The impact of small- and medium-sized enterprises sustainability practices and performance on economic growth from a managerial perspective: some modeling considerations and empirical analysis results

Article

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The impact of SME sustainability practices and performance on economic growth from a managerial perspective: Some modeling considerations and empirical analysis results

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Abstract

The purpose of this study is to assess the relationship between social, environmental and operational practices and performance with financial performance, focusing on small- and medium-sized enterprises (SMEs). We seek to establish a relationship between the sustainability and the financial performance of SMEs in terms of economic development, as expressed by the indicators of turnover and business growth. A dataset derived from 119 British, French as well as Indian firms is utilized and links between sustainability and the financial performance of SMEs are examined. Bayesian regression modeling was chosen and a model comparison approach followed in order to assess the robustness of the results to the specific choice of analysis with respect to the shape of the dependent variable's distribution. Overall findings indicate robust regression results especially for the highly significant covariates, but caution should be exercised when interpreting the borderline results. A significant positive association between certain items of sustainability and firms' financial performance is identified as we found that different indicators of sustainability display associations with the two economic indicators and adoption of the former may influence SME performance.

Keywords: *Small- and Medium-sized Enterprises, sustainability, economic growth, Bayesian model comparison, variable selection, sustainable development.*

1 Introduction

Nowadays, driven by the increasingly pressing concerns raised around environmental, social, and economic issues, the multifaceted constructs of sustainability emerge as high priority for the business world and all the key players in the various chains of production (*Sancha et al., 2016*). In this regard, the notion of organizational sustainability has received considerable interest by practitioners and researchers alike (e.g. *Linnenluecke et al., 2009*), describing proactive activities aiming to contribute to sustainability equilibria. Such equilibria pertain to the integration of socio-economic and environmental performance aspects, as well as underlying inter-relations within and throughout the time dimension while addressing the organizational system as a whole and its critical stakeholders (*Lozano, 2012*; *Lozano et al., 2015*). Indeed, since the 1990s, the concept of sustainability and the various aspects comprising its agenda for action have become increasingly widespread in the business community. Such integration of environmental and social aspects with profit-seeking goals, also defined as a triple-bottom-line (TBL) performance towards organizational sustainability (*Elkington, 2004*), is becoming increasingly relevant to the managerial practice and decision-making of businesses in terms of redefining operations management (*Drake and Spinler, 2013*) as well as its supply chains (*Carter and Rogers, 2008*). Reflecting a systems thinking approach and intertemporal tensions, the concept of sustainability is consistent with the notion of long-term planning and impact assessment (*Bansal and DesJardine, 2014*). In this respect, organizational sustainability refers to the configuration of business strategies and practices that contribute to sustainable development by endorsing social cohesion and environmental conservation in the long-term while simultaneously meeting the economic imperatives of profitability and growth (*Robert et al., 2002; Seuring and Muler, 2008*). Sustainability in a business entity context indicates "a company's activities, voluntary by definition, demonstrating the inclusion of social and environmental concerns in business operations and in interactions with stakeholders" (*Van Marrewijk and Werre, 2003*). In this context, and from a macro-level perspective, SMEs have a key role in sustainable development as they dominate the business sector of any country and, therefore, their cumulative impact is far from negligible (*Cassells and Lewis, 2011; Revell et al., 2010*). Several empirical studies suggest that sustainability practices and performance is of great importance and should be part of companies' operational strategies (e.g. *Pullman et al., 2009*).

Such considerations are no longer confined to large corporations and multinational business entities (*Masurel, 2007; Revell and Blackburn, 2007*; *Siegel, 2009; Revell et al., 2010; Madsen and Ulhøi, 2016*). Under the scope of an ever increasing globalized economy and through the complex and extensive supply chain networks, they are expanding to small and medium-sized enterprises and posing significant managerial and operational risks as well as opportunities (*Lawrence et al., 2006; Bos-Brouwers, 2010; Brammer et al., 2012; Hofmann et al., 2012; Hörisch et al., 2014; Jansson et al., 2015; López-Pérez et al., 2017*).

While securing shareholder value remains the overarching tenet of for-profit organisations, today's business environment presents additional challenges to SMEs which usually respond reactively to emerging and pressing stakeholder expectations or demands (*Lewis et al., 2015*). Indeed, over the past few years business research has established the need for framing and developing effective performance-related measures (e.g. *Shepherd and Gunter, 2006*; *Rao et al. 2009*; *Taticchi et al., 2010*) with formal modeling and decision support systems to offer win-win solutions in terms of economic results and sustainability outputs (*Bai et al., 2012*). *Carter and Rogers (2008)* assert that actively engaging in sustainability practices is no longer optional but rather sheer necessity involving the long-term amelioration of economic results and helping managers formulate a long-term vision for their enterprise.

In this respect, critical questions posed to researchers, practitioners and policymakers are the following: Are sustainability-related practices and performance having an impact on SME growth? Which specific sustainability aspects contribute to a SME's economic performance? Which is the most appropriate association between the latter in terms of a statistical modeling perspective?

The aforementioned questions, along with some recent relevant studies (e.g. *Revell et al., 2011; Brammer et al. 2012; Hörisch et al., 2014; Jansson et al., 2015; López-Pérez et al., 2017*), motivated us to assess the potential impact of specific sustainability practices and performances on SME economic growth. Moreover, of particular interest is an assessment of the most suitable model choice strategies for the selection of the appropriate patterns of association between the response and the predictor variables as well as to identify which of the predictor variables are important via the implementation of a covariate selection methodology. To achieve this, novel statistical methodology has been used in terms of model and variable selection with the aim of obtaining valid and robust results, especially when considering the specific nature of the collected data.

The remainder of the paper is structured as follows. The next section presents a brief background on relevant research. In section 3, the methodological aspects of the current study are presented and then the main results. In section 4, a discussion of the findings is outlined. Finally, the paper concludes with an outline of research implications and future research perspectives.

2 Background

Previous research applications examining associations between various aspects of SME sustainability draw on linear regression models as the basis of a statistical modeling specification. In particular, *Ong et al. (2014)* examine the impact of environmental improvements on the financial performance of large companies in Malaysia using multiple regression analysis, with the dependent economic variables being the return on total assets (ROA) and return on equity (ROE). In another study, *Jayeola (2015)* empirically examines through multiple regression, the relationship between environmental sustainability practice and the financial performance of SMEs, using as a sample 98 SMEs in manufacturing and industry, business services and retail sectors in Sussex, UK. *King and Lenox (2001),* analyzing data on 652 U.S. manufacturing firms between 1987-1996, examine the effects of environmental performance on the companies' financial performance using a multiple regression model including both fixed and random effects covariates. As a dependent variable, the Tobin's q was utilized which measures the market valuation of a company relative to the replacement costs of tangible assets (*Lindenberg and Ross*, *1981*). Other studies on the topic include *Waddock and Graves (1997)* and *Hart and Ahuja (1996).*

However, in many applications the dependent variable utilized for expressing the economic performance is discrete, or the data tend to be skewed (e.g. response variables that present the answers in a dichotomous format, on a Likert scale or as percentages and proportions) (see e.g. *Almeida et al., 2014*; *Ngwakwe et al., 2013;*

Ong et al., 2014). Given that the main assumption of the continuous nature of the dependent variable in ordinary linear regression (OLS) is then violated, OLS regression may not always be the most suitable option for analyzing such data as it will most likely yield erroneous results. In order to correct for this, the vast majority of attempts to approximate normality focus on applying the logarithmic transformation to the response variable (see e.g. *Jayeola, 2015*). However, there is no literature examining the potential implications of such types of transformations and their impact on the results of regression analysis, for instance the differentiations that may appear on the covariate selection.

Other attempts (*Hessels et al., 2011; Vijfvinkel et al., 2011*) include utilizing binary logistic regression modeling, after recoding the continuous dependent variables reflecting companies' financial performance into a dichotomous format (0 and 1 values). This approach however can be criticized for overlooking important information regarding the variability of the initial dependent variables.

Such methodological weaknesses lead us to address the following research questions: Do sustainability practices and performance impact SME economic results linearly? What is the relationship between sustainability practices and performance variables with SME economic growth? What are the implications of transforming the variable of SME economic growth in terms of covariate significance? Which are the most dominant sustainability practices and performances?

Providing answers to such research questions contributes to the debate over the links between the environmental-social aspects of SME performance and their economic performance. *Hoffman and Bazerman (2005)* point out that "(...) *the key to resolving this debate is the recognition that (social and environmental) behaviors are sometimes profit-compatible and sometimes not*" (p. 16) and go on to stress that when key actors acknowledge this, it can be easier to convince for-profit entities to adopt mutually beneficial sustainability practices and move beyond the mere questioning of whether it pays to be socially and environmentally responsible. Hence, this study attempts to contribute to this issue by comparing and discussing the performance of linear regression for analyzing non-normal data, in comparison to potentially more suitable model specifications. In particular, our assessment employs a methodologically rigorous approach utilizing OLS regression, OLS regression with a transformed dependent variable, Poisson regression, and Negative Binomial regression.

3 Methodology

3.1 Data description

The sample includes small and medium sized enterprises (SMEs) only of firms with up to 250 employees. SMEs of three countries are studied in order to examine the influence of geographical locations on the relationship of sustainable supply chain practices and performance with economic growth. SMEs from developed (the UK and France) and emerging economies (i.e. India, a typical example of an emerging economy) are used as samples in order to get the perspectives of varied economies. The random sample of SMEs ensures the validity of the results. Specifically, for sample size selection, we have used $\hat{p} = 0.5$ as an estimate of population proportion that share a certain characteristic on one of the (categorical) explanatory variables in the survey. A margin of error of e=10% is acceptable and with t we denote the value from the standard normal distribution reflecting the confidence level (t = 1.96 for a 95% confidence level). Thereafter, by relying on the simple random sampling formula we should select approximately 96 SMEs. Exceeding the suggested sample size, a total number of 119 SMEs in the UK, France and India were sampled, from the manufacturing or processing industry sector (30 SMEs in the UK, 54 in France and 35 in India). Three-country data were gathered in order to examine the influence of economic status, comparing two developed economies with one emerging.

A questionnaire was distributed to the 119 SMEs' managers/owners including closed-form questions on a number of sustainability indicators of SME practices and performance, with special emphasis on the social, environmental and operational perspective of the company. The questionnaires were completed through personal interviews. Data collected are measured on the Likert scale from 1-5 and 1-10, with managers/owners ranking their company's practices and performances from very low (1) to very high (5 and/or 10). The variables are subject to limitations in the sense that having sustainable activities is to some extent subjective and can be interpreted differently from firm to firm, however we believe that this limitation is largely alleviated by the careful selection of SMEs sample, the proper design and construction of the questionnaire and methodical personal interviews with the managers/owners. Specifically, the questionnaire was formed in line with the themes that emerged from the relevant literature. A pilot survey in each country was undertaken to resolve a few issues related to the interpretation of the questions and language issues. The collected raw data was validated through undertaking case studies in a couple of SMEs in each country that revealed the synergy of the responses and the reality. Cleaning of the final sample of collected data was also performed with great care.

The dependent variables used for the research attempt to reflect the SMEs' economic performance, is measured by the answers and rating of the managers on the variables of turnover and business growth (1 to 10 on the Likert scale). Table A1 in the appendix analytically presents the variables used as independents for our analysis. The sample characteristics of the variables used are presented in Table 1. The questionnaire will be made available as supplementary material.

-- TABLE 1 AROUND HERE –

In addition to the sustainability practices and performance described above, geographical effects on business turnover and growth is also of interest, due to the diverse selection of our sample. To this end, the dummy indicators of French and Indian SMEs are included as covariates, and compared with the reference category of British SMEs.

3.2 Model

3.2.1 Modeling the response variable

A regression-type analysis approach was employed by following the Bayesian paradigm in order to look for the potential associations between the economic performance of SMEs and their sustainability practice and performance indicators collected from the questionnaire. In our study, the dependent variables correspond to the measurement of turnover and business growth, as it was depicted by the answers of SME managers. The predictors are the 22 individual items measuring operational, environmental and social practices and performance indicators, along with the country indicators of France and India.

In order to account for the discrete nature of the collected response data, in addition to the standard multiple linear regression model, we fit a variety of alternative specifications as regards the link distribution of the regression equation.

Hence, the results from various regression-type Bayesian models will be fitted and compared assuming different distributions for the response variables. More specifically, continuous-type distributions, such as the Gaussian fitted to the raw data as well as corresponding transformations of the raw data are assumed. In addition, the responses are modeled using distributions more suitable to count data, such as the Poisson and the negative binomial (NB) distributions. The latter is frequently considered as an alternative to the Poisson distribution in cases of over dispersed data.

Assuming that y_{ik} denotes the $i-th$ response of the $k-th$ independent variable (*i=1,2,…,119; k=1,2,…,24*) and that $\mathbf{X}^T$ denotes the (24×119) matrix comprising of the values of the independent variables. Hence, the regression-type models fitted to our raw data are described by the following equations:

Normal:

$$y_{ik} \sim N\left(\mu_{ik}, \sigma^2_{wth}\right); \qquad e_{ik} \sim N\left(0, \sigma^2_{wth}\right) \tag{1}$$
$$\mu_{ik} = \mathbf{X}^t \cdot \boldsymbol{\beta}$$

Poisson:

$$y_{ik} \sim Poisson\left(\lambda_{ik}\right)$$
$$\log(\lambda_{ik}) = \mathbf{X}^t \cdot \boldsymbol{\beta} \tag{2}$$

Negative binomial (NB):

$$y_{ik} \sim \mathrm{NB}\left(\mu_{ik} = \frac{r\left(1-q_{ik}\right)}{q_{ik}}, q_{ik}\right) \tag{3}$$

$$\frac{r(1-q_{ik})}{q_{ik}} = \mathbf{X}^t \cdot \boldsymbol{\beta}$$

where μ_{ik} and σ^2_{wth} are the mean and variance of the dependent variables under a Gaussian distribution, λ_{ik} denotes the parameter of the Poisson distribution, and r, q_{ik} are the parameters of the NB distribution. Finally, $\boldsymbol{\beta} = (\beta_1, \beta_2, ..., \beta_k)^t$ are the regression coefficients of the predictors.

3.2.2 Data transformations of the dependent variables

There are various reasons for applying a transformation to the dependent variable of a regression model. These may include (a) improving model fit in linear regression, for instance by normalizing the dependent variable, or (b) correcting for the skewness of positive data. Typically, transformations of this type include the logarithmic transformation and the square root transformation.

In the former case, the $\log(x)$ transformation is used (*Box and Cox, 1964*). Log transformations are often applied to count data due to the inherent high degree of variation in these types of data. We will also test the frequently used square root transformation $\sqrt{x}$ and its effect on the results. Unlike the log transform, the square root transformation does not require special treatment of zero responses.

Hence, in addition to the previously described regression models, the following transformed regression models will be applied to the data:

Squared-root transformed Normal:

$$\sqrt{y_{ik}} \sim N(\mu_{ik}, \sigma^2_{wth}); \quad e_{ik} \sim N(0, \sigma^2_{wth}) \tag{4}$$
$$\mu_{ik} = \mathbf{X}^t \cdot \beta$$

log transformed $\log(y_{ik})$***Normal:***

$$\log(y_{ik}) \sim N(\mu_{ik}, \sigma^2_{wth}); \quad e_{ik} \sim N(0, \sigma^2_{wth}) \tag{5}$$
$$\mu_{ik} = \mathbf{X}^t \cdot \beta$$

3.2.3 Bayesian variable selection

The variable selection problem in regression consists of finding the predictors that enter the regression equation of which their coefficients $\boldsymbol{\beta}$ are non-zero. The variable selection problem arises when there is some unknown set of predictors with regression coefficients so small that it would be preferable to ignore them (*George and McCulloch, 1993*).

Typically, standard regression models assume independent covariates, and some type (either forwards or backwards) of stepwise elimination method for variable selection is performed. However, these approaches, although relatively cheap computationally, have been recognized as suffering from drawbacks (see *Hurvich and Tsai, 1990; Roecker, 1991*). In this paper, we illustrate the use of Bayesian covariate selection to adequately address the potential high collinearity issues being present in the specific covariates.

Variable selection in Bayesian regression modeling typically involves the introduction of a vector of binary indicators $\gamma \in \{0,1\}^p$, that serves as an indicator of the *p* possible sets of covariates that should be included in the final model (i.e. $\gamma_i = 0$ or 1 if coefficient β_i is small or large, respectively) (*George and McCulloch, 1993*). Then, Markov chain Monte Carlo (McMC) methodology is utilized in order to approximate the posterior distribution of γ given the data.

In this way, if for the *j*th covariate X_j, $\gamma_j = 1$ then X_j is included in the set of predictor variables, whereas if $\gamma_j = 0$ then X_j is excluded. Many applications of this problem are high dimensional, namely, there exist a large number of candidate variables for selection.

In our study, driven by the results of previously conducted analysis, we hypothesize that only a few of the utilized variables of practices and performance dimensions will have an effect on the economic performance indicators. Hence, we will resort to Bayesian variable selection as defined previously in terms of assigning a probability to each covariate for inclusion/exclusion from the final best model.

Regarding the specification of a prior distribution for the γ's a Bernoulli distribution for the prior specification of indicators γ is used, setting 50-50 odds for each explanatory variable to be selected, that is: $\gamma \sim Bernoulli(0.5)$. This is typically called the uniform prior specification. Subsequently, inference concerning the issue of whether to include each one of the covariates in the final model selection is based on the posterior probabilities given the prior model probabilities.

3.2.4 Hyper g-Prior Specification

As discussed previously, a hyper *g*-prior approach could be utilized for assigning prior distributions to model parameters to improve on the variable selection problem. The most common family of prior distributions for variable selection is Zellner's *g*-prior (*Zellner, 1986*). In the current paper, the popular extension to the classical Zellner's *g*-prior, known as the hyper *g*-prior is followed (*Liang et al, 2008; Sabanés Bové and Held, 2011*), which assumes the regression coefficients of the candidate covariates follow a Gaussian distribution according to:

$$\boldsymbol{\beta} \sim N\left(\mathbf{0}, g e^{\beta_0} \left(\mathbf{X}^t \mathbf{X}\right)^{-1}\right),$$

and the constant term follows a Gaussian distribution with zero mean and large variance, e.g.:

$$\beta_0 \sim N\left(0, 10^4\right).$$

Furthermore, the approach assigns a Beta prior to the shrinkage factor $g/(1+g)$, such that:

$$\frac{g}{1+g} \sim Beta\left(1, \frac{\alpha}{2} - 1\right).$$

The authors propose any choice of α between $2<\alpha\leq 4$ for the specification of the latter prior distribution on g. For our analysis, $\alpha=4$ has been chosen.

3.2.5 Prior specification

Upon selecting the most important covariates through the variable selection scheme described in previous sections, the models selected are fitted to derive the parameter estimates. In doing this, we assign suitable prior distributions to the parameters of chosen covariates. As concerns the prior distributions of parameters β_i of interest, usually the prior mean is set to zero, and the corresponding variance is set large to express prior ignorance, i.e. the dependents are assumed to follow a Gaussian distribution, $N(\mu_i, \sigma^2_{wth})$ where σ^2_{wth} follows an inverse Gamma distribution, with $1/\sigma^2_{wth} \sim Gamma(10^{-3}, 10^{-3})$.

3.3 Inference

For running the models, we have utilized McMC techniques. The posterior distributions have been obtained by using 10,000 iterations as the burn-in period and an additional sample of 10,000 iterations with thinning one out of ten iterations. We have used the WinBUGS software for model estimation (*Lunn et al., 2000*). The model was selected through the use of the posterior mean deviance (see *Spiegelhalter et al., 2002*). Models with smaller mean deviance value are better supported by the data.

4 Results

Bayesian variable selection and inference is performed, hypothesizing that only a small number of practices and performance aspects variables will be of importance to the response variables. To perform this, we rely on the already described Bayesian variable selection methodology.

The results of the variable selection approach for the various modeling considerations, (i.e. the Normal, log-transformed Normal, square root transformed Normal, Poisson and NB specifications) are presented below. In particular, Table 2 gives model selection criteria for the candidate models.

-- TABLE 2 AROUND HERE –

It can be seen that the log-transformed model presents the best fit, according to the posterior mean deviance results, followed by the squared root transformed data. Among the remaining models, the Poisson specification seems to perform better than the Normal and NB modeling specifications. At this point, it should be noted that model comparisons between the models with raw and transformed data are not meaningful, since the transformation of the initial data is expected to reduce the variance of the dependent variable, hence making the posterior mean deviance between the raw data and the transformed data model incomparable.

Next, in Table 3, the posterior inclusion probabilities γ for the variable selection on the response of turnover are presented, using the uniform prior specification. Ideally, the posterior probabilities of inclusion should be close to 0 or 1, for a covariate being included or excluded in the model, respectively. However, covariates are usually selected using a threshold value on the inclusion probabilities. The standard value for this threshold is 0.5, hence this approach is followed for the rest of the analysis.

-- TABLE 3 AROUND HERE --

As can be seen from the results of Table 3, only a few of the candidate independent variables of sustainability practices and performances are included in all models using the threshold value of 0.5. Specifically, the items of standardized business process practices (OPER_PR_3), health and safety practices (SOC_PR_2), long-term relationship with customers performance (OPER_PE_1), waste reduction performance (ENV_PE_2) and health and safety performance (SOC_PE_2) are the ones selected for inclusion in all of the five models. The dummy variable for French SMEs is also included, with the exception of the normal model. Finally, the variables of customer relationship management (CRM) effectiveness practices (OPER_PR_1) and supplier relationship management (SRM) effectiveness performance (OPER_PE_5) are only marginally included in the case of the log-transformed model.

Table 4 shows the results for the second dependent variable of SME economic performance, i.e. the variable of business growth. The goodness-of-fit results are partly similar to the results for the turnover. As regards the log- and square root-transformed models, best fit is exhibited by the log-transformed normal model. For the raw data models however, it can be observed that the best fit is provided by the normal model (posterior mean deviance: 362.4).

-- TABLE 4 AROUND HERE --

The posterior inclusion probabilities for the hyper g-prior approach for the business growth models are shown below (Table 5). Here, the most important covariates for inclusion are found to be CRM practices (OPER_PR_1), lean practices (OPER_PR_4), health and safety practices (SOC_PR_2), and the country effect of France. Furthermore, the energy consumption and emissions performance (ENV_PE_3) is selected for inclusion except for the Poisson and NB models. Other variables marginally included by some of the models are SRM practices (OPER_PR_2), the adoption of standardized environmental system practice (ENV_PR_1), the long term relationship with customer performance (OPER_PE_1) and the reduction of energy consumption and emissions performance (ENV_PE_3).

-- TABLE 5 AROUND HERE --

Next, we present the posterior medians, along with the corresponding 95% posterior credible intervals for each selected coefficient in the turnover model (Table 6).

As revealed by the parameters' estimates and the corresponding intervals, regarding the sustainability practices of SMEs, we find that standardized business process practices have a strong positive effect on the variable of turnover, according to the perceptions of the SME managers. Also, health and safety practices positively affect the dependent. Mixed results are observed however for the question of the importance of sustainability performance. The operational performance of the long term relationship with customers is positively associated with turnover, whereas specific environmental and social dimensions of performance appear to negatively affect business turnover. Specifically, estimated coefficients of the performance on waste reduction (ENV_PE_2), have a negative sign on turnover in all five tested models. The same partly holds for health and safety performance. Finally, the French

SMEs tend to have lower turnover levels when compared to the British SMEs, as found in 4 out of the 5 models.

-- TABLE 6 AROUND HERE --

Following, the results of the second model are presented, utilizing the economic performance variable of business growth as the dependent economic variable (Table 7).

-- TABLE 7 AROUND HERE --

CRM practices appear to be an important factor for the increase in business growth, a result that holds for all fitted regression models. Also, French SMEs, as was the case with turnover, exhibit lower levels of business growth when compared with British SMEs. Health and safety practices are also an important indicator for business growth, according to SME managers. This result is however marginal for three out of the five fitted models.

The results on the remaining covariates are not strongly conclusive however, as either there is no statistically significant outcome in terms of achieving the threshold of 0.5 for variable selection or covariates been selected with a threshold near the borderline of 0.5 are marginally significant according to the parameter estimates results. For instance, SRM practices (OPER_PR_2) although being selected for inclusion with inclusion probabilities threshold values just above 0.5 in the normal and square root –transformed models, the corresponding credible intervals are indicative of a marginal significance on the dependent variable of business growth. The same holds for operational lean practices (OPER_PR_4) and the practice of adopting a standardized environmental system (ENV_PR_1).

The operational performance of long term relationship with customers (OPER_PER_1), and the environmental performance of reduction of energy consumption and emissions (ENV_PER_3) negatively affect business growth to a marginal degree.

Figures 1 and 2 are a visual presentation of the models' fit, plotting together the observed and estimated by the models' outcome variables of turnover and business growth. It is noteworthy that when utilizing the normal and log transformed normal models, we get a few negative predictions, which for the latter model is expected due to the values of ones in the dependent variable.

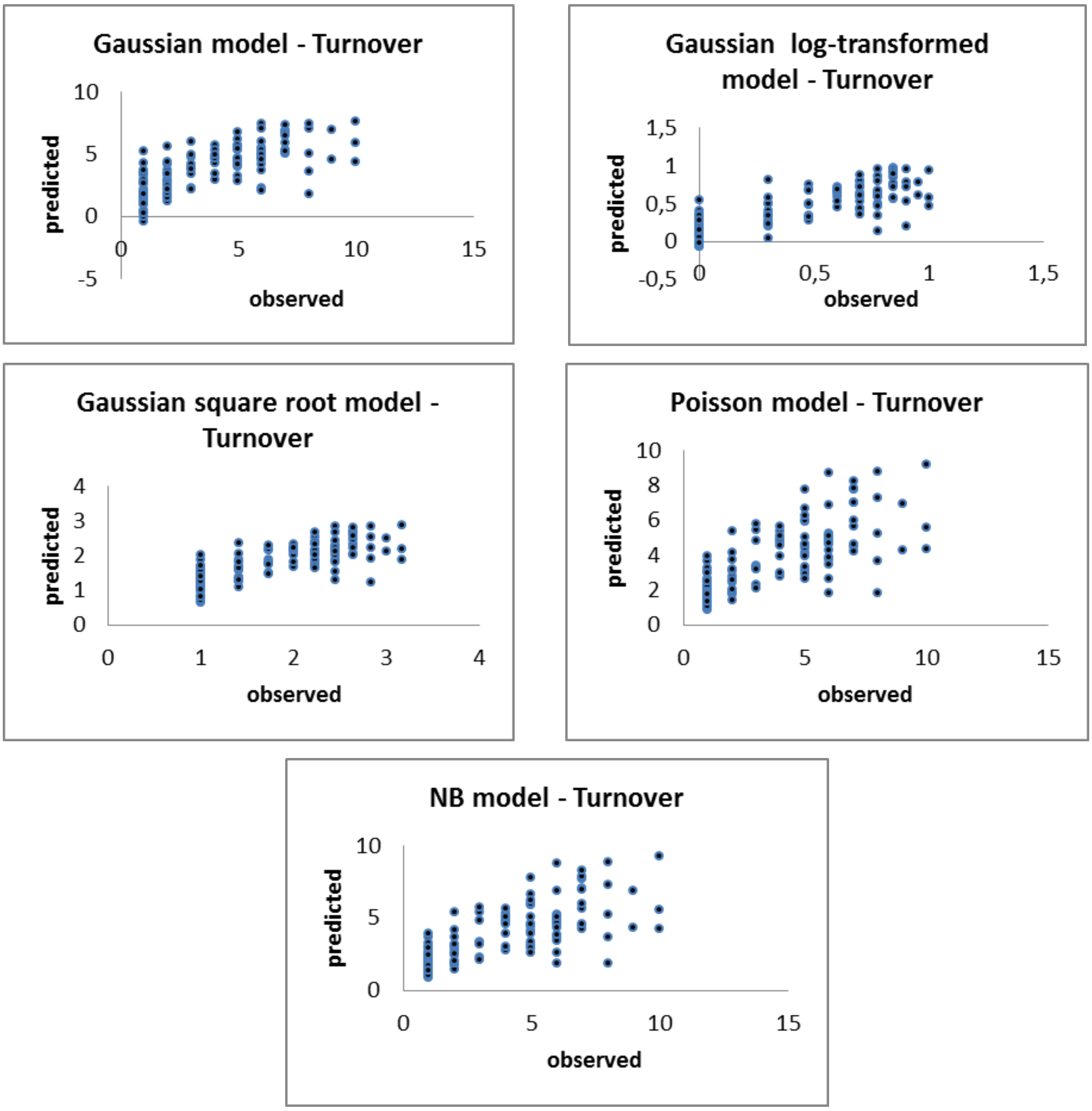

Figure 1: Scatterplot of observed and estimated values of turnover for the fitted models

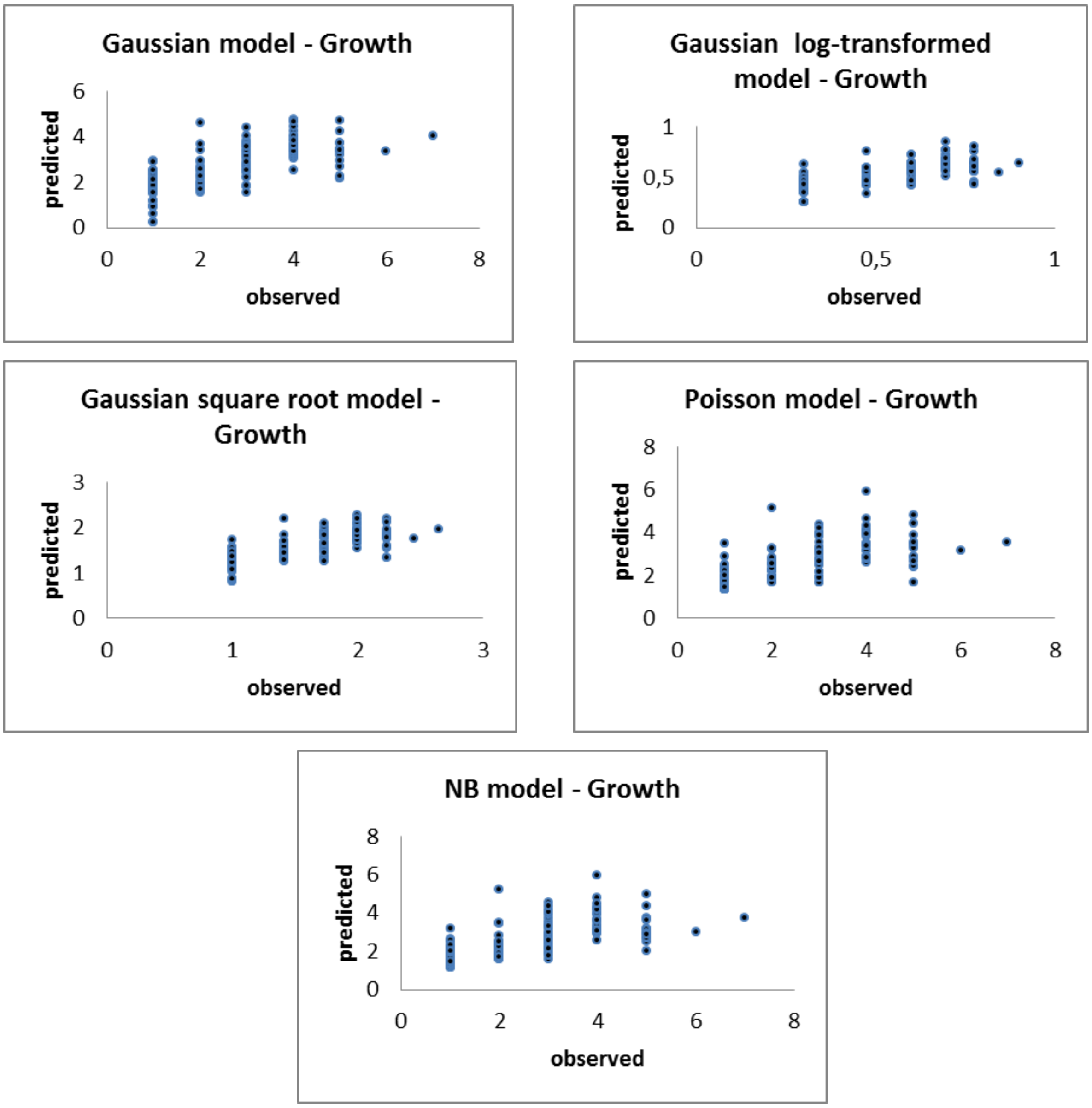

Figure 2: Scatterplot of observed and estimated values of business growth for the fitted models

5 Discussion

Sustainability is nowadays highlighted as the key to long-range business planning in order to facilitate performance refinements and improvements for the common good. With this in mind, we assert that there is a tangible need to develop a better and clearer understanding of the moderating role sustainability has on SME economic performance.

In this paper, we sought to examine the effects of individual sustainability practices and performance dimensions on the economic performance of SMEs, using a carefully chosen sample of SMEs from three countries. Specifically, we examined which operational, environmental and social practices/performance aspects are the most accurate predictors of SME economic performance. The latter was estimated through business growth and turnover, according to the perceptions of the managers/owners of the selected SME sample, using regression-type methodology. The conceptual framework and proposed assessment methodology developed in this paper attempt to meet calls for more theory-building research on SME sustainability (*Ates et al., 2013; Jansson et al., 2017*) and offer several advantages.

Specifically, in order to derive valid and robust results, Bayesian regression models were employed based on various specifications of the distribution of the dependent variables of economic performance measured on a Likert scale, as well as on typical transformations of the latter. More importantly, the results of a typical OLS regression based on assigning a normal distribution on the dependent variable have been compared with more suitable distributions for positive count data, such as the Poisson and the NB. Additionally, for selecting the most important covariates we opted for Bayesian variable selection based on the hyper g-prior specification.

By observing the outcomes, we have seen that only a few of the potential for inclusion explanatory variables were selected, having an inclusion probability that is above 0.5. Thus, despite the relatively large number of covariates (24), all of the fitted models choose a very parsimonious specification, with only a few regressors being included in the model with a threshold probability exceeding 50%. Especially for the covariates near the borderline selection threshold of 0.5, the results in most cases were marginally statistically important, suggesting that potentially a higher cut-off value could be utilized instead of the 0.5 threshold value for covariate selection.

As regards the model comparisons, it may be stated that although the various modeling specifications generally exhibited similar results on the parameters significance, there were also many exceptions, especially concerning those covariates at the borderline of selection. Model fit results showed some contradictory results when utilizing the raw data of the dependent variables, since both normal and Poisson distributional specifications provided the best fit, on different occasions however.

Generally, OLS regression does not produce significantly different results to the alternative specifications. However, the NB and Poisson models, at least for the first model, have shown to yield better performance as regards model fit than the OLS regression model. Superiority of the fit of the normal model in the case of the growth dependent variable may be merely attributed to the fact that the latter variable appears to be slightly less skewed in comparison to the dependent variable of turnover ($\alpha_3 = 0.497$ and 0.441 for the variables of turnover and economic growth, respectively). Hence, the asymmetry of the discrete variable should be taken into account when choosing a suitable distribution for the response in regression modeling. The logarithmic transformation on the other hand, has shown superior performance in comparison to the square root transformation of the data.

In relation to the association between economic indicators and sustainability practices and performances, turnover was found to be positively associated with standardized business processes and health and safety practices. A positive association with turnover was also verified for the long-term relationship with customers' performance, whereas waste reduction and health and safety performance was found to negatively affect turnover.

The positive statistically significant association between health and safety practices and turnover can be attributed to the fact that usually this type of practice is publicized as part of the companies PR initiatives, which in turn may result in a positive effect on its economic growth. Furthermore, health and safety performance is more directly connected to the actual results of the actions and the spending on these actions. The actual spending may have a direct negative result on the turnover that may overcome any indirect increase of business turnover due to the health and safety performance actions.

The results of this study are partly in line with previous research that has identified positive relationships between sustainability management practices and SME performance although the exact items measuring sustainability practices vary from one study to another (e.g. *Jayeola, 2015; Ong et al., 2014; Stewart and Gapp, 2012*).

Our findings reveal more positive effects of certain practices on turnover whereas the corresponding aspects of performance were found to be negative or non-significant. We believe that this result is due to the fact that practices in many instances lead to more positive impacts than their realizations through their performance. Specifically, economic performance is reflected through business growth and turnover, which is directly connected to capital cost, operating cost and cash flow. Companies intending to enhance economic performance will identify most appropriate enablers that will first affect their practices, subsequently to sustainable performances and in the end, their economic performance. If there is no economic benefit to amending sustainability practices, companies will not undertake such a venture. Therefore, practices are expected to always be very positively connected with economic performance. On the other hand, each practice is likely to produce a positive impact on the corresponding sustainable performance but it may not associate positively to others. However, the relationship between sustainable performance and economic performance will depend exclusively on the experience and perceptions of the interviewees from the organizations. Therefore, if it is found that specific sustainable performance does not contribute to economic performance but corresponding practices do, we can interpret that the company did achieve the desired objective but still there is potential for further improvement.

The reduced association (positive or negative) of economic performance with the sustainability practices and performance of the SMEs found in the current study, are in line with the inconclusive and contradictory results of the previous limited literature investigating this association (e.g. *King and Lenox*, *2001; Waddock and Groves*, *1997; Wanger et al.*, *2001*). It should be noted, however, that our findings contradict previous research that argues in favor of the positive association of sustainability (environmental) performance with economic performance (*Yang et al.*, *2011*). *Yang et al. (2011)* also report a negative association between the environmental practices and financial performance of companies; the study however was not restricted, as was ours, to SMEs.

SME business growth was associated with a reduced number of practices and even fewer performance indicators. Specifically, the analysis conducted on the results of all fitted models verified that CRM practices, lean practices, and health and safety practices are positive predictors of SME business growth. Here, as is the case with the turnover model, the corresponding performances are shown to be less important factors for the business growth of SMEs.

Finally, results showed that French SMEs substantially differ from the British and Indian SMEs, with respect to their economic growth (We cannot confidently verify this difference for turnover since the significance is on the borderline of selection, with zero value being close to the 95% upper credible limit). This result might be an indication of reduced results and performance of the adopted sustainability practices by the French SMEs, compared to the British and Indian SMEs, at least for the selected sample of our analysis.

These findings can provide fruitful insights to SME owners/managers trying to identify and control critical sustainability aspects of business practice for their bottom line performance. However, the study has limitations which highlight areas for further research. Firstly, the sample size and generated dataset is relatively small; replicating the methodological approach to larger samples (and perhaps from other countries' business sectors) may provide additional insights and reinforce the results of our assessment. Secondly, our proposed proxies of SMEs sustainability practices and performance can be refined and/or extended to include additional or more rigorous scales, measures and key performance indicators (*Chae, 2009*). Moreover, qualitative data derived from multiple in-depth case studies with selected SME owners/managers could provide support to the study's findings and allow a more detailed investigation of interrelations between sustainability practices found to contribute to business growth and economic performance. A focus on particular industries and sectors is explicitly encouraged as it may allow specific features of sustainability performance growth to be identified in greater detail with regards to how they affect SMEs economic output and growth. Lastly, ethnographic inquiry and action research via observation of a SME may allow researchers to gain experiential insights into sustainability implementation-management, and examine the deeper relationships and implications of the suggested impact of sustainability aspects on SME economic performance.

6 Conclusions

In conclusion, the major contribution of this paper lies in the implementation and comparison of different modeling strategies concerning the distributional specification of the dependent variable, as well as the careful implementation of covariate selection, especially in datasets that include a large number of predictors. It is one of the very few methodological approaches that facilitates a better understanding and identification of key sustainability performance measures with direct influence to business growth.

Various distributions have been utilized for the most accurate modeling of SME economic performance in relation to sustainability practices and performance. These results have also been compared with those obtained by applying transformations on the dependent variable and investigating how the various transformations affect variable importance. The results indicated that only specific practices and performances focused on environmental, social and operational sustainability seem to benefit an SME’s economic performance.

Overall, a few important differences between the various approaches were observed, especially for the covariates on the borderline of selection. However, these differences are not sufficient to suggest that any method performs significantly better than the others. A major finding is that the degree of skewness of the dependent variable should be taken into consideration for choosing the link distribution of the regression modeling.

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TABLES

Table 1: Descriptive statistics of the data

	Mean	Std. Deviation	Minimum	Maximum
ECON_PE_1	3.80	2.589	1	10
ECON_PE_2	2.69	1.436	1	7
OPER_PR_1	2.62	1.150	1	5
OPER_PR_2	2.22	1.114	1	5
OPER_PR_3	2.89	0.974	1	5
OPER_PR_4	2.42	1.435	1	5
ENV_PR_1	2.45	0.838	1	5
ENV_PR_2	2.30	1.183	1	5
ENV_PR_3	2.83	1.052	1	5
SOC_Pr_1	2.30	1.225	1	4
SOC_Pr_2	2.42	1.211	1	5
OPER_PE_1	3.76	1.619	1	7
OPER_PE_2	3.11	1.177	1	5
OPER_PE_3	2.86	1.227	0	6
OPER_PE_4	2.82	1.412	1	5
OPER_PE_5	3.18	1.030	1	5
OPER_PE_6	3.17	1.271	1	5
OPER_PE_7	2.94	0.934	1	5
OPER_PE_8	2.27	1.226	1	5
ENV_PE_1	2.99	1.259	1	5
ENV_PE_2	2.56	1.280	1	5
ENV_PE_3	2.87	1.008	1	5
SOC_PE_1	2.24	1.214	1	5
SOC_PE_2	2.90	1.061	1	5

Table 2: Goodness-of-fit statistics for the candidate models (response variable: turnover)

Model	**Turnover**
	Mean deviance ($\overline{D}$)
Normal	484.3
Log-transformed	-11.05
Square-root transformed	158.6
Poisson	462.1
NB	464.3

Table 3: Posterior inclusion probabilities for the candidate models γ~Bernoulli(0.5) (response: turnover) (inclusion probabilities with value above 0.5 in bold)

Covariate	**Normal**	**Log-transformed**	**Square-root transformed**	**Poisson**	**NB**
OPER_PR_1	0.3279	**0.6293**	0.421	0.3702	0.3959
OPER_PR_2	0.4452	0.3715	0.41	0.3398	0.3344
OPER_PR_3	**0.7595**	**0.6332**	**0.7112**	**0.8188**	**0.8214**
OPER_PR_4	0.3606	0.4168	0.4091	0.3413	0.3759
ENV_PR_1	0.2557	0.2877	0.2746	0.2551	0.2691
ENV_PR_2	0.3774	0.3181	0.3603	0.3803	0.3664
ENV_PR_3	0.4099	0.3899	0.3942	0.385	0.4164
SOC_PR_1	0.3118	0.2732	0.2851	0.2839	0.3093
SOC_PR_2	**0.9823**	**0.9881**	**0.9906**	**0.9901**	**0.9938**
OPER_PE_1	**0.809**	**0.7369**	**0.7816**	**0.8261**	**0.7682**
OPER_PE_2	0.3307	0.2915	0.3135	0.3102	0.3582
OPER_PE_3	0.3784	0.312	0.3557	0.3527	0.3485
OPER_PE_4	0.4677	0.329	0.4036	0.3913	0.4118
OPER_PE_5	0.4588	**0.5322**	0.4932	0.3933	0.3822
OPER_PE_6	0.3584	0.4957	0.4211	0.4986	0.4762
OPER_PE_7	0.3504	0.3026	0.3314	0.3133	0.3222
OPER_PE_8	0.3782	0.3817	0.3941	0.3834	0.4028
ENV_PE_1	0.4453	0.471	0.4849	0.4056	0.4224
ENV_PE_2	**0.6489**	**0.5217**	**0.6223**	**0.6289**	**0.6086**
ENV_PE_3	0.375	0.3351	0.3657	0.354	0.3409
SOC_PE_1	0.3423	0.2841	0.3123	0.3038	0.3131
SOC_PE_2	**0.6453**	**0.8181**	**0.7435**	**0.8545**	**0.8193**
FRANCE	0.4868	**0.8996**	**0.7154**	**0.5875**	**0.5715**
INDIA	0.299	0.2488	0.2714	0.3251	0.3077

Table 4: Goodness-of-fit statistics for the candidate models (response variable: Business growth)

Model	**Business growth**
	Mean deviance ($\overline{D}$)
Normal	362.4
Log-transformed	-146.7
Square-root transformed	79.15
Poisson	387.6
NB	390.4

Table 5: Posterior inclusion probabilities for the candidate models γ~Bernoulli(0.5) (response: business growth) (inclusion probabilities with value above 0.5 in bold)

Covariate	**Normal**	**Log-transformed**	**Square-root transformed**	**Poisson**	**NB**
OPER_PR_1	**0.8244**	**0.9476**	**0.9196**	**0.6402**	**0.6138**
OPER_PR_2	**0.5082**	0.488	**0.5087**	0.473	0.4812
OPER_PR_3	0.359	0.2942	0.3175	0.4423	0.45
OPER_PR_4	**0.5581**	0.4608	**0.5023**	**0.5125**	**0.504**
ENV_PR_1	**0.529**	0.455	**0.5002**	0.4873	0.4794
ENV_PR_2	0.4291	0.3407	0.3762	0.446	0.4413
ENV_PR_3	0.4006	0.3391	0.3769	0.4226	0.4299
SOC_PR_1	0.4481	0.364	0.4123	0.4677	0.4693
SOC_PR_2	**0.6037**	**0.503**	**0.5168**	**0.5579**	**0.5684**
OPER_PE_1	**0.5142**	0.4531	0.4884	0.4942	**0.5187**
OPER_PE_2	0.4945	0.4182	0.4517	0.497	0.484
OPER_PE_3	0.408	0.3354	0.3532	0.436	0.4341
OPER_PE_4	0.4088	0.3326	0.3756	0.4362	0.4367
OPER_PE_5	0.4659	0.3945	0.4344	0.4493	0.4412
OPER_PE_6	0.4043	0.3569	0.3744	0.4415	0.4387
OPER_PE_7	0.3884	0.3156	0.3452	0.4542	0.4607
OPER_PE_8	0.4428	0.4662	0.4862	0.4338	0.4669
ENV_PE_1	0.443	0.3395	0.3826	0.4498	0.4488
ENV_PE_2	0.4092	0.3274	0.3672	0.4266	0.4359
ENV_PE_3	**0.5822**	**0.6443**	**0.6142**	0.4845	0.4769
SOC_PE_1	0.4	0.3436	0.3707	0.4276	0.4165
SOC_PE_2	0.3791	0.328	0.344	0.4455	0.4385
FRANCE	**0.7741**	**0.9636**	**0.9251**	**0.6636**	**0.6419**
INDIA	0.4268	0.3524	0.375	0.4454	0.456

Table 6: Posterior median parameter estimates for the candidate models along with the corresponding 95% credible intervals γ~Bernoulli(0.5) (response: turnover)

Covariate	Normal	Log-transformed	Square-root transformed	Poisson	NB
OPER_PR_1		0.04 (0.00,0.082)			
OPER_PR_2					
OPER_PR_3	0.743 (0.252,1.239)	0.082 (0.018,0.149)	0.211 (0.087,0.337)	0.277 (0.118,0.43)	0.274 (0.117,0.429)
OPER_PR_4					
ENV_PR_1					
ENV_PR_2					
ENV_PR_3					
SOC_PR_1					
SOC_PR_2	1.399 (1.01,1.787)	0.155 (0.097,0.211)	0.33 (0.216,0.443)	0.343 (0.211,0.478)	0.345 (0.212,0.481)
OPER_PE_1	0.315 (0.098,0.543)	0.028 (0.00,0.058)	0.087 (0.028,0.144)	0.098 (0.027,0.169)	0.097 (0.024,0.172)
OPER_PE_2					
OPER_PE_3					
OPER_PE_4					
OPER_PE_5		0.043 (-0.014,0.102)			
OPER_PE_6					
OPER_PE_7					
OPER_PE_8					
ENV_PE_1					
ENV_PE_2	-0.349 (-0.714,0.001)	-0.027 (-0.073,0.018)	-0.084 (-0.174,0.006)	-0.106 (-0.201,-0.009)	-0.103 (-0.203,-0.004)
ENV_PE_3					
SOC_PE_1					
SOC_PE_2	-0.457 (-0.913,0.00)	-0.072 (-0.128,-0.014)	-0.111 (-0.226,0.08)	-0.182 (-0.324,-0.041)	-0.181 (-0.325,-0.037)
FRANCE		-0.167 (-0.269,-0.066)	-0.21 (-0.41,-0.01)	-0.181 (-0.405,0.044)	-0.184 (-0.412,0.04)
INDIA					

Table 7: Posterior median parameter estimates for the candidate models along with the corresponding 95% credible intervals γ~Bernoulli(0.5) (response: business growth)

Covariate	Normal	Log-transformed	Square-root transformed	Poisson	NB
OPER_PR_1	0.3 (0.104,0.499)	0.041 (0.019,0.063)	0.112 (0.053,0.171)	0.118 (0.014,0.223)	0.108 (0.005,0.218)
OPER_PR_2	-0.156 (-0.348,0.03)		-0.048 (-0.106,0.008)		
OPER_PR_3					
OPER_PR_4	0.148 (-0.053,0.35)		0.047 (-0.013,0.107)	0.085 (-0.011,0.182)	0.071 (-0.03,0.172)
ENV_PR_1	0.139 (-0.209,0.487)		0.033 (-0.075,0.14)		
ENV_PR_2					
ENV_PR_3					
SOC_PR_1					
SOC_PR_2	0.237 (-0.048,0.523)	0.039 (0.012,0.067)	0.07 (-0.016,0.158)	0.136 (0.005,0.262)	0.125 (-0.007,0.253)
OPER_PE_1	0.105 (-0.036,0.245)				0.057 (-0.025,0.139)
OPER_PE_2					
OPER_PE_3					
OPER_PE_4					
OPER_PE_5					
OPER_PE_6					
OPER_PE_7					
OPER_PE_8					
ENV_PE_1					
ENV_PE_2					
ENV_PE_3	0.181 (-0.096,0.457)	0.047 (0.017,0.076)	0.084 (0.006,0.161)		
SOC_PE_1					
SOC_PE_2					
FRANCE	-0.982 (-1.563,-0.401)	-0.129 (-0.188,-0.069)	-0.344 (-0.521,-0.168)	-0.271 (-0.551,0.00)	-0.301 (-0.584,-0.26)
INDIA					

APPENDIX

Practices	Performances
Operational: **1.** Customer relationship management (CRM) practices (OPR_PR_1), **2.** Supplier relationship management (SRM) practices (OPR_PR_2), **3.** Standardised business process (OPR_PR_3), **4.** Lean practices (OPR_PR_4).	**Operational:** **1.** Long term relationship with customers (OPR_PER_1), **2.** CRM effectiveness (OPR_PER_2), **3.** Demand uncertainties (OPR_PER_3), **4.** Long term relationship with supplier (OPR_PER_4), **5.** SRM effectiveness (OPR_PER_5), **6.** Supply uncertainty (OPR_PER_6), **7.** Business process effectiveness (OPR_PER_7), **8.** Lean effectiveness (OPR_PER_8).
Environmental: **1.** Adopting standardised environmental system (ENV_PR_1), **2.** Waste management practices (ENV_PR_2), **3.** Energy consumption and emission control (ENV_PR_3).	**Environmental:** **1.** Effectiveness of environmental system (ENV_PER_1), **2.** Waste reduction (ENV_PER_2), **3.** Reduction energy consumption and emissions (ENV_PER_3).
Social: **1.** Corporate social responsibility (CSR) practices (SOC_PR_1), **2.** Health and safety practices (SOC_PR_2).	**Social:** **1.** CSR performance (SOC_PER_1), **2.** Health and safety performance (SOC_PER_2).

Table A1. Analytical description of the 22 observed items from the SMEs' questionnaire (Response: Turnover (ECO_PER_1) & Business growth (ECO_PER_2).