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A COMPREHENSIVE EVALUATION FRAMEWORK ON THE ECONOMIC PERFORMANCE OF STATE-OWNED ENTERPRISES

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Abstract

State-owned enterprises (SOEs) play a key role in the economy of many countries. They are usually thought to be in charge of increasing social welfare. At the same time, their relatively low performance poses several problems, including slowing down economic growth. This effect is especially pronounced in countries where such firms represent a large share of the economy. Therefore, it is crucial for central governments to implement a comprehensive evaluation method to assess the performance of SOEs. Previous studies have offered many ways to evaluate their performance. By employing the principal component analysis technique and using data of 1,148 SOEs, mostly from European countries, our study aims at providing a more comprehensive framework for assessing SOE performance that includes various factors. We selected five factors: profitability, per capita productivity, per capita costs, debt due days, and solvency. The results of our empirical study show that solvency, per capita costs, and per employee productivity have more deterministic power over the success or failure of SOEs, compared to profitability. While profit making of SOEs is important, focusing on profitability as the solve assessment criterion will mislead policy makers, keeping in mind also that the nature of many SOEs is to generate social welfare and not profit.

Keywords: state-owned enterprises, SOEs, performance assessment, public economics

JEL Classification: H11, P11, L32

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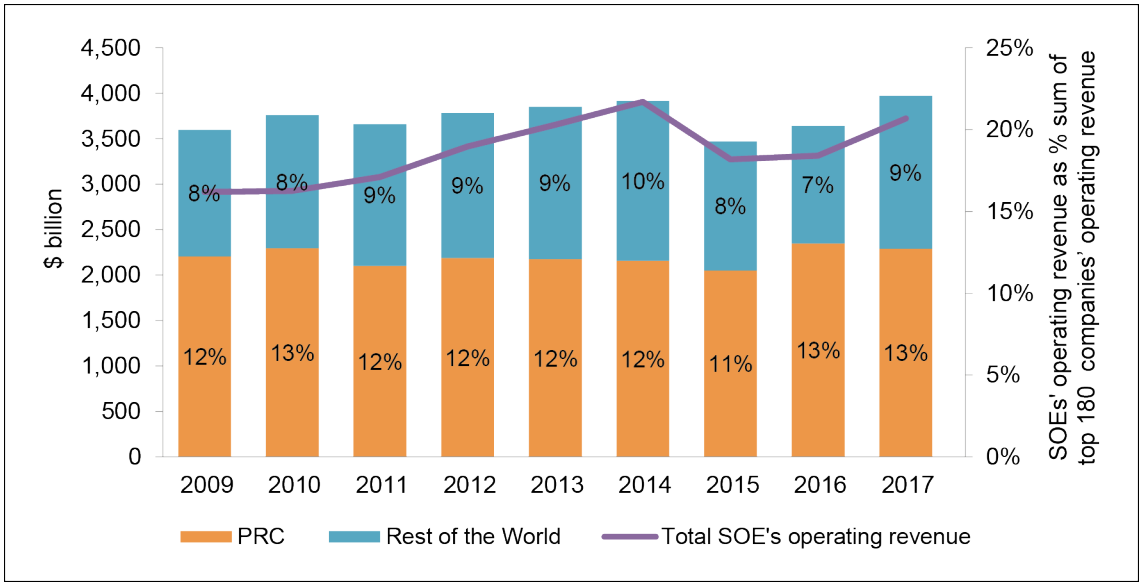
1. INTRODUCTION

State-owned enterprises (SOEs) are important players in many economies, particularly in developing Asia. According to a 2017 study by the Organisation for Economic Co-operation and Development (OECD), central governments of 40 countries, excluding the People's Republic of China (PRC), owned 2,467 commercially oriented enterprises, accounting for around $2.4 trillion and employing 9.2 million people in 2015. The PRC itself has by far the biggest portfolio, owning 51,000 enterprises, valued around $29.2 trillion and employing 20.2 million people (OECD 2017).

SOEs often dominate key sectors in the economy, as significant borrowers and trade controllers of major exports and goods. They also command a sizable share of public resources in many countries. In current and/or former socialist economies, for example, their SOEs represent a significant share in the economy. These types of enterprises also actively provide social services (Forfas 2010) and preserve social stability (Huang, Li, and Lotspeich 2010). They thus often dominate sectors such as finance and networks. In 2015, 51% of global SOE activity (with the exception of Chinese ones) concentrated on electricity, gas, transportation, telecom, and other utilities, representing around 70% of total employment in these firms (OECD 2017); the finance sector represented 26% of SOE activity. In the PRC, in particular, financial firms hold over half of the SOEs' value. Manufacturing, electricity, gas, transportation, and the primary sector each accounted for at least 5% of the value.

Figure 1 shows the share of SOEs' operating revenue in the top 180 companies with the highest operating revenue according to the Orbis database of Bureau van Dijk. In 2017, SOEs represented 22% of the firms with the highest revenue, of which 13% were from the PRC. In addition, the share of SOEs within this category has been almost constant since 2009.

Figure 1: Share of Operating Revenue of State-Owned Enterprises among Top Companies, 2009–2017



PRC = People's Republic of China, SOE = state-owned enterprise.

Notes: An SOE is defined as at least 50.01% of the capital owned by the government. Figures are based on 180 companies with the highest operating revenue.

Source: Authors' analytics based on Bureau van Dijk's Orbis database.

Attempting to fulfill multiple and conflicting roles such as providing social services while operating commercially can negatively affect SOEs' performance (Forfas 2010). Moreover, SOEs face different issues than their private counterparts. Despite questionable efficiency, few SOEs are ever liquidated. They usually operate in relatively noncompetitive markets and have their autonomy limited by government interventions. Managerial techniques in SOEs have proved inadequate for commercially operated firms, especially under the profit-sharing system in the PRC (Fu, Vijverberg, and Chen 2008). While SOEs play a recognized role in providing social services, economists tend to look down on the overall economic performance of SOEs (Perkins 1996; Arocena and Oliveros 2012). At the same time, consensus is lacking on how to evaluate their performance, leading to differing conclusions from one study to another (Huang, Li, and Lotspeich 2010; Elliott and Zhou 2013). As enterprises receiving direct financing from governments, SOEs are expected to produce economic results—and crucially to evaluate these results in an exhaustive manner. Knowing which aspects of SOEs' performance to target for improvement is a potentially useful tool for policy makers. It could also contribute to increasing the economic output of a country, especially where SOEs represent a significant share of the economy.

In this research, we attempt to develop a comprehensive framework for evaluating the economic performance of SOEs by including indicators such as profitability, operation, structure, and per capita variables. Using principal component analysis (PCA) our statistical analysis aims at providing tools to assess the performance of SOEs that will enable central governments to increase the productivity of SOEs—and thus public capital—and to boost economic growth. In this analysis, we define SOEs as companies with at least 50.01% of their shares owned by a central or local government. We do not consider SOEs in which a government has indirect ownership, nor do we take into account firms where a government does not hold a majority of the shares.

The rest of the paper is structured as follows: section 2 summarizes the relevant academic literature on the role and performance of SOEs. Section 3 provides the theoretical model. Section 4 presents the data and statistical method used. Section 5 discusses the results of the empirical analysis. Finally, section 6 suggests some conclusions and policy implications.

2. LITERATURE REVIEW

The literature review covers two categories. First, the role of SOEs in the economy, highlighting the impact SOEs have on social welfare and economic growth. Then, studies assessing the performance of SOEs. While evaluation methods vary from one study to another, the assessments favor looking at efficiency, productivity, and profitability. Studies especially focused on socialist economies, including former ones. In particular, researchers have analyzed SOEs in the PRC, where such firms feature in large numbers.

2.1 Role of State-Owned Enterprises in the Economy

Many authors have addressed the role of SOEs in the economy, emphasizing their impact on social welfare and economic growth. A study conducted by Putterman and Dong in 2000 explored the evolution of the role played by SOEs in the PRC from the 1950s. SOEs improved social welfare in many ways: by increasing the savings rate and by providing employment as well as reasonable wages and benefits compared to their rural counterparts, thereby encouraging the country's industrialization. However, SOEs gradually developed into high-wage enclaves, which eventually led to their demise

(Putterman and Dong 2000). Accentuating this effect were difficulties in laying off workers and the need to keep wages increasing constantly.

Further, SOEs provided large-scale employment during the PRC's economic transition, increasing social stability and overall welfare, as highlighted by Huang, Li, and Lotspeich (2010). In attempting to integrate the positive externalities induced by SOEs into the assessment, their study also emphasized that the stability induced by SOEs had a positive effect on the performance of private firms during that period. Kloviene, Gimzauskiene, and Misiunas (2015), in their study of Baltic countries, recognized SOEs as key actors in public services such as energy, water, public transport, communication, health, education, and social services. The authors also emphasized that SOEs also contribute a significant portion to the country's gross domestic product (GDP), therefore highlighting the need for a proper evaluation framework of their performance. Studying the role of SOEs in the PRC, Jones and Zou (2017) showed that the country's state fragmentation, decentralization, and internationalization since the 1970s increased their autonomy.

Other authors also have explored the role of Chinese SOEs in economic growth. Based on Hirschman's unbalanced growth theory that suggests that a developing economy can accelerate its growth by investing on industries with high backward and forward linkages, Holz (2011) approximated that SOEs contribute to around 2% of growth in their local area. Regression results further show that the SOE share had a negative impact on economic growth in the 1990s, although this effect decreased and eventually disappeared in the 2000s. Abramov, Radygin, and Chernova (2017) found that, although SOEs in the Russian Federation have had a decreased impact on GDP and on the economy in recent years, 26 firms contributed to around 28% of GDP, with firms from the energy sector having increased their impact on growth. The share of SOEs in capitalization, however, stopped increasing after 2008.

2.2 Assessment of the Performance of State-Owned Enterprises

Although many studies have assessed the economic performance of SOEs, they use different estimation methods depending on their analysis. Some authors evaluate performance based on profitability and other financial indicators, while others explored the difference in productivity and efficiency between SOEs and privately owned firms.

Academics concur that SOEs generally exhibit lower efficiency than their private counterparts. Perkins (1996) showed that private firms in the PRC surpassed SOEs in terms of their total factor productivity (TFP) and that firms located in the Shanghai area had a lower TFP than those in the Shenzhen and Guangzhou areas. In general, the study showed that export-oriented SOEs have a higher TFP. Arocena and Oliveros (2012) used a double bootstrap data envelopment analysis model to compare pre- and post-privatization efficiency in Spanish SOEs and their closest private competitors. Their results revealed no significant difference in efficiency between SOEs and their private counterparts before privatization, but the efficiency of newly privatized firms significantly increased while that of their private competitors did not. Elliott and Zhou (2013) showed that non-exporting SOEs in the PRC have the lowest productivity, behind private domestic and international firms. When taking into account export status, however, SOEs become the most productive, even ahead of foreign exporters. This contradicts the general belief that SOEs are less productive.

Moreover, there are studies concluding that reforms could improve efficiency. For example, the 1998 reform in the PRC[1] in particular helped increase the productivity and efficiency of SOEs (Fu, Vijverberg, and Chen 2008). Reform of profit-sharing and bonus payments also increased the productivity of Chinese SOEs by creating incentives for better performance and nurturing a more competitive market (Yao 1997). In Viet Nam as well, following the Doi Moi economic reforms, the TFP of SOEs grew at a rate of around 3%, accounting for 40% of the change in output of the firms (Ngu 2003). By comparing the performance of public and private firms in a Bertrand competition setting in which firms compete on prices rather than quantities, Nguyen (2015) provided a theoretical framework that explains why SOEs' profitability dropped: the trade-off between profits and social welfare enhancement—as SOEs prioritize the latter, their profits are relatively low.

Another way to evaluate the performance of SOEs is to analyze more diverse factors such as profitability and financial indicators. Aivazian, Ge and Qiu (2005) used profitability indicators such as return on assets (ROA) and return on sales, efficiency indicators such as output and sales per employee, and investment indicators in the PRC, while other authors (e.g., Lin and Rowe 2006) tend to base their assessment solely on profitability, which can be measured by ROA, defined as net profits over total assets (Astami et al. 2010). Other studies even use a more comprehensive framework by using various financial indicators such as revenue per employee (gross margin), return on equity (ROE), profit margin, and debt burden (e.g., Abramov et al. 2017) or profit margin, ROE, current ratio (current assets over current liabilities), and solvency ratio (shareholder funds over total assets; e.g., Szarzec and Nowara 2017).

A nonconventional framework of evaluation can also be used to capture SOE performance in a more comprehensive manner. Some researchers have attempted to assess whether SOEs' economic behavior was in line with profit maximization, and therefore were operating as commercial firms. Xu and Birch (1999) concluded that this was the case for SOEs in the energy and electricity sectors in Argentina, while firms in service-oriented sectors focused on employment maximization. Kloviene and Gimzauskiene (2016) highlighted that using typical profitability and financial indicators as performance indicators for SOEs was not appropriate as these firms exhibit special features. Instead, they advise that accountability and performance regulators be evaluated using qualitative methods.

Overall, there is no academic consensus on how to evaluate the performance of SOEs. Some studies prefer productivity and efficiency criteria, while others make extensive use of financial and profitability indicators. While profit making is important, focusing solely on this criterion when analyzing SOEs will mislead the policy makers. In addition, because many SOEs focus on improving social welfare rather than making profit, such objectives should be duly taken into account when evaluating their performance. Due to the lack of data, however, our analysis will not look at SOEs' social impact. The aim of this study is to provide a comprehensive framework for evaluating performance, combining various indicators instead of relying solely on profitability. Our approach most resembles that described by Ahuja and Majumdar (1998), in which the authors used data

[1] In 1998–2003 alone, the number of SOEs in the PRC decreased by about 23,600 and their labor force by 13 million people. This process, promoted under the *gaizhi* policy for ideological and political reasons, took place at a large scale only after the central government adopted its policy of "grasping the large, letting go of the small" (*zhuada fangxiao*) in 1995 (Song 2018). A group of state-controlled holding firms emerged in the SOE sector as a result of the ownership reform. Importantly, *gaizhi* created an essential channel for transferring state production assets to the non-state sector, which can be viewed as a reallocation of resources to more productive uses, which contributed to the rapid growth of this sector. Moreover, ownership transformation helps both local and central governments to reduce the financial burden caused by nonperforming SOEs—a win–win situation (Garnaut, Song, and Yao 2006).

envelopment analysis, a nonparametric method, to create an overall performance measure of Indian SOEs by computing a score from gross fixed assets, value added, number of employees, and profitability ratio. The approach is unique in that we study various indicators—not only profitability or efficiency—and combine them into a comprehensive performance evaluation framework using a PCA methodology.

3. THEORETICAL MODEL

This section provides a theoretical model to compare the characteristics of the optimal objective function of SOEs with those of privately owned enterprises. To do so, we assume two cases: (1) a privately owned enterprise in a market with monopolistic competition and (2) a monopoly market with an SOE.

Case 1: Objective of Privately Owned Enterprises

The profit function of a privately owned enterprise under monopolistic competition can be illustrated as:

$$Max\ \pi = P(Y).Y - C(Y) \tag{1}$$

$$s.t.\ \ Y = F(K, L) \tag{2}$$

where π denotes profit, P is the price of a product which is a function of the total output, Y is the total output, and C is the total cost which is a function of total output. Equation (2) is the constraint, which is the production function, with output or production as a function of capital (K) and labor (L).

Next, we consider the profit and production functions in per employee terms. Hence, we divide all variables by L, resulting in the profit equation per employee:

$$\frac{\pi}{L} = P\left(\frac{Y}{L}\right).\frac{Y}{L} - C\left(\frac{Y}{L}\right). \tag{3}$$

This can be rewritten as equation (4), assuming that the production function of a privately owned enterprise is in the form of a Cobb–Douglas production function as shown in equation (5), where α is the elasticity of production of capital and $(1-\alpha)$ is the elasticity of production of labor and there is constant return to scale. Dividing the Cobb-Douglas production function by L gives us $Y/L = (K/L)\text{^}\alpha$, which substituted in equation (3) results in the profit equation per employee:

$$\frac{\pi}{L} = P\left(\frac{Y}{L}\right)\left(\frac{K}{L}\right)^{\alpha} - C\left(\frac{K}{L}\right)^{\alpha} \tag{4}$$

$$s.t.\ \ Y = F(K, L) = K^{\alpha}L^{1-\alpha}. \tag{5}$$

The profit equation per employee is denoted by $\tilde{\pi}$ using:

$$\tilde{\pi} = P(y).k^{\alpha} - C(k^{\alpha})\ \ given\ that\ y = \frac{Y}{L}; k = \frac{K}{L}; y = k^{\alpha}\ and\ \tilde{\pi} = \frac{\pi}{L} \tag{6}$$

Next, we assume a privately owned enterprise in a monopolistic competition market where the equilibrium is when the marginal revenue is equal to marginal cost $(MR = MC)$. We solve the profit equation to find the equilibrium, using the first-order condition $\tilde{\pi}$ with respect to k, which gives us:

$$\frac{\partial \tilde{\pi}}{\partial k} = \left(\frac{\partial P}{\partial y} . \frac{\partial y}{\partial k}\right) k^{\alpha} + P(y) . \alpha . \frac{y}{k} - \frac{\partial C}{\partial y} . \frac{\partial y}{\partial k} \quad (7)$$

$$= \left(\frac{\partial P}{\partial y} \alpha . \frac{y}{k}\right) y + P . \alpha \frac{y}{k} - \frac{\partial C}{\partial y} \alpha . \frac{y}{k} \quad (7\text{-}1)$$

$$= \alpha \frac{y}{k} \left(\frac{\partial P}{\partial y} y + P\right) - \frac{\partial C}{\partial y} \alpha . \frac{y}{k} \quad (7\text{-}2)$$

with the equilibrium point for the privately owned enterprise where $MR = \frac{\partial P}{\partial y} y + P$ and $MC = \frac{\partial C}{\partial y}$:

$$= \alpha \frac{y}{k} \left\{\frac{\partial P}{\partial y} y + P - \frac{\partial C}{\partial y}\right\} \quad (8)$$

Case 2: Objective of State-Owned Enterprises

The optimal objective of an SOE in this paper is not just profit maximization but also cost minimization with some added liquidity. This means that capital has two components: capital for production purposes (K^f) and capital for liquidity purposes (K^l):

$$K = K^f + K^l \quad (9)$$

Next, we divide all components of capital by L:

$$\frac{K}{L} = \frac{K^f}{L} + \frac{K^l}{L} \quad (10)$$

This gives us the objective function of an SOE (G) in Cobb–Douglas form, where $\tilde{\pi}$ is profit per employee, $C(y)$is total cost per employee, and $\frac{K^l}{L}$ is liquidity per employee:

$$G = g\left(\tilde{\pi}, C(y), \frac{K^l}{L}\right) = (\tilde{\pi})^{\gamma} \left(\frac{1}{C(y)}\right)^{\delta} \left(k^l\right)^{\varphi} \quad (11)$$

An SOE maximizes *G*, subject to the profit equation per employee:

$$s.t. \;\; \tilde{\pi} = P(y).y - w - r(k^f + k^l), \quad (12)$$

where $\tilde{\pi} = \frac{\pi}{L}$, $k^f = \frac{K^f}{L}$, $k^l = \frac{K^l}{L}$, w is the wage rate per hour, r is the interest rate, and γ, δ and φ are the elasticities of profit per employee, total cost per employee, and liquidity per employee, respectively.

In order to find the optimal level of k^f that maximizes *G*, we apply the first-order condition of equation (11) subject to equation (12), resulting in:

$$\frac{\partial G}{\partial k^f} = \gamma . \frac{G}{\tilde{\pi}} . \frac{\partial \tilde{\pi}}{\partial k^f} - \delta \frac{G}{\left(\frac{1}{C(y)}\right)} . \frac{1}{\{C(y)\}^2} \frac{\partial C(y)}{\partial k^f} \quad (13)$$

In order to solve equation (13), two components are unknown: $\frac{\partial \tilde{\pi}}{\partial k^f}$ and $\frac{\partial C(y)}{\partial k^f}$. Hence, we need to solve it first by developing the production function of an SOE.

As with privately owned enterprises, we consider the Cobb–Douglas production function for SOEs:

$$Y = F\left(K^f, L\right) = (K^f)^{\alpha}(L)^{1-\alpha}, \tag{14}$$

where production (Y) is a function of labor (L) and capital (K^f), and α is the elasticity of production of capital and $(1-\alpha)$ is the elasticity of production of labor and there is a constant return to scale.

Next, in order find the output per employee, we divide equation (14) by L:

$$\frac{Y}{L} = \frac{\left(K^f\right)^{\alpha}}{L^{\alpha}} = \left(k^f\right)^{\alpha} \rightarrow y = \left(k^f\right)^{\alpha}, \tag{15}$$

where $y = \frac{Y}{L}$.

The first-order condition of $\tilde{\pi}$ with respect to k^f to find the optimal level of capital that maximizes the SOE's profit can be written as:

$$\frac{\partial \tilde{\pi}}{\partial k^f} = \left\{\frac{\partial P}{\partial y} . \frac{\partial y}{\partial k^f}\right\} y + p(y)\frac{\partial y}{\partial k^f} - r \tag{16}$$

$$\left\{\frac{\partial P}{\partial y} . y + p(y)\right\}\frac{\partial y}{\partial k^f} = r \; where \frac{\partial y}{\partial k^f} = \alpha . \frac{y}{k^f} \tag{16-1}$$

$$\left\{\frac{\partial P}{\partial y} . y + p(y)\right\}\alpha . \frac{y}{k^f} = r \tag{16-2}$$

The second component of the objective function is cost per employee, which the SOE minimizes:

$$\frac{\partial C(y)}{\partial k^f} = \frac{\partial C(y)}{\partial y} . \frac{\partial y}{\partial k^f} = C'(y) . \alpha . \frac{y}{k^f} \tag{17}$$

By substituting equations (16) and (17) in equation (13), we get the optimal level of k^f that maximizes *G*:

$$k^f = \frac{\alpha y\left[\frac{\gamma}{\tilde{\pi}}\frac{\partial P}{\partial y} y + \frac{\gamma . P(y)}{\tilde{\pi}}\right]}{\left[\frac{\delta G . C'(y)}{C(y)} - \frac{r . \gamma}{\tilde{\pi}}\right]} \tag{18}$$

Equation (18) shows the optimal capital for production that maximizes the level of *G*, which is a function of various variables including the elasticity of production of capital, output per employee, elasticity of prices to real output, price level of the monopoly company (SOE), elasticities of profit per employee and total cost per employee, marginal cost per employee, interest rate, and profit per employee.

The theoretical part shows that the optimal objective of an SOE needs to be maximizing profit per employee, minimizing per employee costs, and maximizing the liquidity needed (cash flow, solvency, or power of paying debt) in order to avoid due debt.

4. STATISTICAL ANALYSIS

The following section introduces the data and variables. It also presents the statistical method and the transformation of the data.

4.1 Data and Variables

Variables necessary for the study were carefully selected from the literature review in line with the theoretical model.

As demonstrated in equation (18), the optimal objective function of an SOE involves three groups of variables: per employee profit, per employee costs, and liquidity. In addition, we reviewed the literature to find that, first, one way to evaluate the performance of firms is to consider their profitability indicators, as many authors highlighted. For this reason, we selected four variables to represent profitability: ROE (Var 1), ROA (Var 2), profit margin (Var 3), and cash flow over operating revenue (Var 4). ROE and ROA are obtained using firms' profit–loss statements before tax. As using ROE and ROA is the most traditional way of evaluating how a firm manages the capital it is entrusted with, they are key elements for the assessment of the profitability of SOEs. Positive profit margin and positive cash flow reflect the profitability of a firm. Unlike Astami et al. (2010), for example, we chose several indicators of profitability, rather than only one, to provide a more comprehensive framework of evaluation.

The second type of indicators used in this study is operational ones. In this category, we include two variables: debt due days (Var 5) and ratio of export revenue over operating revenue (Var 6). Debt due days are understood as a default variable in this study—the variable embodies the delay in repayment of installment and interest fees owed by an SOE to a banking institution. If this delay is over 90 days, then the company is considered as defaulting. There might be some concerns about using debt due days as an indicator of default, as few SOEs ever end up in bankruptcy thanks to heavy government support. However, based on the literature, this indicator appears to be rather popular in assessing the success or failure of SOEs. In addition, our theoretical model shows that the liquidity, solvency, or power of paying debt (in order to have less due debt) is one of the components of the optimal objective function of an SOE. The rationale behind the inclusion of Var 6 is detailed in studies by Perkins (1996) and Elliott and Zhou (2013). Given the difference in performance between export-oriented firms and domestic-oriented firms, the ratio of export revenue over operating revenue reflects the internationalization of SOEs; export-oriented SOEs tend to perform better and have greater efficiency.

The third type of indicators is structural ones. It is crucial to evaluate the financial structure of SOEs as part of their performance, not solely their profitability. For this reason, we selected three variables to capture this aspect: liquidity ratio (Var 7), solvency ratio based on assets (Var 8), and solvency ratio based on liabilities (Var 9). Solvency ratio allows assessing a firm's ability to meet its debt obligations. A low solvency ratio attests of a higher risk of insolvency and therefore potential bankruptcy. The liquidity ratio also plays a key role in evaluating solvency, as it captures the ability of a company to pay off its debts without raising external funds. Solvency is an important factor in a firm's performance, though previous studies often have overlooked it, possibly because SOEs tend to enjoy "soft budget constraints" not subject to market liquidation.

Finally, the last category of variables is related to per employee indicators. When assessing the performance of SOEs, per employee variables are essential as some firms reportedly have low productivity and are focused on employee maximization rather than profit maximization. In addition, SOEs are often overemploying (Putterman and Dong 2000) workers. In this study, six variables were selected: profit per employee (Var 10), operating revenue per employee (Var 11), costs of employee divided by operating revenue (Var 12), average cost of employee (Var 13), working capital per employee (Var 14), and total assets per employee (Var 15). Var 10–12 and Var 15 assess the profitability per employee and therefore productivity, which is a factor in SOE performance evaluation that has been abundantly tackled. Average cost of employee is a way to evaluate the weight employees have on a firm, through wages, social security requirements, unemployment insurance, or employment subsidies for laid-off SOE workers. As shown by Huang, Li, and Lotspeich (2010), these can sometimes be a burden for SOEs. Working capital per employee (Var 14) is a standard key performance indicator and represents the operating liquidity of a business. Thus, it is useful in assessing the economic performance of a firm. All 15 variables are summarized in Table 1.

Table 1: Model Variables

Notation	Definition	Unit	Group
Var 1	Return on equity using P/L before tax	%	Profitability
Var 2	Return on assets using P/L before tax		
Var 3	Profit margin		
Var 4	Cash flow/Operating revenue		
Var 5	Debt due days	Days	Operational
Var 6	Export revenue/Operating revenue	%	
Var 7	Liquidity ratio	%	Structure
Var 8	Solvency ratio (asset based)		
Var 9	Solvency ratio (liability based)		
Var 10	Profit per employee	$	Per employee
Var 11	Operating revenue per employee	$	
Var 12	Costs of employees/Operating revenue	%	
Var 13	Average cost of employee	$	
Var 14	Working capital per employee	$	
Var 15	Total assets per employee	$	

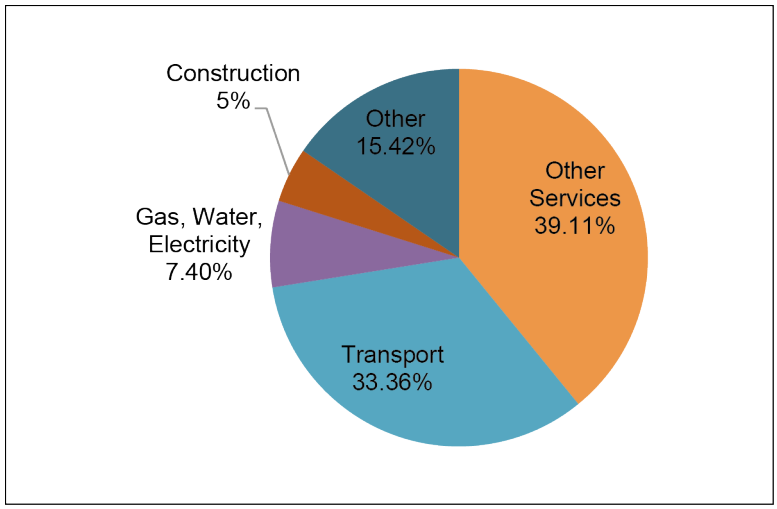
P/L = profit–loss statement.

Source: Authors' compilation.

We retrieved the data used in our analysis from the Orbis database of the Bureau van Dijk. They encompass 1,148 SOEs, primarily from Europe—that is, Bosnia and Herzegovina, Croatia, Estonia, France, Germany, Hungary, the United Kingdom, and others. French SOEs represent the majority of the data, followed by Croatian ones. Countries were selected based on their available datasets in a global sample; for each company, the latest data were used.

As shown in Figure 2, most SOEs studied are service providers: a third being transportation companies, 7% energy sector companies, and 5% construction companies. Only 15% of the total sample represents companies that are not service providers.

Figure 2: Data Breakdown by Sector



Source: Authors' compilation.

To conclude this section on descriptive statistics, Table 2 represents the correlation matrix between the 15 variables in the analysis. Because of the use of different variables to assess profitability or productivity, it is not abnormal to witness a high correlation between the variables. In particular, there is a high correlation (shown in bold) between profitability variables: ROE with ROA (Var 1 and Var 2), ROA with profit margin (Var 2 and Var 3), and profit margin with cash flow over operating revenue (Var 3 and Var 4). In addition, per employee indicators are also strongly correlated: profit per employee (Var 10) and operating revenue per employee (Var 11) are both strongly correlated with total assets per employee (Var 15).

Table 2: Correlation Matrix between Variables

	Var 1	**Var 2**	**Var 3**	**Var 4**	**Var 5**	**Var 6**	**Var 7**	**Var 8**
Var 1	1.000	**.421**	.321	.129	–.039	.013	.007	.001
Var 2	**.421**	1.000	**.570**	.337	–.097	.017	.062	.371
Var 3	.321	**.570**	1.000	**.645**	–.150	–.009	.139	.334
Var 4	.129	.337	**.645**	1.000	–.166	–.038	.124	.316
Var 5	–.039	–.097	–.150	–.166	1.000	–.057	–.089	–.191
Var 6	.013	.017	–.009	–.038	–.057	1.000	.055	–.038
Var 7	.007	.062	.139	.124	–.089	.055	1.000	.264
Var 8	.001	.371	.334	.316	–.191	–.038	.264	1.000
Var 9	.024	.123	.080	.154	–.079	–.095	–.076	.117
Var 10	.110	.114	.216	.160	–.026	.141	.071	.074
Var 11	.020	.002	–.009	–.032	–.038	.201	.138	–.018
Var 12	–.051	–.118	–.160	–.151	–.077	–.127	–.084	–.030
Var 13	.069	–.007	–.051	–.109	–.022	.153	–.001	–.073
Var 14	.004	–.007	–.022	–.031	–.022	.022	–.022	–.093
Var 15	.043	.001	.128	.214	–.024	.194	–.017	–.033

continued on next page

Table 2 *continued*

	Var 9	Var 10	Var 11	Var 12	Var 13	Var 14	Var 15
Var 1	.024	.110	.020	–.051	.069	.004	.043
Var 2	.123	.114	.002	–.118	–.007	–.007	.001
Var 3	.080	.216	–.009	–.160	–.051	–.022	.128
Var 4	.154	.160	–.032	–.151	–.109	–.031	.214
Var 5	–.079	–.026	–.038	–.077	–.022	–.022	–.024
Var 6	–.095	.141	.201	–.127	.153	.022	.194
Var 7	–.076	.071	.138	–.084	–.001	–.022	–.017
Var 8	.117	.074	–.018	–.030	–.073	–.093	–.033
Var 9	1.000	–.046	–.062	.075	–.008	–.058	–.043
Var 10	–.046	1.000	.237	–.129	.094	.175	**.580**
Var 11	–.062	.237	1.000	–.168	.097	.192	**.482**
Var 12	.075	–.129	–.168	1.000	.186	–.163	–.195
Var 13	–.008	.094	.097	.186	1.000	.242	.073
Var 14	–.058	.175	.192	–.163	.242	1.000	.265
Var 15	–.043	**.580**	**.482**	–.195	.073	.265	1.000

Note: Correlations over 40% are shown in bold.

Source: Authors' compilation.

Due to the high correlation between variables, a regression analysis using these 15 variables is not possible. For this reason, the study introduces PCA, a statistical method that allows converting a set of observations into linearly uncorrelated variables. This method is further detailed in the next part.

4.2 Principal Component Analysis

PCA is a data-reduction technique that extracts data, removes redundant information, highlights hidden features, and visualizes the main relationships that exist between observations (e.g., as used in Yoshino and Taghizadeh-Hesary 2014, 2015). PCA simplifies a dataset and creates a set of new variables, emphasizing latent features present in the dataset. PCA, unlike many other transformation methods, does not have a fixed set of vectors and adapts its basic vectors depending on the dataset. An additional advantage lies in the fact that the analysis indicates the similarities and differences between the various models created (Ho and Wu 2009). Using this method, we reduce the 15 variables listed in Table 1 to determine the minimum number of components that can account for the correlated variance.

Before proceeding, we test the suitability of the data for factor analysis. To do so, we perform two tests: the Kaiser–Meyer–Olkin (KMO) test and Bartlett's test of sphericity. KMO is a measure of sampling adequacy that indicates the proportion of common variance that might be caused by underlying factors (e.g., Yoshino and Taghizadeh-Hesary 2014, 2015). A KMO value higher than 0.6 generally indicates that factor analysis may be useful, as is the case in our study with a value of 0.64. Bartlett's test of sphericity shows whether the correlation matrix is an identity matrix, indicating that variables are unrelated (e.g., Yoshino and Taghizadeh-Hesary 2014, 2015). A significance level less than 0.05 indicates that there are significant relationships among the variables, as is the case in our study with less than 0.001. We can thus proceed with the PCA.

Table 3: Total Variance Explained

	Initial Eigenvalues		
Component	**Total**	**% of Variance**	**Cumulative %**
Z1	2.782	18.549	18.549
Z2	2.164	14.430	32.979
Z3	1.284	8.563	41.542
Z4	1.227	8.178	49.720
Z5	1.114	7.428	57.147
Z6	.964	6.425	63.572
Z7	.902	6.015	69.587
Z8	.865	5.767	75.355
Z9	.821	5.475	80.829
Z10	.696	4.641	85.470
Z11	.653	4.351	89.821
Z12	.524	3.496	93.317
Z13	.433	2.888	96.205
Z14	.314	2.093	98.298
Z15	.255	1.702	100.000

Source: Authors' compilation.

The next step is to determine how many factors should be used. Table 3 lists the estimated factors and their eigenvalues. We retain only those factors accounting for more than 10% of the variance (eigenvalues >1) in the final analysis—that is, the first five factors. Altogether, Z1 through Z5 explain 57% of the total variance of the performance indicators.

In running the PCA, we use the direct oblimin rotation method. Direct oblimin is the standard method to obtain a non-orthogonal (oblique) solution, allowing factors to be correlated (Yoshino and Taghizadeh-Hesary 2015). Interpreting the revealed PCA information requires studying the pattern matrix. Table 4 presents the pattern matrix of factor loadings obtained using direct oblimin rotation.

The first component, Z1, has five variables with an absolute value neatly over 0.5 (large loadings). We exclude asset-based solvency ratio (Var 8) as a component of Z1, however, to simplify the interpretation of the component. Indeed, all variables representing profitability (ROE, ROA, profit margin, and cash flow over operating revenue) have a value of over 0.5 and show positive signs. Therefore, we choose to interpret Z1 as the component representing profitability in the analysis. The second component, Z2, has four variables over 0.5: profit per employee (Var 10), operating revenue per employee (Var 11), working capital per employee (Var 14), and total assets per employee (Var 15). Given that all the variables explaining the variance of the component pertaining to the category of per capita profitability, Z2 can be understood as a reflection of productivity per employee. The next component, Z3, is composed of two variables: cost of employee over operating revenue (Var 12) and average cost of employee (Var 13). Exceptionally, we decided to include Var 12 despite its value being below 0.5 to simplify the interpretation of Z3 as a reflection of per employee costs inside SOEs. The fourth component, Z4, only presents one variable with a value over 0.5. Z4 can hence be understood as showing debt due and default. Finally, the fifth variable represents "solvency" of SOEs, since the only variable that represents at least 0.5 of the factor loadings is the liability-based solvency ratio (Var 9).

Table 4: Matrix of Factor Loading

	Component				
	Z1	**Z2**	**Z3**	**Z4**	**Z5**
Var 1	**0.597**	–0.096	0.424	–0.313	0.393
Var 2	**0.680**	–0.304	0.254	–0.134	0.233
Var 3	**0.805**	–0.263	0.060	–0.120	0.027
Var 4	**0.707**	–0.233	–0.115	–0.051	–0.259
Var 5	–0.262	0.107	–0.080	**–0.559**	0.165
Var 6	0.122	0.399	–0.006	0.213	0.372
Var 7	0.271	–0.019	–0.400	0.487	0.377
Var 8	0.502	–0.348	–0.218	0.391	–0.017
Var 9	0.129	–0.280	0.231	0.072	**–0.576**
Var 10	0.473	**0.520**	0.023	–0.035	–0.198
Var 11	0.237	**0.631**	–0.128	0.151	0.014
Var 12	–0.318	–0.244	**0.449**	0.415	–0.169
Var 13	–0.024	0.307	**0.649**	0.372	0.156
Var 14	0.108	**0.501**	0.242	–0.021	–0.090
Var 15	0.423	**0.704**	–0.054	–0.074	–0.312

P/L = profit–loss statement.

Notes: The extraction method is principal component analysis, and the rotation method is direct oblimin with Kaiser normalization. Variables with large loadings (absolute value greater than 0.5) for a given factor are in bold.

Source: Authors' compilation.

Because the use of PCA was partially motivated by the high correlation between variables, Table 5 shows a correlation matrix between the components. There appears to be no correlation between the components. This also means that we could have used a regular orthogonal rotation method, which does not allow correlation between components. Using an oblique rotation method provided the same result as using an orthogonal rotation.

In this section, we detailed the methodology that allows us to assess the performance of SOEs. Using PCA, we established four components representing profitability, per employee productivity, per employee costs, and solvency. The results of this evaluation are presented in the next part.

Table 5: Component Correlation Matrix

Component	**1**	**2**	**3**	**4**	**5**
1	1.000	.124	–.102	.161	–.069
2	.124	1.000	.041	.041	.144
3	–.102	.041	1.000	–.076	.014
4	.161	.041	–.076	1.000	–.074
5	–.069	.144	.014	–.074	1.000

Note: The extraction method is principal component analysis, and the rotation method is direct oblimin with Kaiser normalization.

Source: Authors' compilation.

5. EMPIRICAL RESULTS

5.1 Regression Results

We now present the results of a regression conducted using the components derived from the PCA as variables. Given the lack of correlation between the components, we use ordinary least squares (OLS) as the estimation method for the regression. The objective of this regression is to estimate the determinants behind the success or failure of SOEs through the performance indicators that we defined in the previous section. For this purpose, we chose debt due days (Z4) as the dependent variable in this study, interpreting it as a label of success or failure of an SOE. What this variable means is that a company with a delay of over 90 is considered as defaulting. As mentioned earlier, the variable represents the delay in the repayment of credit and even defaults after a certain threshold. Defaulting is considered a failure for an SOE; thus, the higher Z4, the lower the success of the company. The results of the regression are shown in Table 6. All variables in the regression are statistically significant. In addition, indicators of goodness of fit are very high: both R-squared and adjusted R-squared are close to 99%, meaning that the model fits the data.

Table 6: Regression Results

Variables	Coefficient	t-Statistic	Std. Error	Probability
C Constant	19.19	9.59	2.00	0.00
Z1 Profitability	–0.14	–10.34	0.01	0.00
Z2 Per employee productivity	–0.22	–48.40	0.004	0.00
Z3 Per employee costs	0.26	31.49	0.008	0.00
Z5 Solvency	–0.60	–71.41	0.008	0.00

Notes: The dependent variable is Z4, and the estimation method is ordinary least squares (OLS).
Observations = 1,137; R-squared = 0.994; Adjusted R-squared = 0.994; Durbin–Watson statistics = 1.98.
Source: Authors' compilation.

Out of all variables, only the estimated coefficients for per employee costs (Z3) show a positive sign. It should not come as a surprise that higher costs per employee negatively affect SOEs' performance, and empirical results confirm this fact. Higher costs per employee are shown to increase the days for repayment of credit, and therefore increase the chances of defaulting. On the other hand, the estimated coefficients for profitability, productivity per employee, and solvency all display a negative sign. Being a profitable firm (Z1) or a firm with high productivity per employee (Z2) decreases the number of days needed for a firm to pay back its loan to be a more successful firm. This derives from the fact that highly productive firms have higher revenues per employee and can pay back their debt with more ease. The same reasoning applies to firms with higher profitability. Solvency (Z5) is even more straightforward as the component captures the ability of a firm to pay off its debt. Having a higher solvency in the first place will definitely decrease the likelihood of a firm defaulting.

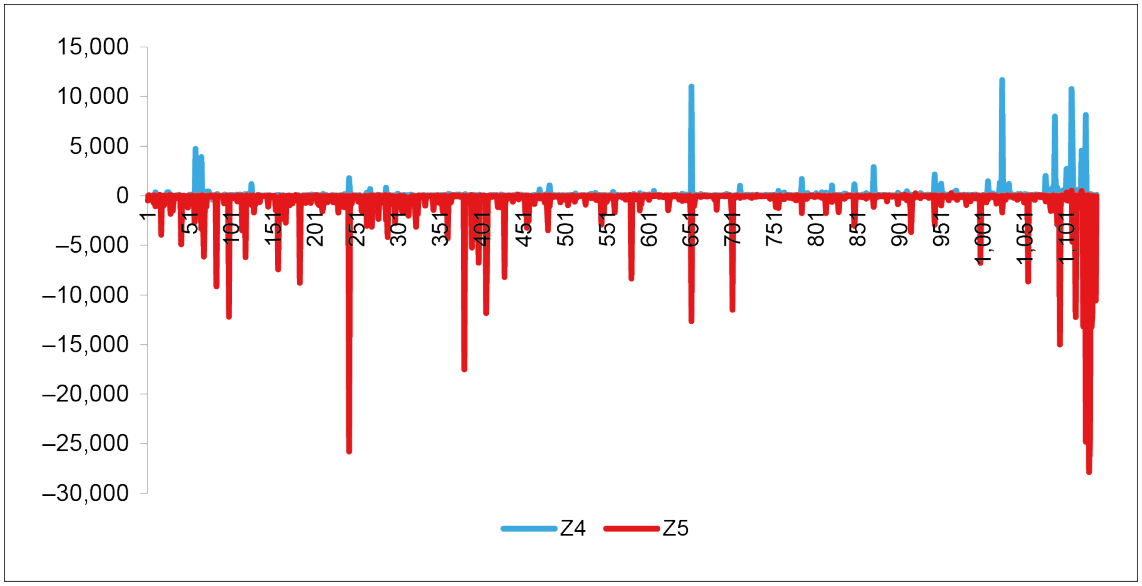
In addition, the size of the estimators and thus the magnitude of each indicator on the performance of SOEs significantly differ. As shown in Table 6, the solvency component

possesses the highest coefficient in absolute terms, 0.60. Solvency (Z5) hence appears to have a more decisive role in explaining why some companies default. Second, per capita variables such as productivity (Z2) and costs (Z3) have a medium-sized effect on a firm's performance with their respective coefficients being 0.22 and 0.26 in absolute terms. It appears that per capita variables have a relatively significant influence on the success or failure of companies. Finally, the size of the estimator for profitability is the smallest, with an absolute value of 0.14. According to the empirical results, profitability proves to have the least deterministic power over the success or failure of SOEs, contrary to common perception. Overall, solvency, per employee costs, and per employee productivity are key components in explaining why some SOEs have due debt and why some fail to repay their outstanding debt in the given time. While profitability explains this effect as well, it does not have as much deterministic power as the previously mentioned variables. In analyzing the performance of SOEs, solvency, per employee costs, and per employee productivity should thus be prioritized as indicators, rather than traditionally used profitability variables.

5.2 Variable Movements

This section explores the movements of each variable against Z4, the variable representing default in this analysis. Figure 3 shows the movements of solvency (Z5) associated with those of long due debts and therefore default (Z4). The graph shows that positive movements from debt due days are associated with strongly negative ones from solvency. Firms that have longer debt due days, or even default, do not usually have high solvency ratios, which is unsurprising as solvency ratios are a key indicator of the ability of a company to pay back its loans.

Figure 3: Movements of Solvency against Debt Due Days

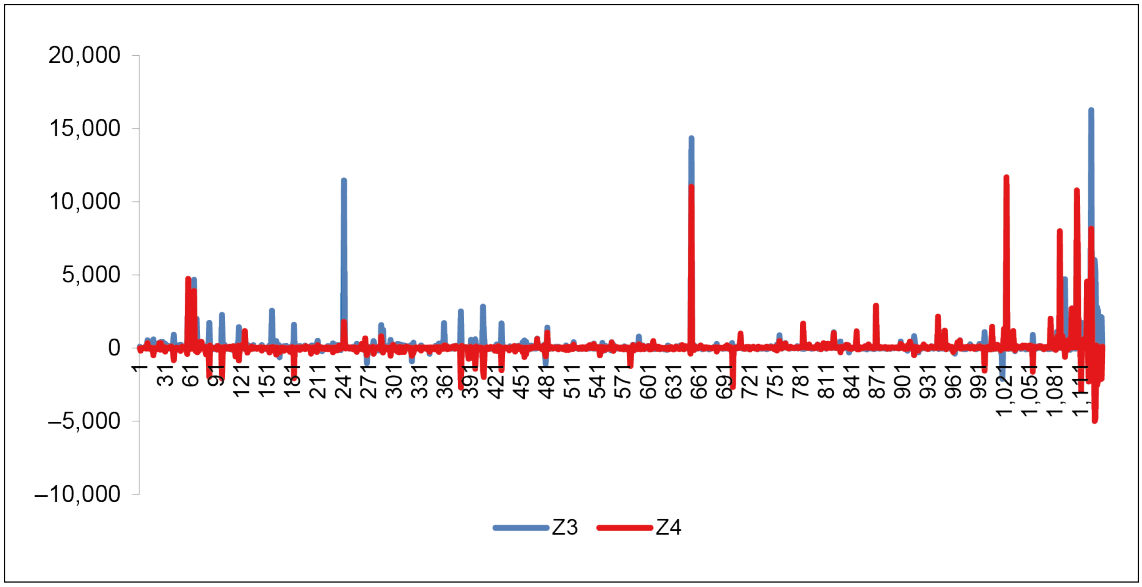


Z4 = debt due days (default variable), Z5 = solvency.

Source: Authors' compilation.

Figure 4 displays the movements of per employee costs (Z3) associated with the default variable (Z4). This variable's coefficient had the second highest coefficient in absolute value terms, and was the only one to feature a positive sign. As shown in the graph, positive movements of debt due days come with positive movements from costs per employee, although not as large in terms of size as the previous solvency variable. Firms with higher costs per employee are likely to also take longer to pay their accumulated debt and have long due dates, and some might even default.

Figure 4: Movements of Per Capita Costs against Debt Due Days



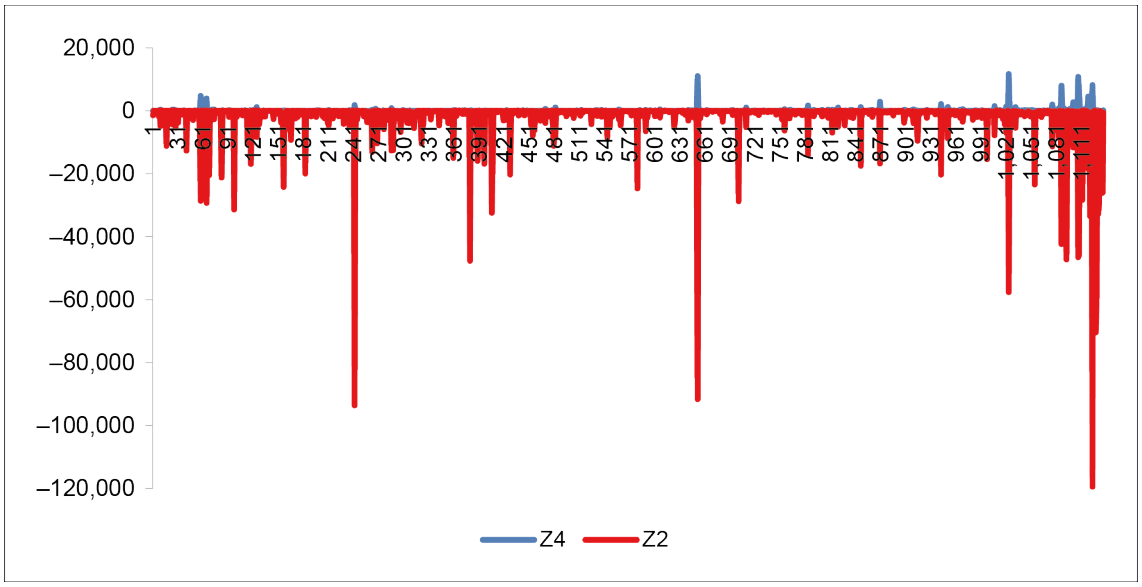
Z3 = per employee costs, Z4 = debt due days (default).

Source: Authors' compilation.

Figure 5 illustrates the movements of productivity per capita (Z2) against the default variable (Z4). Productivity per employee showed a negative sign in the regression and had a relatively large coefficient in absolute value terms. These features are clearly visible on the graph: when the default variable is positive, productivity per employee is largely negative. According to these empirical results, highly productive firms will not be likely to default or fail to pay back their loans on time.

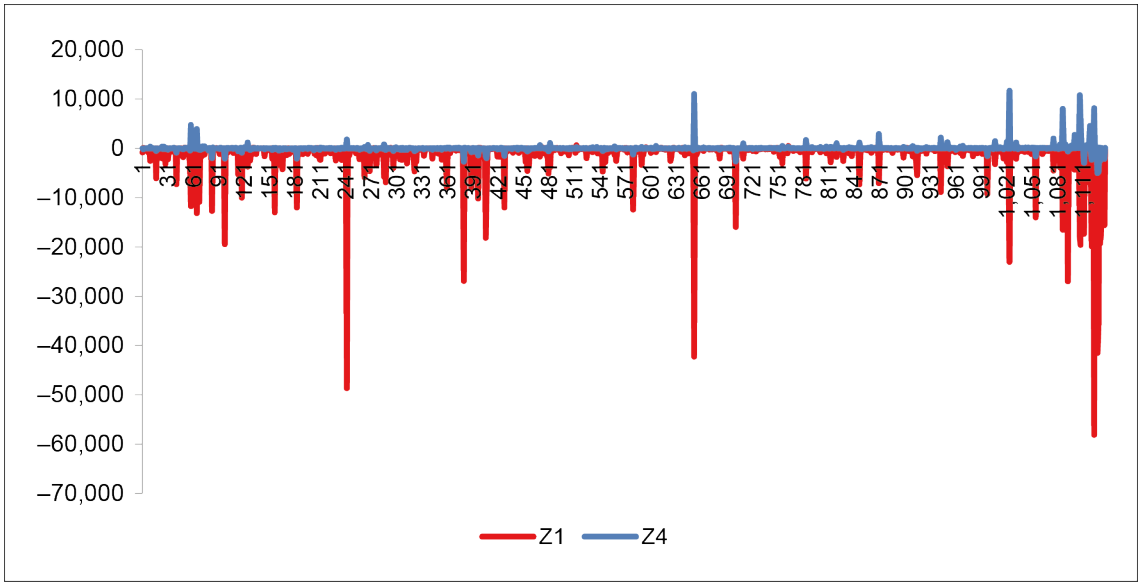
Finally, Figure 6 represents the movements of profitability (Z1), the variable usually used in assessing SOEs' performance, against debt due days, the dependent variable of the regression (Z4). The regression results showed that, out of all variables, profitability had the smallest impact on the success or failure of SOEs. The graph shows a clear pattern of negative movements of profitability with debt due days. Firms with lower profitability will more often find themselves unable to pay back their debt in time and therefore default. Firms with lower profit margins are likely to have less capital available to pay back their loans, and therefore default.

Figure 5: Movements of Per Capita Productivity against Debt Due Days



Z2 = per employee productivity, Z4 = debt due days (default).
Source: Authors' compilation.

Figure 6: Movements of Profitability against Debt Due Days



Z1=profitability, Z4 = debt due days (default).
Source: Authors' compilation.

6. CONCLUSION AND POLICY IMPLICATIONS

SOEs play a key role in the economy of many countries, especially in developing Asia, including the PRC and Central Asian countries where they represent a large share of the economy. Because SOEs use public funding, these types of firms are usually thought to be charged with increasing social welfare. At the same time, SOEs' economic performance is generally seen as rather mediocre, as their priority remains social welfare enhancement. Such poor performance may slow down economic growth and even negatively affect other private firms, making it harder for them to access credit. This effect is especially pronounced in countries where SOEs figure largely in the economy. Therefore, it is crucial for central governments to implement a comprehensive evaluation method to assess the performance of such firms.

Previous studies have offered many frameworks to analyze the performance of SOEs. Most focus on profitability and financial factors as indicators of success of SOEs. Yet, none offered a comprehensive framework of evaluation, capturing all aspects of their performance. By employing PCA, a statistical analysis technique, our study aims at providing such a comprehensive framework, incorporating various factors explaining SOE performance such as profitability, operational, structural, and per employee indicators. We applied 15 financial variables of 1,148 SOEs mostly located in Europe and subjected them to PCA. This methodology reduced the number of variables to five components: Z1 (profitability), Z2 (per employee productivity), Z3 (per employee costs), Z4 (debt due days), and Z5 (solvency).

In order to assess which of these variables had the most impact on the performance of SOEs, we ran a regression using the components obtained through the PCA. We used the component representing default and debt due days as the dependent variable. The results of the empirical study show that, contrary to common belief, solvency and per employee variables (costs and productivity) have more deterministic power over the success or failure of SOEs, compared to profitability. While higher per employee costs are associated with a higher likelihood of default among SOEs, higher profitability, productivity, and solvency are usually correlated with lower risks of default—and hence successful SOEs.

As regards policy implication of this research, PCA is an efficient method to provide a comprehensive evaluation framework, capturing various performance elements that are usually highly correlated in one study. In addition, the regression offers a glance at the performance factors with the highest deterministic power on the success or failure of SOEs. While profitability is usually the favored indicator of many studies assessing SOE performance, our study showed that solvency, per employee costs, and per employee productivity are more decisive in evaluating their performance.

Finally, it is important to mention that we used financial statements as the base of assessing the performance of SOEs and that the proposed evaluation framework does not evaluate their social welfare objectives. From the point of view of governments, it might be important to evaluate the social impact—in addition to financial performance. That will be the next recommended step for researchers.

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