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ARE EFFICIENT FIRMS MOTIVATED TO INVEST? EVIDENCE OF MANUFACTURE OF MOTOR VEHICLES IN THE CZECH REPUBLIC

A sample of 24 representative firms in the Czech economy is a subject of a study for their technical efficiency and, subsequently, for their willingness to invest. The former concept is accomplished with the help of the frontier production function. The latter one is based on the value of Tobin's *Q*, defined as the ratio of the market value of business capital assets to their replacement value; if it is greater than one, *Q* indicates the profitability of further investment. The analysed firms differ in their technical performance, but all of them are profitable and this might be their motivation to invest. A comparison of technical efficiency and Tobin's *Q* as two evaluations follows under a hypothesis that one of them matches the other one. Applying the Passing–Bablok method, the finding is that those two items are not interchangeable in spite of a high correlation.

Keywords: *frontier production function, Tobin's Q, panel data, VAR model*

1. Introduction

The Czech Republic (CR) is a small open economy with a high demand for investment, part of which comes from abroad. The foreign investors, especially, have no reason to stay there if they do not earn profits. Therefore, it seems probable that they produce at an acceptable degree of efficiency, but it is not clear if they intend to invest repeatedly or to explore actual resources only and leave the country. Due to today's high capital mobility, such production behaviour is current practice.

A sample of 24 firms representing the manufacture of motor vehicles, trailers and semi-trailers, and other transport equipment in the CR are treated. In [14], the Czech automotive industry is characterized as follows: *It can be said without exaggeration that*

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the automotive sector is an economic pillar of the Czech Republic, as the country offers development of artificial intelligence that is expected to drive the autonomous vehicles of the future, improvement of the handling and performance of electric vehicles and traditional skills in manufacturing standard vehicles with internal-combustion engines. According to statistics from February 2017, 118 000 people work directly in the Czech automotive industry, though that number rises to 400 000 when figuring in the employees of indirect suppliers. Those numbers refer to the country with 10 million inhabitants. Further information is given in [8]: *The automotive sector makes up nearly 25% of the country's industrial production and exports and approximately 7.4% of GDP.* The chosen firms are parts of international concerns (e.g., Škoda Auto belongs to Volkswagen), represent foreign capital invested in the CR (e.g., Hyundai) or are speculated to be the subject of potential foreign acquisition (Škoda Transportation). In fact, the sample makes up such a substantial part of the Czech industry that the collapse of the sample firms will most probably be an economic disaster for the country.

The data comes from the database Amadeus32 [1] and covers the years from 2007 to 2016 (last published when preparing this text), and hence it is a panel structure. The firms are studied for their technical efficiency and, simultaneously, for benefits from further investment. The former is expressed with the help of the frontier production function, and the latter is studied using the concept of Tobin's *Q*. A comparison of those two economical aspects follows.

2. Theoretical background

Two basic approaches exist, allowing comparing different units for their efficiency: the methods based on DEA, e.g., [5, 6], and, alternatively, a comparison working on the assumption that a frontier production function is a relevant benchmark as it is, e.g., in [9, 16, 11], and [12]. In any case, numerical scale results after computations. Tobin's *Q*, given as a ratio of the market value of business capital assets to their replacement value, can be interpreted as an investment indicator [2, 4]. It is also used as a proxy for firm value [17], thus the numerical results can also be interpreted as a scale. Comparing two or more scales of measurement by statistical methods has been developed, e.g., in [3, 13], in the context of firm values applied in [17].

If a firm with an acceptable efficiency expects a benefit from further investment, its investment (when realised) will also be profitable for the economy of the country. A non-efficient and/or not investing firm tends to finish its operation.

The goal of the article is to answer the question of whether there exists any relation between those two economical aspects of the studied data sample. After computing the scales in question, a hypothesis is formulated that one of them matches the other one. A correlation can be computed as rough information. A comparison of different scales of measurement of experimental results by the Passing–Bablok method is a more subtle approach and will be applied.

3. Methodology

3.1. Efficiency

Having a production function $Y = f(K, L)$, we understand the technical efficiency TE_i of the ith subject as an output-oriented measure defined by

$$TE_i = \frac{Y_i}{f\left(K_i, L_i\right)}$$

where Y_i is the current output of the subject, and $f(K_i, L_i)$ is the feasible technological maximum represented by the frontier production function of the group of units to be compared. Evidently, $TE_i \leq 1$. Let us suppose the Cobb–Douglas form $Y = AK^{\alpha}L^{\beta}$. Relevant frontier production function can be estimated with the help of the corrected ordinary least squares (COLS) method, which is to be performed in two steps:

1. OLS is used to obtain consistent and unbiased estimates of slope parameters α and β, and a consistent but biased estimate of constant $\gamma = \log A$.

2. The biased constant $\hat{\gamma}$ is shifted up to encompass all the observed data above. This is done by setting $\hat{\gamma}' = \hat{\gamma} + max_i \left\{\hat{u}_i\right\}$, $\hat{u}_i$ being residuals from the OLS regression.

The production frontier estimated by COLS represents, in fact, the "best practice" technology (for details, e.g., [9])

Now, we have $Y_i = \hat{Y}_i \exp\left(\hat{u}_i\right)$ and $(K_i, L_i) = \hat{Y}_i \exp\left(max_i \{\hat{u}_i\}\right)$. So

$$TE_i = \frac{\hat{Y}_i \exp\left(\hat{u}_i\right)}{\hat{Y}_i \exp\left(max_i \left\{\hat{u}_i\right\}\right)} = \exp\left(\hat{u}_i - max_i \left\{\hat{u}_i\right\}\right) \tag{1}$$

3.2. Tobin's *Q* as an investment indicator

The investment behaviour of the firm is supposed to be formalized as an optimizing problem

$$V_t \rightarrow \text{MAX}$$

subject to

$$I_t - \delta K_t = K_t^*$$

in which V_t is the value of the firm, K_t stands for capital and I_t for investment. The solution gives an optimal investment with the goal to maximise the value of the firm. According to Tobin' theory (see, e.g., [4]), investment depends on the ratio Q of relevant shadow price, which in fact is the market value of business capital assets, to their replacement value. The interpretation of such a Q is as follows:

- $Q > 1$ indicates a marginal expected profit of a unit of capital to be higher than a unit of additional cost, which is a motivation to invest,
- $Q = 1$ is an equilibrium state when there is no incentive for the firm to invest,
- $Q < 1$ relates to an unprofitable environment.

In practice, neither Q nor the nominator, as well as the denominator, are observable. A calculation of Q is proposed by Behr and Bellgardt [2], which reflects the fact that only a small part of firms are quoted on stock markets. The Q is computed for firm i at period t using the market value of equity market V_{it}, the value of outstanding debt D_{it}, remaining assets aside from the capital stock N_{it} and replacement value of capital stock K_{it} as

$$Q_{it} = \frac{V_{it} + D_{it} - N_{it}}{K_{it}} \tag{2}$$

All comprised variables are standardly followed except for V_{it}, which can be computed according to the formula

$$\widehat{V_{it}} = \sum_{\tau=1}^{\infty} \widehat{P_{it+\tau}} \delta_{t\tau}^{\tau} \tag{3}$$

with

$$\delta_{t\tau}^{\tau} = \frac{1}{\left(1 + r_{t\tau}\right)^{\tau}}$$

r being a market interest rate, and $\hat{P}$ a prediction of pre-tax profits. For applying (2) via (3), a panel data set is proposed. A prediction of $\hat{P}$ comes from a VAR model in which sales S and cash flows CF are comprised.

$$P_{it} = \beta_{10} + \beta_{11} P_{it-1} + \beta_{12} S_{it-1} + \beta_{13} CF_{it-1} + u_{1t}$$

$$S_{it} = \beta_{20} + \beta_{21}P_{it-1} + \beta_{22}S_{it-1} + \beta_{23}CF_{it-1} + u_{2t} \qquad (4)$$

$$CF_{it} = \beta_{30} + \beta_{31}P_{it-1} + \beta_{32}S_{it-1} + \beta_{33}CF_{it-1} + u_{3t}$$

In (4), the panel structure of data is important because it provides us with a sufficient number of observations.

This approach can be used universally but from a practical point of view it is useful to reflect the finding of Behr and Bellgard [2] that the smaller firms react stronger to Q. Besides, what is computed by (4) is an average value Q^a, while the theory refers to Q as to a marginal value Q^m. In general, it is not $Q^a = Q^m$ (necessary conditions for equality are formulated and proved by Hayashi [3]). In case of a monopoly, usually $Q^a > Q^m$. The concept of the optimal solution is used to formulate an econometric model and to perform a relevant stochastic inference. So, whichever results are found, they refer neither to global nor to local optimal solution of an optimizing problem.

4. Computations

The concept of technical efficiency could be generalized to process panel data (see, e.g., [15]), too. Nevertheless, for this part of the analysis, only the 2016 cross-section was used since the results of years 2007–2009 approximately are affected not only by the financial crisis but also by different starting procedures in the case of some new firms (Fig. 1). The high differentiation of performance is somewhat surprising. It may partially be explained by a finding that the estimated production function itself has one atypical feature: the role of labour is weaker than the empirical standard.

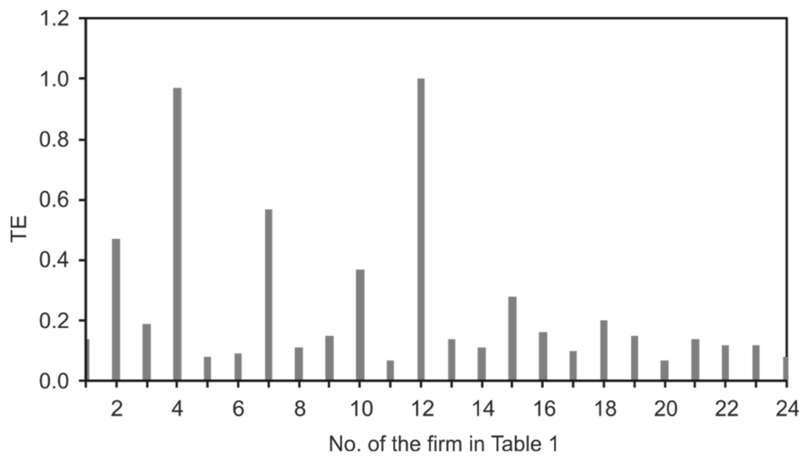

Fig. 1. Technical efficiency of firms

Table 1. Firms: forecasted value, Q indicator

No.	Firm	Forecasted value [10^3 €]	Q
1	Škoda Auto	4 066 270	1.339
2	Hyundai	1 309 842	2.988
3	Toyota Peugeot Citroen	731 962.2	2.795
4	Mobis automotive	292 083.6	18.552
5	Bosch Diesel	267 643.4	1.266
6	Robert Bosch	162 388	1.311
7	Faurecia Automotive	69 950.83	5.129
8	Brose	1 000 398	6.561
9	Sungwoo Hitech	216 347.9	1.308
10	Eberspaecher	94 735.52	4.676
11	Škoda Transportation	282 885.6	2.207
12	SAS Autosystemtechnik	158 518.8	22.894
13	Adient	65 780.41	3.906
14	TRW Automotive	167 934.4	1.117
15	Jtekt Automotive	100 819.5	5.169
16	Valeo autoklimatizace	72 022.61	2.191
17	Magna Exterioirs	145 280	2.825
18	TRW-Carr	127 318.9	5.414
19	Mahle Behr	120 659.3	3.102
20	Tyco Electronics	113 915.2	1.474
21	Lear Corporation	65 242.04	4.543
22	Benteler	94 965.33	3.114
23	Magna Automotive	22 489.28	1.074
24	Hanon Systems Autopal	165 173.9	2.404

The explanation is straightforward: the output and the capital are measured in world prices but the wages in the CR are approximately at the 30–40% level of those in the EU. Incidentally, this is a reason for the presence of many foreign investors in the CR. In any case, management of particular firms probably considers their economic results as acceptable, according to their own internal quantitative criteria. To compare, various branches of the Czech industry were analysed after the first decade of switching from centrally planned to a market-oriented economy, and before a massive flow of foreign investment [7]. The elasticities of output to capital (about 0.2) and to labour (about 0.8) were the same as in standard economies but the competitiveness of the Czech industry was low.

Applying Q-computations, the question of the number of summands in (3) arises. A common practice (justified in [2]) is to respect the empirically verified rule that it is sufficient to consider four years as a relevant time horizon. The purpose of (4) is not to study its panel structure and characteristics, but only to have sufficient data to estimate parameters and to predict $\widehat{P_1} - \widehat{P_4}$. That is why the pool regression was applied after the finding that P (t-value = –5.866), CF (t-value = –8.002) and S (t-value = –10.898) are stationary, according to the ADF test (critical t-value = –2.874 at the 5% level). After accomplishing all the necessary computations, the results are summarized in Table 1. The average value of Q is 4.473, and the median is 2.988. No result $Q \leq 1$ occurs.

To proceed with a description of the Czech industry in the last decade of the past century, the paper [10] dealing with 92 Czech firms (without foreign capital) could be mentioned, showing that the average Q was –0.355, with a median of –0.190.

5. Comparison

Before comparing both scales, the Q indicator is normalized as $QN = Q/Q_{\mathrm{MAX}}$. TE and QN are summarised in Table 2 and in Fig. 2. Correlation (TE, QN) = 0.89.

Table 2. *TE* and *QN*

No.	1	2	3	4	5	6	7	8	9	10	11	12
TE	0.14	0.47	0.19	0.97	0.08	0.09	0.57	0.11	0.15	0.37	0.07	1
QN	0.05	0.13	0.12	0.81	0.05	0.05	0.22	0.28	0.05	0.20	0.09	1
No	13	14	15	16	17	18	19	20	21	22	23	24
TE	0.14	0.11	0.28	0.16	0.10	0.20	0.15	0.07	0.14	0.12	0.12	0.08
QN	0.17	0.04	0.22	0.09	0.12	0.23	0.13	0.06	0.19	0.13	0.04	0.10

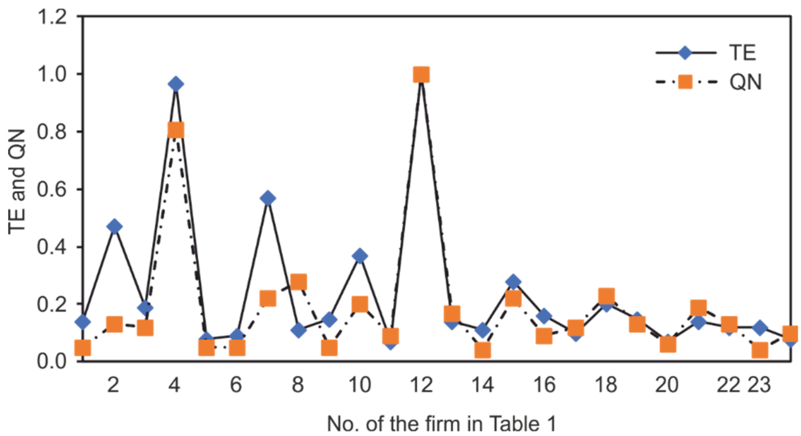

Fig. 2. *TE* and *QN*

With the two evaluations, we have to ask if one of them matches the other one. Having, in general, evaluations X and Y, the problem may be solved by analysing the relation

$$Y = \beta_0 + \beta_1 X$$

The comparison is accomplished by estimating the model and testing whether $\beta = 0$ and $\beta_1 = 1$. The result does not depend on the assignment of the methods (or instruments) to X and Y. Unfortunately, the ordinary least squares method is not acceptable because of the failure of the assumption that the X values are fixed by the design of the study. Here, both Y and X values are subject to errors, which requires special regression techniques.

For further computations, the Passing–Bablok [13] regression is used which for each of the $N = \binom{n}{2}$ possible pairs of points defines the slope

$$S_{ij} = \frac{Y_i - Y_j}{X_i - X_j}$$

According to rules summarised in [13], β_1 is determined as a shifted median of all S_{ij} values. Using the slope, β_0, as well as confidence bounds, are calculated.

Applying the technique, it was found that

$$QN = -0.029 + 0.978TE$$

As for the 95% confidence intervals, it is

$$-0.030 < \beta_0 < -0.026, \quad 0.613 < \beta_1 < 1.392$$

Constant β_0 is evidently negligible, but zero value is not in the confidence interval. On the other hand, the slope is near one, but the tolerance is ±39%, approximately.

Though the first schematic evidence seems to speak in favour of a strong similarity of both evaluating indicators, the detailed statistic review shows no systematic pattern.

6. Conclusions

The sample of an important segment of the Czech industry which operates with the participation of foreign capital is studied for their effectiveness and for the profitability of investment.

Contrary to the preliminary expectation, the firms are rather imbalanced with regard to their production performance, which could partially be explained by their non-standard production function. The role of the labour factor is suppressed due to the cheap labour forces, while capital and output are bought and sold for world prices.

Tobin's Q is defined through an optimisation problem, which helps to interpret a relation of Q to 1 (greater, less, or equal) in terms of possible profitability/non-profitability of further investment. The author's own computations are performed with the help of a panel VAR system.

Tobin's *Q* may also be seen as another form (proxy) of evaluation of firms and a statistical comparison with technical effectiveness is delivered. In spite of promising features, severe statistical analysis does not validate the hypothesis that one indicator implies the other one. Nevertheless, the data sample studied shows that the implication *the higher the efficiency, the higher the motivation to invest* and *vice versa* occurs in 89%.

As for the practice, there is no unprofitable firm in the sample, according to Tobin's *Q* values. It is $Q > 1$ for all units, which means that marginal expected profit of a unit of capital is higher than a unit of the additional cost. A comparison with some previous findings of the author [10] is mentioned, giving the evidence of an improving condition of the Czech industry. If for the firms, there is a motivation to invest based on their own economic characteristics, the concept of government investment incentives should possibly be reconsidered.

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