) higher than one. The value 1 is always within the one-standard error boundary. The parameter **b**, standing for the optimal level of investment with minimal adjustment costs, is also quite high and tends to be around 0.5 with low significance. This is the major difference between our results and those from the pioneering study of Bond and Meghir (1994) where their results implied a contradictory negative value of **b**, ranging from -0.20 to -0.45 (with one exception when b=0.93) in their regressions.[21] The last parameter **a** is not well-identified and is always completely insignificant, so there could be no assessment about its value from the conducted analysis. R-squared was always between 0.17-0.20, mainly above 0.19. We report only the results based on regressions with time and ownership dummies since these dummies were very often significant, while the other dummies (industry, and especially regional, dummies) were not. The parameters **b** and π were estimated with lower standard error after the exclusion of insignificant dummies. Regressions with larger sets of dummies have not revealed changes in the mean of estimates, just that standard errors were higher, so we do not report them.

Regardless of the method we used, the dummies we included, or what we assumed about the production function, the coefficients associated with exports were always insignificant (they never reached the 10% level of significance). This robust result leads to the conclusion that a firm's management does not take into account exports as being different from domestic sales and that exports never play a role in the cash-flow of the enterprise. Nevertheless, we do report the value of parameter $\mathbf{a}_E$ computed from exports, as well.

The column before the last in Table 3 reports the test results of a constant return to scale of the production function. The assumption of constant returns to scale was never rejected at any reasonable level of significance. In order to prevent any misinterpretation of this test we should stress that the null hypothesis is of the form "Given the production function is a Cobb-Douglas one, is it exhibiting constant returns to scale?"

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[21] Please note that **b** was assumed to be positive since negative values are hard to interpret; keeping status quo (i.e., b=0) is theoretically the lower bound limit since no action causes no adjustment costs.

(2) Capital Is Assumed to Be Uncorrelated with Individual Effect:

We can add capital and combinations including capital into the set of instruments from the previous estimation. The results presented in the second half of Table 3 are more significant and similar to the previous ones with a smaller set of instruments above. Contrary to the previous estimation, the coefficient associated with exports is significant. However, the value of $\mathbf{a}_E$ is such that we cannot reject the hypothesis that the structural parameters **a** of the cost adjustment function, computed from the whole sales and exports, are the same (but this is mainly because of the low significance of the total sales coefficient). We have again used a coefficient associated with exports to calculate the value of structural parameter $\mathbf{a}_E$. The mean value of this parameter computed from the exports is around 1000 with sufficiently significant t-statistics (above 2). Again, there is no evidence that the adjustment cost functions are different for domestic and foreign sales.

The parameter π is again slightly higher than 1 and always significant at the 1% level; however, value 1 is still within the one standard error boundary. Parameter **b** again takes high positive values, supposing the optimal investment rate with lowest adjustment costs to be around 0.5. Note that if the assumption of capital uncorrelation with individual effect is invalid, these results are inconsistent. This is also the point where slightly different definitions of capital could cause problems, since the method used is not robust for measurement error in capital. The IV estimates with the i.i.d. error assumption seem to perform much worse than GMM with MA error.

IV.3.ii.Short Panel

(1) RHS Variables Are Instrumented:

The short-panel estimation uses more lagged values as instruments and hence we assume that all current variables (not only the capital and investment) are correlated with individual effect. Assuming in addition that the error process is i.i.d. or correlated over time with some low order MA process (1 or 2), the previous year variables (excluding the capital and investment) are always proper instruments for estimation (since valid instruments are those which are lagged more than the order of error process). We were not able to reject the hypothesis that exports are treated in the same way as domestic sales, as can be seen from the top of Table 4. This was again because of the high standard error of the relevant estimates. The estimated parameter π oscillates around 1 and is insignificantly different from 1.

Compared with the long-panel estimations, parameter **b** takes on lower values of about 0.2, however, having the similar standard errors as before (hence the t-statistics are much lower). The test again did not reject the assumption of constant returns to scale on any level (the one before the last column). R-squared is above 0.12, usually around 0.13.

(2) Capital Is Assumed to Be Correlated with Individual Effect:

These last results shown in the second half of Table 4 seem to us to be the most appealing ones since the estimates have the smallest standard errors and the mean values are very close to the theoretically expected values. We have again assumed several types of the error process, that is, i.i.d. or correlated over time with a low order MA process. The set of proper instruments now includes (excluding the capital and investment) the current and lagged RHS variables (since valid instruments are all exogenous RHS, not only the ones which are lagged more than the order of error process).

As before, we were not able to reject the hypothesis that exports are treated in the same way as domestic sales; both estimates of parameters $\mathbf{a}_E$ from exports and **a** from domestic sales take values around 1000. The estimated parameter π oscillates around 1 and is significant. Parameter **b** seems to take low values, about 0.1 or 0.2, but the t-statistics are again quite low. The test did not reject the assumption of constant returns to scale on any level. R-squared is above 0.12, usually around 0.14.

V. Conclusions

First of all, our analysis provides results which challenge Bond and Meghir's (1994) pioneering study, since their estimates yield significant negative values of a structural parameter **b**, which would mean that the adjustment costs are minimal at a rather high speed of disinvestment of 30% a year.

The conducted analysis suggests several main points. The first one is that the per capital optimal level investment from the point of minimal adjustment costs is around the interval 0.1 to 0.2, and firms are investing approximately 0.09 of capital per year. This level of investment is similar to the one of Great Britain analyzed by Bond and Meghir (1994). Czech firms therefore seem to be quite close to the "optimal" point with minimal costs of adjustment.

Remarkable is the value of the estimated discount factor π, which coincides with a theoretical value quite close to 1 for a long-time horizon. This finding contradicts the usual arguments that management in transition discounts the future with a very high discount factor different from the overall interest rate. We have to argue that this is not supported by our investment estimates and hence maintain that managerial decisions are more long-term sighted; but one has to keep in mind that managers could discount each type of action by a different factor, and what was found for investment might not hold true in other circumstances. We can also strictly interpret this result as direct evidence of neglecting the "soft" temporary nature of the macroeconomic environment during early transition, hoping foolishly that these favorable conditions will prevail for long time.

The third major point raised in our analysis is that directly exporting firms probably do not distinguish between domestic and foreign markets, or, at least, we were not able to disprove this claim based on the estimation results showing that parameter **a**, computed from domestic sales, differs from $\mathbf{a}_E$, computed from exports. In other words, the concept of the multiproduct firm is in our framework dubious and since the coefficient associated with exports is insignificant, exports cannot be considered as a factor influencing the firm's cash flow. Both markets are likely to be treated equally since (1) the estimates of the influence of export sales on the investment function are such that their mean values range approximately between 500 and 1000 (taking into account only estimates with reasonable t-statistics and positive mean values, i.e., those which are in line with the assumptions on the sign of the coefficient); and (2) the standard errors are such that we were never able to reject the hypothesis of equal treatment of the total and foreign sales. This is not such a surprising finding since the country considered had a very stable exchange rate, but we have to admit that the data is such that the estimates of parameter **a** should not be strictly interpreted. The problem is that the coefficient used for the computation of the parameter value (the one associated with total sales) is usually insignificant. This could be caused by the total output constraint on the domestic market and the firms' use of exports to ease this restriction. Since the exports are not constrained by the limited domestic demand, they probably have a much higher explanatory power and, thus, the structural parameter $\mathbf{a}_E$ of the model is better identified. Anyway, we cannot recommend any export-oriented government policy since there is no evidence that firms distinguish between exports and domestic sales. Which again questions labeling the "soft" macroeconomic environment in the early transition desirable. The microeconomic level was not on average "clever" enough to take advantage of these temporary conditions.

Combining these two extremely suggestive pieces of evidence we might conclude that even though on the macroeconomic level the Czech Republic was a leader among the transforming economies (EBRD 1995), on the microeconomic level the governmental economic policy was a failure with harmful potential for the future. Firstly, the firms were unable to find that the "soft" budgeting through macro policy is not sustainable in the long term. Secondly, the fixed exchange rate was extremely costly and at the end the favorable currency policy turned against the economy — real appreciation was fast and the trade balance started to deteriorate and the unrestructured firms lost their price advantage. These results are even stronger since they are independent of the assumption on error process and choice of instruments. Hence the economic policy conclusion is quite straightforward: a "soft" environment is not viewed as a "temporary help" but rather as a "long term policy," which could be lobbied for.

As a byproduct of the analysis conducted in this paper, we have not been able to reject constant returns to scale of the production function assuming the Cobb-Douglas form. Since the parameter estimates seem to be quite sensitive to any misspecification, the results could be different for another production function (e.g., constant elasticity or translog).

One obvious omitted problem can be found in the cashflow. With the exception of exports, which turned out not to be significant (hence the firm's investment is not influenced by exports), we have not controlled for the cash flow or limited access to bank credits since the data on outstanding debts is poor. A more complex method explicitly dealing with these constraints and measurement errors in the debt and cash variables could give better results; see Lizal and Svejnar (1998).

As we indicated earlier, the error process is likely to be at least an one-year moving average; thus, a longer panel in the time dimension is a necessity. Also, the assumption of costless adjustment of labor can play a role.[22] The problem of minor changes in the capital variable or other variable definitions could be overcome by a different method allowing for measurement errors. However, such methods unfortunately demand long time dimensions of the data and the CSO no longer monitors export sales, so there is no opportunity to prolong the time dimension of the sample and improve the estimation.

A panel covering several more years would be a good background for estimating the investment equation with the measurement error problem. Since our estimates do not change significantly with the assumption on the order of the MA process but rather with the assumption on the exogeneity of instruments, we suggest focusing on the estimates from the short panel, since the instruments used could be safely considered exogenous and therefore could correct for the possible measurement error.

[22] Singer (1998) et al. have found significant adjustment costs for revenue adjustment. On the other hand, they admit that the real importance of adjustment costs is negligible; the adjustment costs to a 50% drop of sales do not exceed 1% of the total costs.

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Table 1 Quarterly Characteristics

Variable / Period	1992/Q1 Mean (Std.Dev)	1992/Q2 Mean (Std.Dev)	1992/Q3 Mean (Std.Dev)	1992/Q4 Mean (Std.Dev)	1993/Q1 Mean (Std.Dev)	1993/Q2 Mean (Std.Dev)	1993/Q3 Mean (Std.Dev)	1993/Q4 Mean (Std.Dev)
Capital (mil. Kc)	647 (2848)	603 (2578)	647 (3125)	622 (3083)	618 (2492)	589 (2278)	641 (2929)	627 (2960)
Investment (mil. Kc)	6.68 (26.34)	9.38 (37.33)	10.96 (58.75)	23.53 (201.90)	7.90 (46.80)	11.41 (50.73)	14.02 (92.06)	22.31 162.19
Sales (mil. Kc)	122 (480)	120 (405)	118 (480)	147 (606)	124 (494)	120 (442)	117 (454)	139 (597)
Labor (employees)	847 (2507)	781 (2117)	772 (2080)	723 (1990)	761 (2223)	701 (1905)	692 (1861)	650 (1768)
Production (mil. Kc)	103 (381)	102 (365)	100 (437)	115 (494)	107 (408)	103 (391)	97 (403)	112 (498)
Export (mil. Kc)	25.6 (143.9)	28.1 (141.7)	26.2 (141.8)	27.6 (134.6)	31.2 (179.5)	33.9 (192.9)	31.1 (156.5)	33.8 (186.3)
Average Wage (1000Kc/month)	4.019 (0.914)	4.338 (1.010)	4.319 (0.919)	5.105 (1.290)	4.883 (1.157)	5.487 (1.352)	5.389 (1.218)	6.116 1.582
Investment/ Capital	0.0169 (0.0532)	0.0238 (0.0712)	0.0209 (0.0570)	0.0349 (0.0814)	0.0138 (0.0447)	0.0234 (0.0671)	0.0236 (0.0609)	0.0327 (0.0737)
N	1241	1517	1553	1559	1253	1540	1568	1582

Table 2 Year-to-Year Comparison

	1992 Mean (Std. Err.)	1993 Mean (Std. Err.)	% Change
Average Wage (in Kc/month)	4480 (1330)	5500 (1610)	22.69
Labor (employees)	664 (1945)	605 (1745)	-8.86
Sales (in 1000 Kc/month)	37362 (170520)	37018 (166370)	-0.82
Exports (in 1000 Kc/month)	7849 (47357)	9436 (55732)	20.21
Production (in 1000 Kc/month)	31406 (146310)	31189 (140900)	-0.69
CPI (whole year)	12.7	18.2	n/a
PPI (whole year)	9.6	11.4	n/a

Note: Cross-section of all firms in monthly panel by 12 months in a given year, 22560 observations (1880 enterprises), balanced panel.

Table 3 Structural Parameter Estimates, Long Panel

Method	π	b	a	a_E	p-value	R^2
Capital Instrumented						
IV X	1.334* (0.794)	0.584 (0.80)	-155 (228)	-354 (2360)	63%	0.191
IV C	1.202* (0.653)	0.461 (0.659)	-286 (454)	209 (317)	x	0.195
GMM MA(1) X	1.378** (0.604)	0.596 (0.595)	-216 (251)	-128 (210)	25%	0.185
GMM MA(1) C	1.172*** (0.414)	0.415 (0.420)	-855 (2524)	517 (1293)	x	0.198
GMM MA(4) X	1.329*** (0.465)	0.571 (0.468)	-272 (332)	-213 (463)	33%	0.191
GMM MA(4) C	1.187*** (0.353)	0.466 (0.382)	-878 (2510)	451 (791)	x	0.197
Capital in Instrument Set						
IV X	1.499 (1.094)	0.788 (1.110)	2340 (4180)	728 (597)	75%	0.193
IV C	1.503 (1.097)	0.775 (1.107)	12100 (58000)	900 (849)	x	0.194
GMM MA(1) X	1.244*** (0.432)	0.503 (0.437)	3270 (5540)	881** (354)	54%	0.197
GMM MA(1) C	1.212*** (0.407)	0.467 (0.410)	19300 (102000)	993*** (353)	x	0.198
GMM MA(4) X	1.244*** (0.353)	0.521 (0.364)	5290 (14300)	903*** (342)	35%	0.196
GMM MA(4) C	1.226*** (0.341)	0.499 (0.351)	25400 (180000)	984*** (301)	x	0.197

Note: Standard errors are in parentheses. All estimates are corrected for heteroskedasticity. X stands for the Cobb-Douglas production function of arbitrary returns to scale, C for arbitrary production function with constant returns to scale. There were 9987 observations and dummies for time and ownership were included in the regression. p-value is a test of constant returns to scale; rejection would be signaled by a smaller number than chosen level of significance (i.e., less than 10%, 5% or 1%). Significance at 10%, 5% and 1% is denoted by *, ** and ***, respectively.

Table 4 Structural Parameter Estimates, Short Panel

Method	π	**b**	**a**	$\mathbf{a_E}$	p-value	R^2
All RHS Variables Instrumented						
IV X	0.961** (0.439)	0.193 (0.378)	1320 (6600)	-1360 (6480)	99%	0.124
IV C	0.963** (0.405)	0.194 (0.366)	1420 (4060)	-1420 (6770)	x	0.124
GMM MA(1) X	0.972*** (0.281)	0.237 (1.693)	-1600 (889)	964 (2100)	56%	0.141
GMM MA(1) C	1.084** (0.452)	0.344 (0.387)	-1160 (2580)	770 (1750)	x	0.137
GMM MA(2) X	0.961** (0.375)	0.193 (0.351)	1300 (5000)	-1300 (4190)	98%	0.124
GMM MA(2) C	0.992* (0.560)	0.200 (0.350)	-1560 (3630)	832 (2130)	x	0.143
Capital Instrumented						
IV X	0.968* (0.569)	0.124 (0.564)	-1200 (1760)	998 (998)	87%	0.124
IV C	0.954* (0.536)	0.115 (0.575)	-1060 (981)	946 (757)	x	0.124
GMM MA(1) X	0.948*** (0.244)	0.182 (0.228)	-629*** (216)	681*** (231)	22%	0.141
GMM MA(1) C	1.084** (0.452)	0.344 (0.386)	-1160 (2580)	770 (1750)	x	0.137
GMM MA(2) X	0.978*** (0.246)	0.207 (0.233)	626*** (210)	671*** (220)	21%	0.141
GMM MA(2) C	1.013*** (0.248)	0.184 (0.289)	-743*** (275)	720*** (264)	x	0.144

Note: Standard errors are in parentheses. All estimates are corrected for heteroskedasticity. X stands for the Cobb-Douglas production function of arbitrary returns to scale, C for arbitrary production function with constant returns to scale. There were 4148 observations and dummies for time and ownership were included in the regression. p-value is a test of constant returns to scale; rejection would be signaled by a smaller number than chosen level of significance (i.e., less than 10%, 5% or 1%). Significance at 10%, 5% and 1% is denoted by *, ** and ***, respectively.

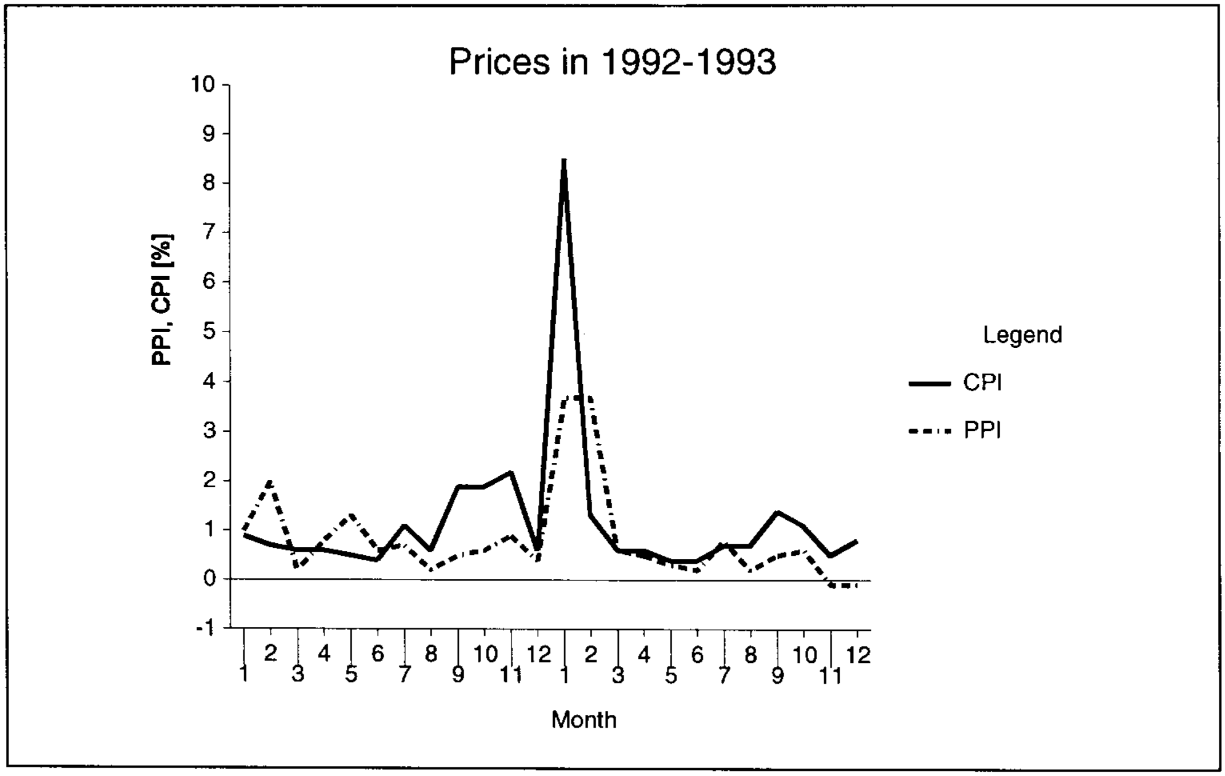

Figure 1 Price Indexes (% change, preceding month is 100%)

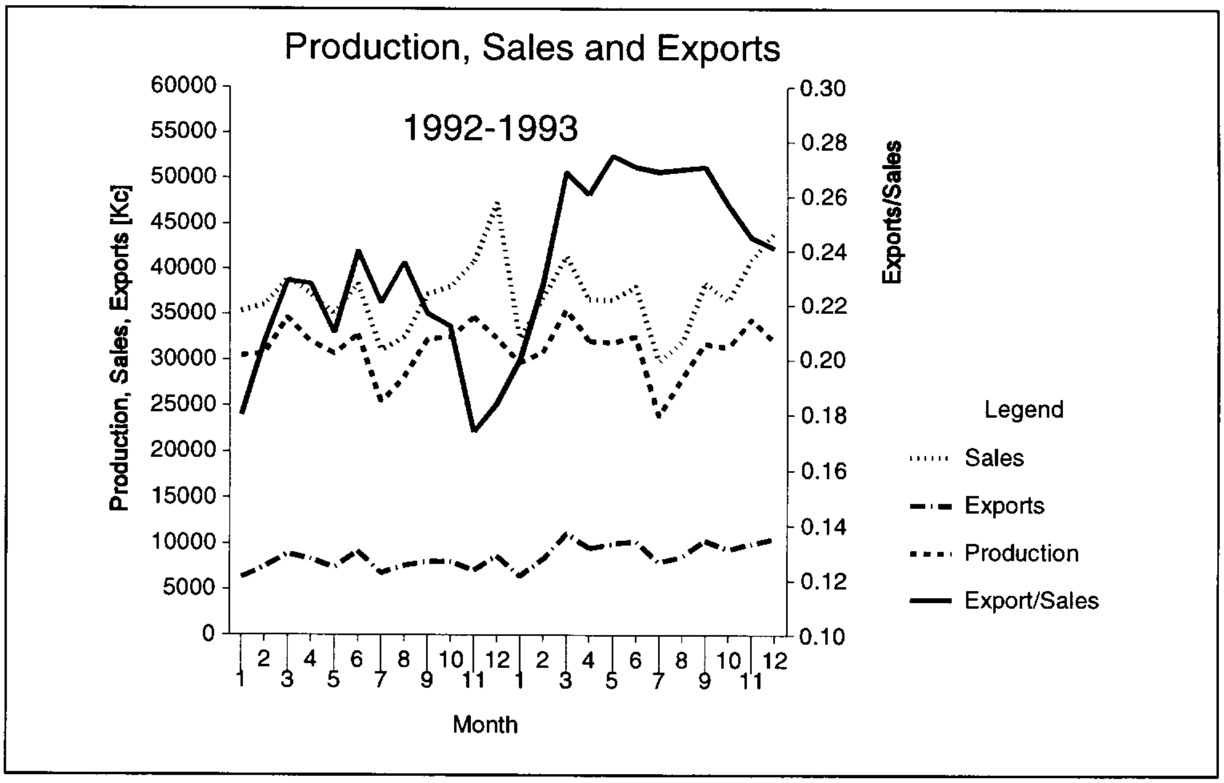

Figure 2 Volume of Production, Sales and Exports, and Export Share

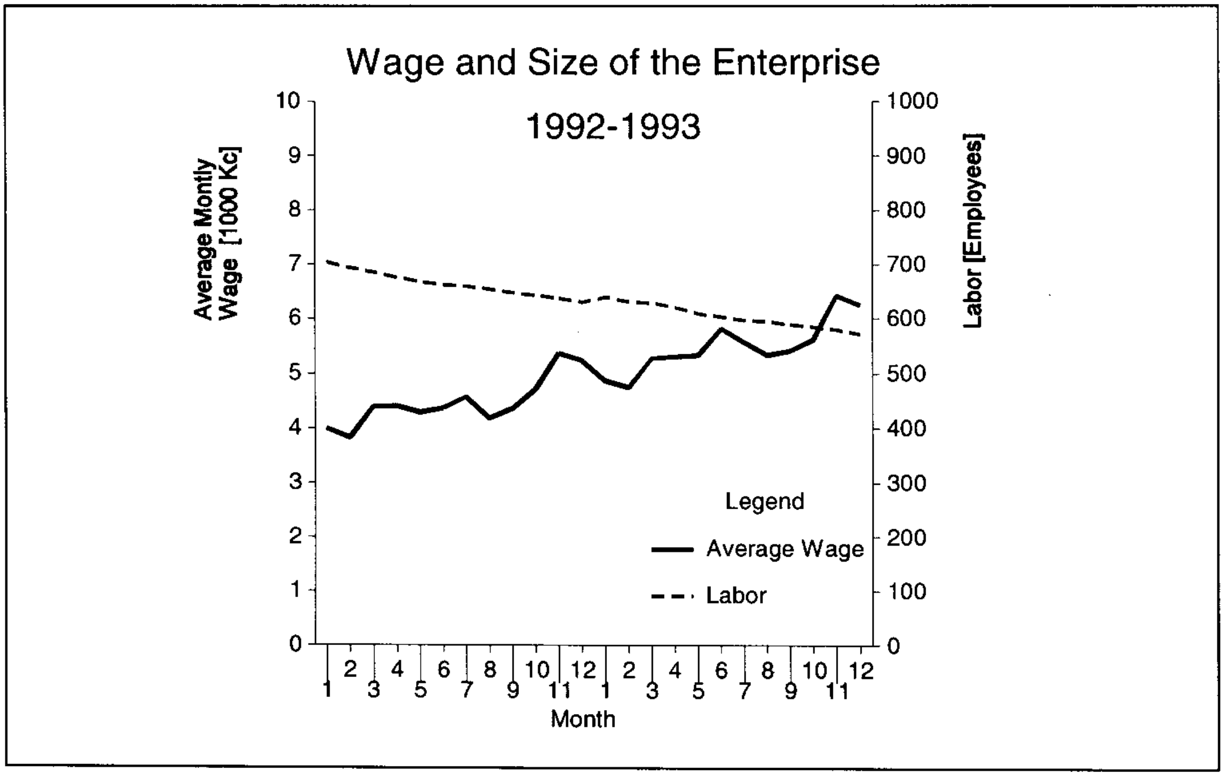

Figure 3 Average Monthly Wage and Average Enterprise Size