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Methodological assessment of the SME Scoreboard 2016

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Abstract

The European Commission's Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs (DG GROW), with the scientific support by the European Commission Joint Research Centre (JRC), assesses the Performance of Small and Medium Enterprises in Europe, depending on the performance in the ten principles of: (1) Entrepreneurship, (2) 'Second chance', (3) 'Think small first', (4) 'Responsive administration', (5) State aid & public procurement, (6) Access to finance, (7) Single market, (8) Skills and innovation, (9) Environment, and (10) Internationalisation. This JRC technical report describes the underlying rationale behind the quantitative measurement of these principles and discusses the methodological approach which has been followed to calculate how countries perform in the outlined principles, from the choice of the indicators, to the data quality controls (including missing data and outliers), normalization and weightings, to the statistical coherence and robustness checks.

1 Introduction

Small and Medium Enterprises (SMEs), i.e. those firms that hire up to 250 employees, consist of 99% of all EU businesses and thus play a key role in European economy. In 2008 the EU Council of Ministers has officially endorsed the Small Business Act for Europe (SBA), a document that recognizes the central role of the SMEs in the EU28 economy. This political act aimed to guarantee the full commitment of the European Commission and the Member States to regular monitoring of progress in implementation of the SBA across Europe. Thus, for the first time a comprehensive SME policy framework of the EU Member States (MSs) has been put into motion. Indeed, the SBA aims to improve the overall approach to entrepreneurship specific to the SMEs as well as to permanently anchor the 'Think Small First' principle in policy making from regulation to public service, and to promote SMEs' growth by helping them tackle the remaining problems which hamper their development.

More recently (October 2016), the Commission proposed the re-launch of the Common Consolidated Corporate Tax Base (CCCTB), a single EU system allowing companies to compute easily their taxable income. This helps improving the Single Market in Europe, which is one of the principles of the SBA. CCCTB is also meant to incentivize R&D spending and thus innovation, another principle of the SBA, by allowing R&D investments to be fully deductible.

Since 2008 the European Commission's Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs (DG GROW) produces the SME Performance Review. This document includes, among others, the SBA country fact sheets whose main purpose is to describe the performance of the SMEs across the EU28 MSs using quantitative indicators that cover the broad range of ten SBA principles such as: (1) Entrepreneurship, (2) 'Second chance', (3) 'Think small first', (4) 'Responsive administration', (5) State aid & public procurement, (6) Access to finance, (7) Single market, (8) Skills and innovation, (9) Environment, and (10) Internationalisation. Due to statistical affinities between indicators included in the principles: (3) 'Think small first' and (4) 'Responsive administration', combined with a small number of indicators within the former principle, both of them have been merged into a single statistical dimension. Consequently, the ten aforementioned SBA principles are framed into nine dimensions, each populated with four up to twelve indicators (per principle). The dimensions are not aggregated into a composite indicator due to insufficient statistical coherence of the underlying framework. Instead, the dimensions are presented together in a form of a scoreboard and the attention is focused on the individual principles and the indicators that define them. Since 2011, the SBA Fact sheets are produced by DG GROW with scientific support by the Joint Research Centre (JRC).

The report is structured in the following manner.

Section 2 is devoted to literature review that aims to cover indicators and composite indices measuring aspects relevant to the ten SBA principles that are used across the world. In the review we discuss conceptual aspects such as the methodology or policy relevance, as well as technical aspects such as data availability.

Section 3 presents in detail the nine-dimensional framework, corresponding to ten principles of the SBA, the rationale behind each principle and the underlying indicators that were selected by DG GROW after consultation with national experts. A total of 74 indicators were selected from 20 sources, such as Flash Eurobarometer on Entrepreneurship, World Bank Doing Business, European Payment Index, European Central Bank database on interest rates, and other.

Section 4 discusses the methodological approach used to calculate the SBA principles, related to data quality issues (missing data, potential outliers), choice of normalization, weighting and aggregation formula. Raw data were first checked for reporting errors and outliers that could strongly bias the results were treated. Missing data were estimated using a hybrid approach that combines a bootstrap time-series cross-sectional

expectation-maximization algorithm with a number of heuristic rules based on trend identification developed jointly by the JRC and DG GROW. The SBA principles were calculated as simple averages of the normalized (with min-max) indicators per country for 2001-2016 with highly correlated indicators being counted as a single indicator.

Section 5 analyses the statistical coherence of the SBA framework based on an analysis of the covariance structure within and across the principles. The analysis suggests that, at least from the statistical point of view, the SBA principles are strongly multidimensional and the underlying indicators capture very diverse aspects of SMEs achievements with little overlap of information between them. While on the one hand such diversity can be considered as advantageous, on the other hand it is a strong argument against building up a composite indicator in which all the SBA principles are aggregated into an overall index.

Section 6 assesses the robustness of country classifications with respect to the EU average for each principle, with a view to examine to what extent the results depend on the selected set of indicators or on the methodological judgments made during the development of the SBA principles. When comparing country positioning with respect to the EU average, the statistical robustness and coherence analysis confirmed that 92% of countries' positioning are statistically reliable.

Section 7 provides a summary of the methods and the conclusions.

2 Literature review

A scoreboard of indicators is a quantitative tool that aims to measure a latent complex phenomenon. Usually, this requires simplification a real-life concept through some sort of agglomerative statistical model in which indicators are aggregated together at pre-defined stages. In some cases the aggregation proceeds all the way through until a single number (a composite index) is obtained, in other cases the aggregation is stopped at certain intermediate level in which case a multivariate scoreboard is produced. In either case, the final product is a summary measure of a complex issue which is easy to understand for policy decision-makers and the general public.

Because such simplifications often come at the expense of information loss, their practical relevance to decision making is sometimes discussed (Paruolo, Saisana and Saltelli 2013). Another concern comes from subjective choices made when deriving indices and scoreboards, which include issues such as: framework specification, normalization procedure, weights assignment and aggregation method (Saisana and Philippas 2012).

Nevertheless, despite all the criticism they receive, the popularity of composite indices and scoreboards for policy use is steadily increasing over recent years. Bandura (2011) lists over four hundred country-level indices that address a variety of topics from economic progress through environmental sustainability to quality of education. More than hundred country-level indices and databases related to governance, or some of its components have been identified by Rotberg, Bhushan and Gisselquist (2013). A recent study of the United Nations (Yang 2014) reviews in detail more than hundred composite measures of human well-being and progress, which cover subjects varying from happiness-adjusted to environmentally-adjusted income and from child development to the development of information and communications technology.

Coherently with the SBA principles, the OECD, together with European Commission, the European Bank for Reconstruction and Development, and the European Training Foundation develops the *"SME Policy Index",* in which it assesses the policy dimensions that are related to each SBA principle based on governmental self-assessments and local consultants' evaluations. The aim is of being a benchmarking tool for emerging economies to guide policies towards SMEs. It allows across time comparisons in the evolution of country policies and gives country specific recommendations (OECD et al., 2015).

Framework conditions that are related to the growth of entrepreneurial activities, such as entrepreneurial culture, access to human capital, support initiatives for knowledge creation and networking, market conditions, availability of sufficient and appropriate finance, prevailing business regulations and the quality of the supporting infrastructure are assessed through two composite indicators for European countries, *the Entrepreneurship and Scale-up Indices* (ESIS) (Van Roy and Nepelski, 2016). Those have been developed by the European Commission, DG CONNECT and DG JRC, to support policies on enhancing ICT innovation and entrepreneurship in Europe.

A composite indicator on SMEs, specific for a non-European country, is the *Standard Chartered Hong Kong SME Leading Business Index*, a composite indicator on more than 800 Hong Kong based operating firms in which the dimensions of "Staff Number", "Investments", "Sales Amount", "Profit Margin" and "Global Economic Growth" are covered. The composite indicator is developed quarterly by the Hong Kong Productivity Council and it is sponsored by Standard Chartered Hong Kong.

When isolating each identified SBA principle, it is moreover possible to identify simple or composite indicators that have been built in EU as well as in other not European countries to assess each dimension. This Section unveils how aspects related to the SBA principles have been captured in selected examples of simple or composite indicators, summarized into Table 1.

Table 1: Review of indices relevant in the Small Business Act context

SBA Principle	Indicator/Index	Developers
I. Entrepreneurship	Global Entrepreneurship Index	GEDI
	Female Entrepreneurship Index	GEDI
	OECD-Eurostat Entrepreneurship Indicators Programme	OECD
	Global Entrepreneurship Monitor	Global Entrepreneurship Research Association
II. 'Second chance'	World Bank "Doing Business"	World Bank
III. 'Think small first'	World Bank "Doing Business"	World Bank
IV. Responsible Administration	World Bank "Doing Business"	World Bank
V. Public Procurement	World Bank "Doing Business"	World Bank
	SMEs access to and demand aggregation in public procurement	DG MARKT, PwC, ICF GHK and Ecorys
	State aid Scoreboard	DG COMP
	European Payment Index	Intrum Justitia
VI. Access to Finance	World Bank "Doing Business"	World Bank
	Global Entrepreneurship Monitor	Global Entrepreneurship Research Association
	Access to Finance of Enterprises	European Central Bank
	Financing SMEs and Entrepreneurs 2016 Scoreboard	OECD
VII. Single Market	Global Entrepreneurship Monitor	Global Entrepreneurship Research Association
	Digital Economy and Society Index (DESI)	European Commission
VIII. Skills and Innovation	European Innovation Scoreboard	European Commission
	Innovation Output Indicator	European Commission
	Global Innovation Index	Cornell University, INSEAD and WIPO
IX. Environment	Eco-Innovation Scoreboard	Eco-Innovation Observatory for European Commission, DG Environment
X. Internationalisation	World Bank "Doing Business"	World Bank
	UNCTAD Internationalisation Statistics	UNCTAD
Transversal indicators		
	SME Policy Index	OECD, European Commission, European Bank for Reconstruction and Development, European Training Foundation
	the Entrepreneurship and Scale-up Indices	European Commission
	Standard Chartered Hong Kong SME Leading Business Index	Hong Kong Productivity Council, Standard Chartered Hong Kong.

Entrepreneurship and the leverages that drive its growth and success in different and specific contexts are captured throughout the World by multiple indicators.

The Global Entrepreneurship Index (Acs et al. 2016) summarizes attitudes, resources, and infrastructure (entrepreneurship 'ecosystem') on a yearly basis for 132 countries (including EU28, China, India, Australia and the US) in a single composite indicator, centred on 14 pillars. It is developed by the Global Entrepreneurship and Development Institute (GEDI). The aim of the index is to rank countries and to provide them with a picture on how each country performs in both the domestic and international context. The same institute constructed the *Female Entrepreneurship Index*, an index launched in 2013 that measures conditions for female entrepreneurship development (GEDI, 2015). In its last edition it covers 77 countries. It contains three main sub-indices on the quality of: the entrepreneurial environment; the entrepreneurial eco-system; and women's entrepreneurial aspirations[1].

The *OECD-Eurostat Entrepreneurship Indicators Programme* (EIP), launched in 2006, develops indicators on entrepreneurship - both on entrepreneurial performance and on entrepreneurial determinants - to be internationally-comparable across 37 countries and with the aim of guiding policy making. OECD (2016) report is extended by new data extracted from an online SMEs survey prepared by Facebook in co-operation with the OECD and the World Bank. EIP stresses the multi-faceted nature of entrepreneurship and does not summarize it into a single composite indicator, rather it collects and reports indicators from multiple data sources[2].

The *Global Entrepreneurship Monitor* (GEM) is used as a source for several indicators in the SBA (even in coming principles, e.g. 'Second chance', 'Think small first' and Responsible Administration, Access to Finance and Single Market) (Kelley et al. 2016). It provides comparable country measures of entrepreneurial activity for more than 100 countries (including EU28, China, India, Australia and the US) and it is based on two dimensions: entrepreneurial behaviour and attitudes and the national context. It was launched in 1999 as a joint project between Babson College (USA) and London Business School (UK) under the Global Entrepreneurship Research Association's supervision. It provides complementary information on the Adult Population Survey (APS), covering more than 2000 adult's entrepreneurial attitude in every country, and the National Expert Survey (NES), administered to selected experts to assess the Entrepreneurial Framework Conditions. It does not summarize indicators into a composite indicator.

'Second chance' principle is largely assessed by the *World Bank "Doing Business",* a flagship publication by the World Bank (World Bank, 2017) that captures regulations that enhance business activity and those that constrain it, covering 190 countries over time. In particular it assesses the ease of doing business under multiple perspectives: starting a business, dealing with construction permits, getting electricity, registering property, getting credit, protecting minority investors, paying taxes, trading across borders, enforcing contracts and resolving insolvency.

The **'Think small first'** and the **Responsible administration principles** are represented as well by the *World Bank "Doing Business"* (World Bank, 2017). In particular the report provides a country base measurement of the ease of starting a business in an economy by recording all procedures officially required or commonly done in practice by an entrepreneur to start up and formally operate an industrial or commercial business—as well as the time and cost required to complete these procedures and the tax payments in number per year and hours per year. It also records

[1] Data is sourced from international datasets such as the Global Entrepreneurship Monitor, the International Labor Organization, the World Economic Forum, the World Bank, UNESCO, and United Nations Development Program.

[2] Sources such as National Statistical Offices, OECD Timely Indicators of Entrepreneurship, OECD Main Economic Indicators Database, OECD Structural and Demographic Business Statistics, OECD Trade by Enterprise Characteristics, Labour Force Surveys and Census Population data, OECD Entrepreneurship Finance Database and OECD Patent Database

the paid-in minimum capital that companies must deposit before registration as well as the costs to enforce contracts. As for the previous principle, it gives a ranking of economies on the ease of starting a business depending on their distance to frontier scores.

The *World Bank "Doing Business"* (World Bank, 2017) measures **Public Procurement** and it assesses for a pilot of 78 countries the government indicators that have been developed by the Benchmarking Public Procurement project to measure transaction costs of public procurement contracts, the accessibility and transparency of particular aspects of the procurement process and constraints that private companies face, as well as the presence of specific legal provisions or policies to promote fair access for SMEs to government. Sources for single indicators are the DG MARKT study on "*SMEs access to and demand aggregation in public procurement*" indicates, for European Countries, the share of SMEs in the contracts awarded by Member States (PWC et al. 2014). DG COMP develops the *State aid scoreboard*[3], in which European countries are compared with respect to the total aid earmarked for SMEs. Finally the *European Payment Index*, developed by Intrum Justitia (Intrum Justitia, 2016), signals the number of days of delay before payments is made by the public authorities, and it is available for 25 European countries.

The same *Intrum Justitia* provides single indicators on the **Access to Finance** principles, namely the duration in days it takes for a company to get paid and the relative amount of receivables that has to be written as a consequence of the lack of payment. The World Bank "Doing Business" (World Bank, 2017) provides as well indicators which are coherent to this principle: the *strength of legal rights index*, measuring the degree to which collateral and bankruptcy laws protect the rights of borrowers and lenders and facilitate lending, and the *Depth of credit information index,* that measures rules and practices affecting the coverage, scope and accessibility of credit information. The *Global Entrepreneurship Monitor* (Kelley et al. 2016) provides indication on the *Equity funding* available for new and growing firms, the *professional Business Angels* funding available to those firms as well as the *crowdfunding* possibilities. The European Central Bank Survey on the "*Access to Finance of Enterprises*" (SAFE) (ECB, 2016) gives an indication on the rejected applications, on public financial support and on the willingness of banks to provide loans. A composite indicator for the euro area has been constructed and it is named the *perceived external financing gap indicator* which is specific for SMEs. The OECD produces the *Financing SMEs and Entrepreneurs 2016 Scoreboard* (OECD, 2016b) and monitors access to finance framework conditions and constrains for 37 countries.

The *internal market scoreboard* aims to give an overview of the practical management of the **Single Market** in Europe and provides a picture on the dismantlement of barriers to the European Single Market. The *Global Entrepreneurship Monitor* (Kelley et al. 2016) provides as well multiple indicators on the accessibility to the market for new firms, including the effectiveness of anti-trust legislation. The *Digital Economy and Society Index* (DESI) [4]is a composite index that summarises MS' digital performance and tracks the evolution of EU digital competitiveness. It is centred on the dimensions of Connectivity, Human Capital, Use of Internet, Integration of the Digital Society and Digital Public Services.

Skills and Innovation are accounted for by a variety of indicators and composite indicators in Europe and the World.

The *European Innovation Scoreboard* (former Innovation Union Scoreboard) (EC, 2016), compares EU member states and other European countries based on strengths and weaknesses of their national innovation systems. Its Summary Innovation index is split in three sub-indices, enablers, firm activities and outputs, which are composed respectively by 8, 9 and 8 indicators. The scoreboard presents a regionalized extension,

[3] The scoreboard is available here http://ec.europa.eu/competition/state_aid/scoreboard/index_en.html
[4] DESI index is available here https://ec.europa.eu/digital-single-market/en/desi

the *Regional Innovation Scoreboard* that covers 214 Regions across 22 EU countries and Norway.

The *Innovation Output Indicator* (Vertesy and Deiss, 2016), developed by the European Commission (DG RTD) to benchmark national innovation policies, is a composite indicator centred on technological innovation, skills in knowledge-intensive activities, the competitiveness of knowledge-intensive goods and services, and the innovativeness of fast-growing enterprises. It covers EU Member States, Japan, Switzerland, United States, Iceland, Norway and Turkey.

The *Global Innovation Index* (Cornell University et al., 2016), developed by a collaboration between Cornell University, INSEAD, and the World Intellectual Property Organization (WIPO), provides four indexes for 128 countries: a) The Innovation Input sub-index, b) the Innovation Output sub-index, c) the overall Global Innovation Index (a simple average of a) and b)), and the Innovation Efficiency Ratio (the ratio of b) over a)). Both score values and the ranking of the country are provided to allow for benchmarking and international comparisons. An independent statistical assessment of the Global Innovation Index is provided every year, since 2011, by the European Commission's Competence Centre on Composite Indicators and Scoreboards (COIN) at the Joint Research Centre (JRC) (Saisana, et al. 2016). The JRC audit focuses on the statistical soundness of the multi-level structure of the index as well as on the impact of key modelling assumptions on the GII results. This JRC audit helps to guarantee the transparency and reliability of the GII for both policy makers and other stakeholders, thus facilitating more accurate priority setting and policy formulation in the innovation field.

The *Eco- Innovation Scoreboard* (ECO-IS), developed by the Eco-Innovation Observatory for DG Environment, ranks European Member States coherently with the SBA **Environment** principle. It provides an overview of the Eco-Innovative performance of European Member States under different dimensions of eco-innovation in five areas: eco-innovation inputs, eco-innovation activities, eco-innovation outputs, resource efficiency outcomes and socio-economic outcomes[5].

The **Internationalisation** principle, which constitutes a relevant dimension even in the previously outlined principle, is captured by the *World Bank "Doing Business"* indicators (World Bank, 2017), in which importing and exporting activities are assessed. Of interest although with a focus which is not applicable to Small and Medium Enterprises, UNCTAD (UNCTAD, 2016) presents *Internationalisations statistics* for the largest non-financial Multinational Firms in the World.

[5] The scoreboard is available at the following link http://ec.europa.eu/environment/ecoap/scoreboard_en

3 SBA Fact Sheets

The SBA fact sheets to assess ten SBA principles are prepared by DG GROW annually since 2008. The indicators' framework behind the fact sheets is refined each year in order to align the quantitative information with the newest scientific discoveries and policy trends in the field of SMEs performance in Europe. Thus, although the SBA principles remain fixed over time, the quantitative framework varies from year to year, where the changes include aspects such as removing/incorporating indicators, merging dimensions, revising data collection methodologies for indicators, etc.

3.1 Framework and rationale

In 2016 edition of the fact sheets the SBA profiles are calculated for all 28 EU Member States plus 11 non-Member States[6] which also contribute to the EU's Competitiveness of Enterprises and Small and Medium-sized Enterprises (COSME) Programme. Following the decision to merge the principles 'Think small first' and 'Responsive administration' into a single statistical dimension, ten SBA principles are grouped into nine statistical dimensions in the following manner: (1) Entrepreneurship, (2) 'Second chance', (3-4) 'Think small first' and 'Responsive administration', (5) State aid & Public procurement, (6) Access to finance, (7) Single market, (8) Skills & Innovation, (9) Environment, and (10) Internationalisation. These principles are listed in Table 2, which also includes a rationale behind each SBA principle following the relevant Commission Communication (COM(2008) 394 final).

Table 2: SBA principles and rationale

SBA Principle	Rationale (from COM(2008) 394 final)
I. Entrepreneurship	To create an environment in which entrepreneurs and family businesses can thrive and entrepreneurship is rewarded
II. 'Second chance'	To ensure that honest entrepreneurs who have faced bankruptcy quickly get a second chance
III-IV. 'Think small first' & 'Responsive administration'	To design rules according to the 'Think small first' principle To make public administrations responsive to SMEs' needs
V. State aid & public procurement	To adapt public policy tools to SME needs: facilitate SMEs' participation in public procurement and better use State Aid possibilities for SMEs
VI. Access to finance	To facilitate SMEs' access to finance and develop a legal and business environment supportive to timely payments in commercial transactions
VII. Single market	To help SMEs to benefit more from the opportunities offered by the Single Market
VIII. Skills and innovation	To promote the upgrading of skills in SMEs and all forms of innovation
IX. Environment	To enable SMEs to turn environmental challenges into opportunities
X. Internationalisation	To encourage and support SMEs to benefit from the growth of markets

[6] The eleven non-EU countries are: Albania, FYROM, Iceland, Israel, Liechtenstein, Moldova, Montenegro, Norway, Serbia, Turkey and the United States of America (USA). These non-EU countries (with the exception of USA that were included only for comparison purposes) are in the data base for historical reasons as they were included in the old Competitiveness and innovation Framework Programme (CIP). In the new COSME programme there are only 7 non-member states (Albania, FYROM, Iceland, Moldova, Montenegro, Serbia, Turkey)

The 2016 version of the SBA fact sheets summarizes information on ten SBA principles, each of them being composed of several individual indicators, with a total of 74 indicators that have been selected by DG GROW in consultation with national experts, refined as described into the next Section "*Refinement of the SBA framework*". A total of 20 sources of information have been used, which include: the Flash Eurobarometer "Businesses' attitudes towards corruption in the EU", the Flash Eurobarometer on Entrepreneurship, former DG MARKT study on "SMEs access to and demand aggregation in public procurement", the Global Report (GEM), the World Bank Doing Business, the Global Competitiveness Report, the DG GROW study on "start-up procedures for the SME", the Eurobarometer survey on SMEs and the environment, the Eurostat Community survey on ICT usage and e-Commerce in enterprises, Survey on the Access to Finance of Enterprises SAFE, National Expert Survey (NES) of the Global Entrepreneurship Monitor (GEM), the State aid scoreboard, the European Payment Index, the European Central Bank database on interest rates, Bank of England, the Eurostat report on Venture Capital, the Comext database on international trade, the Internal market scoreboard, the Eurostat Community Innovation Survey, CVT survey. Table 3 lists the 74 indicators underlying the 2016 SBA profiles.

The first principle on **Entrepreneurship** is captured by ten indicators, measuring early stage entrepreneurial activity of men and women, ownership rate of established businesses, improvement-driven activity, entrepreneurial intention, degree to which school education develops entrepreneurial spirit, share of people who consider starting a business as a desirable career, share of people who consider successful entrepreneurs as those receiving high status, and finally media attention for entrepreneurship.

The second principle on **'Second chance'** is described by five indicators, time and cost to close a business, degree of support for a second chance, fear of failure rate and the strength of insolvency framework index.

The third and fourth principles are merged into a single dimension on **'Think small first' & 'Responsive administration'**, which is built by thirteen indicators that describe burden of fast-changing legislation and complexity of administrative procedures, burden of government regulations, and licenses and permits systems, and measure time and cost to start a business, paid in minimum capital, time and cost required to transfer property, number of tax payments per year, time required to comply with major taxes, cost to enforce contracts.

Table 3: SBA Framework

I. Entrepreneurship (9 indicators)	VII. Single market (9 indicators)
1.1 Total early-stage Entrepreneurial Activity (% adults who have started a business or are taking the steps to start one) 1.2 Total early-stage Entrepreneurial Activity for Female Working Age Population (% women who have started a business or are taking the steps to start one) 1.3 Established Business Ownership (%) 1.4 Improvement-driven opportunity entrepreneurial activity (% of entrepreneurs) 1.5 Entrepreneurial intention (% adults who intend to start a business within 3 years) 1.6 Entrepreneurship as Desirable Career Choice (%) 1.7 High-status to successful entrepreneurship (%) 1.8 Media attention for entrepreneurship (%) 1.9a Entrepreneurship Education (the extent to which training in creating or managing SMEs is incorporated within the education and training system at basic school) 1.9b Entrepreneurship Education (the extent to which training in creating or managing SMEs is incorporated within the education and training system at post-secondary levels)	7.1 Number outstanding single market directives (directives not notified or not transposed into national legislation) (-) 7.2 Average transposition delay- overdue directives (months) (-) 7.3 Number of pending infringement proceedings (-) 7.4 Public contracts secured abroad (by total value of contracts) 7.5 SMEs with intra-EU imports (%) 7.6 SMEs with intra-EU exports (%) 7.7 Selling Online Cross-border to other EU countries (% of SMEs) 7.8 New and growing firms can easily enter new markets (1=worst, 5=best) 7.9 New and growing firms can enter markets without being unfairly blocked by established firms (1=worst, 5=best)
II. 'Second chance' (5 indicators)	**VIII. Skills and innovation (12 indicators)**
2.1 Time to resolve insolvency (in years) (-) 2.2 Cost to resolve insolvency (cost to recover debt as % of debtor's estate) (-) 2.3 Degree of support for a second chance (%) 2.4 Fear of Failure (% of pop. who indicate that fear of failure would prevent them from setting up a business) (-) 2.5 Strength of insolvency framework index (0-16)	8.1 SMEs innovating in-house (%) 8.2 Innovative SMEs collaborating with others (%) 8.3 SMEs introducing product or process innovations (%) 8.4 SMEs introducing marketing or organizational innovations (%) 8.5 Sales of new-to-market and new-to-firm innovations (% turnover) 8.6 SMEs selling online (% of SMEs) 8.7 SMEs purchasing online (% of SMEs) 8.8 Enterprises providing training to their employees (%) 8.9 Turnover from e-commerce 8.10 Digital skills and e-leadership: Percentage of total persons employed that have ICT specialist skills 8.11 Digital skills and e-leadership Enterprise provided training to their personnel to develop/upgrade their ICT skills 8.12 R&D Transfer
III-IV. 'Think small first' & 'Responsive administration' (13 indicators)	**IX. Environment (5 indicators)**
3.1 Time to start a business (in calendar days) (-) 3.2 Cost to start a business (in Euro) (-) 3.3 Paid-in minimum capital (% of income per capita) (-) 3.4 Time required to register property (in calendar days) (-) 3.5 Cost required to register property (% of prop.	9.1 SMEs that have introduced resource-efficiency measures (%) 9.2 SMEs that have benefitted from public support measures for resource-efficiency actions (%) 9.3 SMEs that offer green products or services (%)

value) (-) 3.6 Number of tax payments per year (-) 3.7 Time required to comply with major taxes (hours/y) (-) 3.8 Cost to enforce contracts (% of claim) (-) 3.9 Fast-changing legislation and policies are a problem when doing business (% of businesses who agree with the statement) (-) 3.10 The complexity of administrative procedures are a problem when doing business (% of businesses who agree with the statement) (-) 3.11 starting a business (number of procedures) (-) 3.12 Burden of government regulations (1=worst, 7=best) 3.13 The people working for government agencies are competent and effective in supporting new and growing firm (1=best, 5=worst)	9.4 SMEs with more than 50% turnover generated by green products or services (%) 9.5 SMEs that have benefitted from public support measures for production of green products (%)
V. Public procurement (4 indicators)	**X. Internationalisation (6 indicators)**
5.1 SME's share in total value of public contracts awarded (%) 5.2 Share of businesses having taken part in a public tender of public procurement procedure (%) 5.3 Average delay in payments from public authorities (days) (-) 5.4 Enterprises submitting a proposal in a public electronic tender system (eProcurement)	10.1 Time to export Documentary compliance (hours) (-) 10.2 Cost to export Documentary compliance (US $) (-) 10.3 Time to import Documentary compliance (hours) (-) 10.4 Cost to import Documentary compliance (US$) (-) 10.5 SMEs exporting outside the EU (% of SMEs) 10.6 SMEs importing from outside the EU (% of SMEs)
VI. Access to finance (10 indicators)	
6.1 Venture capital investments (% of GDP) 6.2 Strength of legal rights (0=worst, 12=best) 6.3 Total duration to get paid (number of days) (-) 6.4 Bad debt loss (% of total turnover) (-) 6.5 Cost of borrowing for small loans (relative to large loans) (-) 6.6 Rejected loan applications and loan offers (% of loan applications by SMEs) (-) 6.7 Access to public financial support including guarantees (% of respondents who indicated a deterioration) (-) 6.8 Willingness of banks to provide a loan (% of respondents who indicated a deterioration) (-) 6.9 Equity funding available for new and growing firms (1=worst, 5=best) 6.10 Professional Business Angels funding available for new and growing firms (1=worst, 5=best)	

The fifth principle on **Public procurement** draws on four indicators, which measure the SME's share in the total value of public contracts awarded, share of businesses having taken part in a public tender of public procurement procedure, delay in payments from public authorities, enterprises use of available e-procurement options.

The sixth principle on **Access to Finance** is built of ten indicators that measure venture capital investments, strength of legal rights, total duration to get paid, bad debt losses, rejected loan applications/offers, access to public financial support including guarantees, willingness of banks to provide a loan, equity funding available for new and growing firm and professional Business Angels funding available for new and growing firms.

The seventh principle on **Single Market** is captured by nine indicators, measuring single market directives not transposed or notified, transposition delay for overdue directives, number of pending infringement procedures, public contract secured abroad, SMEs with intra-EU imports/exports, share of SMEs selling online to other EU countries and the

easiness of entering new markets for new and growing firms without being blocked by established enterprises.

The eight principle on **Skills and Innovation** is a mix of twelve indicators that measure share of SMEs innovating in-house, innovative SMEs collaborating with others, SMEs introducing product or process innovations, SMEs introducing marketing or organizational innovations, sales of new-to-market and new-to-firm innovations, SMEs selling/purchasing online, enterprises providing training to their employees, turnover from e-commerce and digital skills and e-leadership.

The ninth principle on **Environment** builds on five indicators, namely SMEs that have introduced resource-efficiency measures, SMEs that have benefitted from public support measures for resource-efficiency actions, SMEs that offer green products or services, SMEs with more than 50% turnover generated by green products or services, and finally SMEs that have benefitted from public support measures for production of green products.

The tenth principle on **Internationalisation** describes the SMEs landscape on six indicators measuring the cost/time/documents required to import/export and importing/exporting from outside the EU.

3.2 Refinement of the SBA framework

The SBA profiles are updated every year to account for new developments in the methodology and refinements in the existing data sources. With this information in mind, it is important to note that the 2016 edition of the fact sheets has undergone a major refinement of the framework relative to the 2015 edition. Overall 11 indicators have been dropped from the framework due to conceptual reasons, e.g., a major revision in methodology has been applied to an indicator or an indicator has been discontinued completely. On the other hand 25 new indicators have been incorporated into the conceptual framework of SME fact sheets as a result of new data sets becoming available or new indicators relevant to SMEs performances being developed. Out of these 25 indicators, 17 indicators have been used in the process of producing the SME fact sheets, while the remaining 8 indicators have not been used in the calculations due to lack of statistical coherence with the overall framework. The refinements are summarized in Table 4.

Table 4: Refinements of the SBA framework in 2015-2016

Indicator dropped from the SME fact sheets	SBA principle	Old/ New	Reason for not incorporating into the framework
Degree to which school education helped develop an entrepreneurial attitude	I. Entrepreneurship	Old	Insufficient data coverage: no new data available after 2012
SMEs interacting online with public authorities	III-IV. 'Think small first' & 'Responsive administration'	Old	Insufficient data coverage: indicator discontinued after 2013
Licensing complexity (1-26)	III-IV. 'Think small first' & 'Responsive administration'	Old	Insufficient data coverage: only single data entry available (for 2012)
New firms can get most of the required permits and licenses in about a week (Likert scale 1-5)	III-IV. 'Think small first' & 'Responsive administration'	New	Conceptual reason: due to calculation methodology being not clear it was impossible to reproduce the results
Total aid earmarked for SMEs	V. Public procurement	Old	Statistical incoherence: the indicator is negatively correlated with other indicators[7]
Depth of credit information index (0-8)	VI. Access to finance	Old	Statistical incoherence: the indicator is negatively correlated with other indicators
Private lenders' funding (crowdfunding) available for new and growing firms (Likert scale 1-5)	VI. Access to finance	New	Insufficient data coverage: only single data entry available (for 2015)
New and growing firms can afford the cost of market entry (Likert scale 1-5)	VII. Single market	New	Conceptual reasons: does not fit into the overall framework
The anti-trust legislation is effective and well enforced (Likert scale 1-5)	VII. Single market	New	Conceptual reasons: does not fit into the overall framework
Documents to export (number)	X. Internationalisation	Old	Insufficient data coverage & conceptual reasons: due to methodological refinements the indicator was discontinued by the developers (World Bank)
Time to export (days)	X. Internationalisation	Old	Insufficient data coverage & conceptual reasons: due to methodological refinements the indicator was discontinued by the developers (World Bank)
Cost to export (US$ per container)	X. Internationalisation	Old	Insufficient data coverage & conceptual reasons: due to methodological refinements the

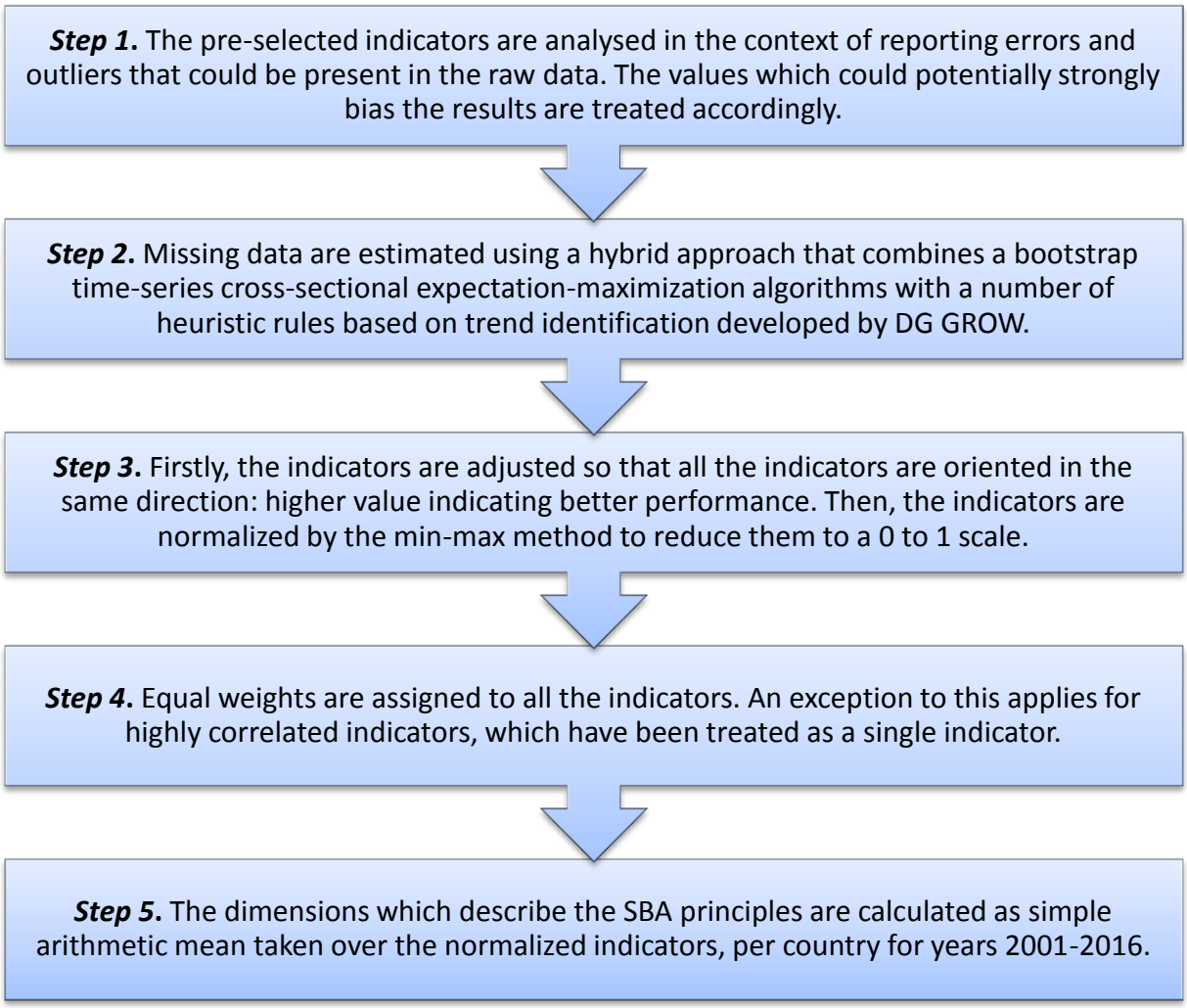
[7] Table 3 reports the expected negative sign of each indicator and labels the expected negative ones with the symbol (-). After correcting for the expected direction of the indicator all the correlation coefficients should point to the same (positive) direction. In the case of "Total aid earmarked for SMEs" and "Depth of credit information" a negative and thus undesirable correlation is observed with the other indicators underthe principle V. Public Procurement and VI. Access to Finance, respectively. This led to the exclusion of these indicators from the framework as methodologically suggested in OECD/JRC (2008).

			indicator was discontinued by the developers (World Bank)
Documents to import (number)	X. Internationalisation	Old	Insufficient data coverage & conceptual reasons: due to methodological refinements the indicator was discontinued by the developers (World Bank)
Time to import (days)	X. Internationalisation	Old	Insufficient data coverage & conceptual reasons: due to methodological refinements the indicator was discontinued by the developers (World Bank)
Cost to import (US$ per container)	X. Internationalisation	Old	Insufficient data coverage & conceptual reasons: due to methodological refinements the indicator was discontinued by the developers (World Bank)
Time to export Border compliance (hours)	X. Internationalisation	New	Conceptual reasons: does not fit into the overall framework
Cost to export Border compliance (US$)	X. Internationalisation	New	Conceptual reasons: does not fit into the overall framework
Time to import Border compliance (hours)	X. Internationalisation	New	Conceptual reasons: does not fit into the overall framework
Cost to import Border compliance (US$)	X. Internationalisation	New	Conceptual reasons: does not fit into the overall framework

The SBA principles are calculated for each year from 2001-2016 for the 28 EU Member States and eleven non-EU countries. However, when discussing the current situation in the SBA fact sheets, the timeliest indicators are used. About 21% of dataset is from 2016, 53% from 2015, about 15% from years 2013-2014, 8% from 2011-2012 and only 3% of dataset comes from earlier years (2005-2010). The SBA profiles well cover the economic crisis peak years, which were particularly severe for SMEs. This period allows capturing short and medium-term effects of both the economic downturn and of the policy stimulus packages for recovery. However, such period does not suffice for the understanding of longer term effects of stimulus packages, such as those related to the EU Regional Funds for entrepreneurship and SMEs.

4 SBA Fact Sheets - Methodology

The assessment of the SMEs across the EU28 Member States is carried out along the ten SBA principles, which are grouped in nine statistical dimensions, following the directions described in the related Commission Communication document (COM(2008) 394 final). The compilation of individual indicators discussed in the previous section necessary involves a number of normative choices about parameters of the model. In this section we describe the methodological choices made jointly by the JRC and DG GROW back in 2012 in the process of constructing the SMEs fact sheets from a set of raw indicators (Saisana, 2012). In particular, the following five crucial steps are listed and elaborated upon:



Below, those steps are described in details.

4.1 Step 1: Selection of indicators and data checks

Candidate indicators were selected by DG GROW for their relevance to a specific SBA principle (based on literature review and consultation with national experts) and for their timeliness. To represent a fair picture of country differences, indicators were scaled by, e.g., the number of SMEs, total turnover, or other units.

The most complete time series data were considered for each country, with a cut-off at year 2001. Country scores for a given principle were calculated only if data availability was at least 50% in that principle. For instance, when considering the dimension 'Think small first' & 'Responsive administration', which is constituted by 13 indicators, country scores for countries having less or equal to 6 (i.e. below 50%) indicators for this dimension were not calculated.

Data values outside the 1.5 interquartile range were checked for reporting errors.[8] Potentially problematic indicators that could bias the overall results were flagged as those having skewness (absolute) greater than 2 and kurtosis greater than 3.5, which are thresholds that are widely adopted in the context of composite indicators to detect

[8] The interquartile range is the difference between the upper (75% of values) and the lower (25% of values) quartiles.

potential outliers. Yet, as they are only heuristic rules of thumbs, each flagged case needs to be analysed individually to determine whether any outlier treatment is needed. Where necessary, the outliers were treated by *winsorisation*[9], where the country values skewing the indicator's distribution were assigned the next highest (lowest) value, up to the level where the values of skewness and kurtosis entered within the specified ranges to be treated as not outliers in the distribution.

4.2 Step 2: Missing data

Up until 2012 release of the SBA fact sheets missing data were not estimated but principles' scores were calculated on a basis of available information only. This was motivated by the need to achieve full transparency and straightforward replicability of the reported results. However, as this approach notable shortcoming is that it might discourage countries from reporting low data values[10], since 2012 edition of the fact sheets the data set is complemented with a multiple steps imputation algorithm that combines a data-driven bootstrap time-series cross-sectional expectation-maximization approach with heuristic trend-based imputation rules developed by the experts in the field[11]. This approach has comparative advantages over other imputation methods (Blankers et al. 2010), and has proven to work efficiently with various datasets and with varying data coverage. For our purposes, ten complete datasets were 'simulated' by keeping the observed values as fixed and by imputing the missing values in accordance with a proper distribution reflecting the uncertainty about the missing data (Honaker, 2012). The final imputed values of each missing data points were then computed by averaging the ten 'simulated' values in the country-year matrices.

4.3 Step 3: Normalisation

Given that the indicators used to measure achievement in each principle are expressed in different units[12], normalization to a common scale is required. The methods that are most frequently used are standardization (or z-scores) and rescaling.

Standardization: $\frac{x_i - mean(x)}{std(x)}$

This method converts the indicators to a common scale of mean zero and standard deviation of one. Re-scaling: $\frac{x_i - min(x)}{max(x) - \min(x)}$

This approach is easier to communicate to a wider public, given that it normalizes indicators to an identical range [0, 1], where higher scores represent better achievement. A key advantage of this method over standardization, at least in the context of the SBA framework, is that re-scaling widens the range of an indicator, which is an advantage for those indicators with a small range of values. This is useful for the SBA profiles to allow differentiation between countries with similar levels of SMEs performance. However, this method is not appropriate in the presence of extreme values or outliers, which can distort the normalized indicator. To control for this, in step 1 above we identified and treated extreme values. The minimum and maximum values needed

[9] Outliers can polarize the findings and bias the results, for this reason in the presence of outliers a winsorization process has been followed. On the basis of skewness or kurtosis, values that have been detected to be outliers are treated to be assigned to the next closest value, up to the level where its skewness and kurtosis become acceptable. This winsorization occurred for 4 indicators, spread over 3 principles: Average delay in payments by public authorities (5.3), Number of pending infringement proceedings, (7.3); New and growing firms can enter markets without being unfairly blocked by established firms (7.8); Time to export Documentary compliance (hours) (10.1) and Time to import Documentary compliance (hours) (10.3).

[10] Note that here 'no imputation' is equivalent to replacing missing values with the average of the available data within each principle.

[11] J. Honaker and G. King, 2010; J. Honaker, G. King, and M. Blackwell, 2012; G. King et al., 2001.

[12] For instance, in dimension 'III. Think Small First', the indicator "Time to start a business" is measured in days, while the "Cost to start a business" is in Euro. Normalization is needed to report them to a common scale that makes the two indicators comparable.

for the re-scaling were determined in the "complete" dataset after the imputations in the 2001-2016 period.

The direction of the indicators' effect was taken into account at this stage. For indicators were higher raw values are desirable, such as SMEs with intra-EU exports, the formula was $\frac{x_i - \min(x)}{max(x) - \min(x)}$.

For indicators were lower raw values are desirable, such as time to start a business, the formula was: $\frac{\max(x) - x_i}{max(x) - \min(x)}$, which was applied to 28 indicators, flagged with the symbol (-) into Table 3.

4.4 Step 4: Weights

The SBA profiles, for simplicity and upon suggestion of the country desks, are calculated using equal weights for the indicators underlying each principle. There is only one exception to this rule that involves highly correlated[13] indicators, which were treated by the JRC as a single indicator (by assigning half weight to each normalized score). We anticipate here that assigning equal weights to the indicators does not necessarily guarantee an equal contribution of the indicators to the variance of the country scores on the SBA principles[14].

4.5 Step 5: Aggregation

Arithmetic mean is the aggregation function used in this step for computing the dimensional scores of the SBA principles. The advantage of this choice lays in the easiness of communication of the resulting SBA fact sheets as the arithmetic mean has been traditionally used to compute most of the well-known indices in the international scene.

One of the main counter arguments against the use of the arithmetic mean is that it belongs to a class of functions characterized by perfect substitutability, i.e. poor performance in one indicator can be fully compensated by good performance in another. However, SBA principles are aggregated to a lower level of aggregation and do not result in a single index (as suggested in the next Section 6), rather in a scoreboard for the identified dimensions.

To summarize, the SBA principles are calculated using a simple mean of the normalised indicators per country per year from 2001 to 2016, with the exception of the two highly correlated pairs previously identified for the dimension '1. Entrepreneurship'. Country scores for each principle are also calculated using the most recent data. To allow for better comparison among countries performance, the data for the most recent year are re-scaled in the 0-1 scale. The EU average serves as a reference point for comparing countries' performances. For each dimension the EU average is calculated as a simple arithmetic mean of all the EU28 member states' scores for a given dimension rather than the average of the indicators (normalized) using the most recent data reported for the EU (as a country)[15]. This choice is to assure the consistency between the EU member

[13] Highly correlated indicators (i.e., Pearson correlation coefficients greater than ~ 0.90 over 2001-2016) were treated as a single indictor. These were: the pair of 'Total early-stage Entrepreneurial Activity (TEA)' and 'Total early-stage Entrepreneurial Activity for Female Working Age Population', belonging to the dimension I. Entrepreneurship.

[14] For details regarding the distinction between equal weighting and equal importance see: Paruolo, P., Saltelli, A., Saisana, M. (2013) Ratings and rankings: Voodoo or Science? *Journal of the Royal Statistical Society A,* 176 (2):1-26.

[15] In case of indicators from Eurostat, the geographical aggregates (e.g. EU28, EU15, EA18) are calculated by Eurostat as the sum of the national data expressed in a common unit. Where single Member States' figures are lacking, Eurostat may use unpublished estimates to impute country data and hence calculate the European aggregates. European aggregates should be seen as estimates and can sometimes deviate from what is obtained when summing up the national data. This can be due to dissemination of single or several national data sets outside the normal data treatment cycles. It can also be due to possible inconsistencies in national

states' scores and the EU average score and is motivated by two facts: (a) the EU (as a country) has significantly more missing data than either of the EU member states; (b) the most recent data available for the EU (as a country) are often misaligned with the most recent data available for individual countries as these might vary from country to country.

4.6 Compound growth rates

To complement the SME performance analysis of countries we compute the progress rates per country and dimension, which are calculated over the period of 2008-2016. To limit the influence of 'noise' in the data in computing the compound annual growth rates we take the three years averages as the basis of our calculations. Thus, the formula for growth rates is:

$$\left(\frac{(y_{2016}+y_{2015}+y_{2014})/3}{(y_{2008}+y_{2009}+y_{2010})/3}\right)^{1/6}-1,$$

where y refers to the country score on a given principle. Due to specific technical concerns this general method of computing the growth rates had to be modified for the following five dimensions:

- Due to methodological changes in designing the indicator 'Average delay in payments - public authorities' the growth rates until 2016 could not be computed for the principle "V. Public procurement". Instead, a shorter time series is analysed and the 2008-2014 (3y averages) compound growth rates are used as a proxy for this dimension.
- Due to methodological changes in designing the indicators 'Strength of legal rights index', 'Total duration in days to get paid' and 'Bad debt loss' the growth rates until 2016 could not be computed for the principle "VI. Access to finance". Instead, a shorter time series is analysed and the 2008-2014 (3y averages) compound growth rates are used as a proxy for this dimension.
- Due to methodological changes in designing the indicators: 'Share of SMEs selling online', 'Share of SMEs purchasing online' and 'Turnover from e-commerce', the growth rates from 2008 could not be computed for the principle "VIII. Skills & Innovation". Instead, a shorter time series is analysed and the 2010-2016 (3y averages) compound growth rates are used as a proxy for this dimension.
- Due to data quality concerns, the indicators 'SMEs with a turnover share of more than 50% generated by green products or services' and 'SMEs that have benefitted from public support measures for their production of green products' cannot be reliably used to compute the growth rates. Thus the time-series for the principle "IX. Environment" is computed as a proxy based on three remaining indicators.
- Due to methodological changes in composition of principle "X. Internationalisation" (discontinuation of 6 indicators) and lack of sufficient temporal information for the newly incorporated indicators, new growth rates for this dimension cannot be computed. Instead, the 2008-2015 (3y averages) growth rates using the indicators from 2015 edition are used as a proxy for this dimension.

The EU average scores are computed as average of the EU28 countries' scores on individual (disaggregated) indicators, which is a slightly different method than the one used to compute EU average for performance scores (average on aggregated scores). This is because, contrary to the case of performance scores, the issue of misalignment of data is not a problem when computing the growth rates, where the missing data are imputed anyway. By computing the EU averages on disaggregated indicators level we

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data e.g. the totals have been revised with different cycle than their breakdowns. For more details on Eurostat methodology see http://ec.europa.eu/eurostat/data/metadata

also assure the consistency of the EU growth rate with the combined growth rates individual EU member states. Finally, it is important to note that the growth rates are reported for all the countries, which makes them somewhat sensitive to imputations especially for countries which are characterized by relatively poor coverage of data. Therefore, the growth rates on SBA dimensions should be taken rather indicatively and the main analysis should be carried out at the disaggregated level of individual indicators.

5 Conceptual and statistical coherence

This section delves into the conceptual and statistical coherence in the SBA framework. In particular the following properties are tested using the most recent available data for the full set of 39 countries (i.e.: the 28 EU Member States plus 11 non-Member States, see Footnote 5): the good conceptual grouping and the coherence of the indicators within their dimension, the absence of silent indicators in the framework and the discussion whether to aggregate the dimensions in a single composite indicator is suggested or not.

5.1 Principal component analysis and cross-correlation analysis

Principal component analysis confirms that the SBA principles are indeed multidimensional and the underlying indicators capture very diverse aspects with little overlap of information between them.

Table 5 shows the amount of indicators' variance explained by the first principal component[16] (else termed latent dimension) and by the SBA principle. The first latent dimension in each principle captures between 28% and 55% of the total variance in the underlying indicators. More variance is explained in the more homogenous principles – Skills and Innovation, Environment and Internationalisation– whilst less variance is captured by the more heterogeneous principles –Entrepreneurship, Access to Finance and 'Think small first' and 'Responsive administration'. For simplicity and ease of communication, the SBA principles are calculated as simple means of the underlying indicators. This choice receives statistical justification, at least in terms of the total variance explained, given that amount of variance explained by the SBA principle is for six of the ten principles, very similar to the maximum variance that could be explained by a linear function. Ideally, the variance explained should be close to 69% and in principle it should not be lower than 50%.

In any case, the multidimensionality of the ten principles discussed here that emerges from Table 5, suggests that it is important to emphasize on the individual indicators of the SBA principles, as the scores on the ten SBA principles can be considered as only indicative of the amount of information contained in the underlying indicators. In fact, DG GROW discusses the countries scores on the SBA principles but the bulk of information and discussion in the SBA fact sheets relates to the individual indicators that populate the SBA framework.

A more detailed analysis of the correlation structure within and across the SBA principles confirms the expectation that the indicators are more correlated to their own principle than to any other principle and all correlations, when significant, they have the expected sign (see example in Table 6[17]).

[16] The first principal component is a weighted average of the indicators, whereby the indicators receive statistically driven weights based on the covariance matrix. An important property of the first principal component is that it captures the maximum possible variance in the underlying indicators that could be explained by any weighted arithmetic average of the underlying indicators.

[17] From Table 6 it also emerges that the third indicator "Degree of support for allowing for a second chance" would, in statistical terms, better fit the third and fourth principle, as the coefficient associated (0.28) is higher

Table 5: Variance explained the SBA principles and the principal components

SBA principle	Variance explained by the first principle component	Variance explained by the SBA principle
I. Entrepreneurship	31%	26%
II. 'Second chance'	34%	29%
III-IV. 'Think small first' & 'Responsive administration'	28%	26%
V. Public procurement	37%	35%
VI. Access to Finance	29%	28%
VII. Single Market	36%	36%
VIII. Skills and Innovation	55%	50%
IX Environment	37%	35%
X. Internationalisation	41%	41%

Table 6: Example of coherence test in the 'Second chance' principle

	I	II	III-IV	V	VI	VII	VIII	IX	X
Time to resolve insolvency	0.20	**0.61**	0.37	0.31	0.22	0.47	0.65	0.09	0.36
Cost to resolve insolvency	0.26	**0.69**	0.67	0.07	0.21	0.45	0.44	0.07	0.46
Degree of support for allowing for a second chance	0.21	**0.23**	0.28	0.05	0.25	0.03	0.13	0.13	0.20
Fear of Failure Rate	0.31	**0.51**	0.10	0.15	0.09	0.28	0.08	0.05	0.15
Strength of insolvency framework index	0.10	**0.53**	0.11	0.15	0.01	0.23	0.08	0.27	0.07

Notes: (1) Pearson correlation coefficients between the indicators included in the 'Second chance' principle and the ten SBA principles. (2) I. Entrepreneurship, II. 'Second chance', III-IV. 'Think small first' & 'Responsive administration', V. Public procurement, VI. Access to Finance, VII. Single Market, VIII. Skills and Innovation, IX Environment, X. Internationalisation. (3) The numbers in grey are the correlation coefficients of the indicators with their own SBA principle, and the numbers in bold were considered high enough to be taken into consideration when interpreting the results. Correlation are computed on the latest available year.

5.2 Assessment of the implicit weights

Statistical coherence is furthermore controlled for by the assessment of the so called implicit weights. Despite the equal weights assigned (by construction) to the indicators, their implicit weights = are not necessarily equal. The implicit weights are a function of the nominal weights, the data correlation structure and the indicators' variances. We calculate the implicit weights using the Pearson correlation. If indicators are supposed to be equally important their implicit weights should not differ too much. Results of this sensitivity test are reported in Table 7. What emerges is a quite heterogeneous picture, in which in several cases implicit weights differ from the equal weight.

than the 0.23 value of the indicator with respect to its own dimension. As the difference is not too high no re-allocation was suggested.

'Entrepreneurship', for instance, is mostly explained by three indicators: "1.8 Media attention for entrepreneurship", weighting 45%, "1.1 Total early-stage Entrepreneurial Activity", weighting 42% and "1.2 Total early-stage Entrepreneurial Activity for Female Working Age Population", weighting 34%. On the contrary, there are indicators in this dimension which account only slightly to build the dimension 'Entrepreneurship'. This is the case for "1.4 Improvement driven entrepreneurial activity", "1.5 Entrepreneurial attention", "1.6 as desirable Career Choice" and "1.7 High-status to successful entrepreneurship", whose weights are respectively 7%, 14%, 11% and 14%. In other words those indicators have only half – or even less - of the implicit weights of the former three indicators. This affects the construction of the overall dimension, as not all indicators have the same implicit weights.

Should one aim for an equal contribution of the indicators to the overall variance of the Entrepreneurship scores, then the weights (multiplicative coefficients) attached to the indicators should be adjusted accordingly.

Another relevant example is found in the second column of Table 7, with respect to the dimension 'Second Chance', which is mainly driven by the values of the indicator "2.2 Cost to resolve insolvency", whose weight – 62% - is more than two times higher than the weight of the remaining indicators.

This remark would be highly relevant if one attempted to produce a ranking of the countries based on the SBA principles scores. In the context of the SBA fact sheets, where the emphasis is given on the underlying indicators and the SBA scores are used as a mere indication of as country's performance with respect to the EU average, this analysis is only meant to shed more light and transparency on the number crunching in the calculation of the SBA principles.

Table 7: Implicit weights of the indicators in the ten SBA principles

	I	II	III-IV	V	VI	VII	VIII	IX	X
#.1	0.42	0.35	0.35	0.16	0.14	0.28	0.62	0.21	0.09*
#.2	0.34	0.62	0.10	0.26	0.20	0.05*	0.53	0.52	0.61
#.3	0.19	0.12	0.18	0.46	0.37	0.26	0.56	0.27	0.44
#.4	0.07*	0.07*	0.25	0.34	0.18	0.23	0.45	0.40	0.64
#.5	0.14	0.23	0.10		0.03*	0.26	0.02*	0.19	0.17
#.6	0.11		0.25		0.19	0.21	0.48		0.09*
#.7	0.14		0.38		0.23	0.44	0.55		
#.8	0.45		0.08*		0.29	0.15	0.69		
#.9	0.32 (a) 0.19 (b)		0.53		0.28	0.01*	0.37		
#.10			0.58		0.28		0.32		
#.11			0.44				0.55		
#.12			0.38				0.34		
#.13			0.34						

Notes: (1) Numbers represent the squared Pearson correlation coefficients. These implicit weights do not sum up to one because of the interdependence between the indicators. (2) The order of the indicators is the same as in Table 3 (highly correlated indicators 1.9(a) and 1.9(b) have been combined to one). (3) Indicators that have much lower contribution to the variance of the relevant SBA principle than the equal weighting expectation are marked with an asterisk. (4) I. Entrepreneurship. II. 'Second chance'. III-IV. 'Think small first' & 'Responsive administration'. V. State aid & public procurement. VI. Access to Finance. VII. Single Market. VIII. Skills and Innovation. IX Environment. X. Internationalisation.

5.3 Ten SBA principles: a scoreboard or a composite?

For each edition of the SBA fact sheets we ask the question whether it is feasible to combine all the dimensions behind ten principles of the SBA into a single composite measure providing a summary measure of SBA performance. In the 2016 edition of the SBA scoreboard this question is particularly relevant due to major revision of the framework relative to the 2015 edition. To answer this question the statistical properties of dimensional scores across ten principles were explored. We have concluded that, from a statistical point, it is not recommended to combine the individual principles together by calculating an average due to a largely multi-dimensional character of the underlying data. There are three latent dimensions in the ten SBA principles (grouped into nine dimensions) that altogether capture most of the total variance (see Table 8). Furthermore, the first principal component describes only 23.4% of the total variance, which means that any aggregate of nine SBA dimensions would capture at most one-fourth of the total variance in the principles.

Nevertheless, the analysis revealed the "statistical" grouping of the SBA principles which gives further insight into the relationships between the principles. The first latent dimension is described by two principles: Skills and Innovation and Internationalisation (23% explained variance), the second latent dimension is described by three principles: Entrepreneurship, 'Second chance', 'Think small first' & 'Responsive administration' (23% explained variance), and the third latent dimension is described by three dimensions: State aid & public procurement, Access to finance and Environment (22% explained variance).

Table 8: Principal Components Analysis results for the SBA principles

	Principal Component 1	Principal Component 2	Principal Component 3
I. Entrepreneurship	-0.18	0.87	0.14
II. 'Second chance'	0.32	0.76	-0.19
III-IV. 'Think small first' & 'Responsive administration'	0.46	0.57	0.22
V. State aid & public procurement	-0.43		0.64
VI. Access to finance		0.26	0.66
VII. Single market	0.53	0.49	0.49
VIII. Skills and innovation	0.76	0.27	0.18
IX Environment	0.23		0.87
X. Internationalisation	0.82	-0.16	
Explained variance (% total)	23.40%	22.95%	21.80%

Notes: (1) The pooled dataset of 39 countries with data of the latest available year was used. The numbers in light blue reflect the highest component loading of an SBA principle (three components were extracted and rotated with the varimax method).

5.4 Impact of modelling assumptions on the SBA results

Every country score across nine dimensions of the SBA is an outcome of a number of modelling choices: the indicators selected the estimation of missing data, the treatment of outliers, the normalization of the indicators, the weights assigned to them, and the aggregation method, among other elements. Some of these choices are based on the opinion of experts in the field (e.g., selection of indicators or assigning equal weights to the indicators within each principle), or common practice (e.g., min-max method to normalize the indicators), driven by statistical analysis (e.g., averaging pairs of highly correlated indicators prior to the final aggregation step) or simplicity (e.g., arithmetic mean of the indicators). This section will assess the uncertainty of the SBA principles

attributed to those normative judgments which cannot be fully justified neither by theoretical reasons, nor by the data properties, namely, the smoothing of outliers (via winsorization), the min-max normalization of the indicators, the equal weights attached to the indicators and the aggregation formula (simple mean)[18]. We have dealt with these uncertainties simultaneously in order to assess their joint influence on the final results. In the present analysis the data are assumed to be error-free since DG GROW already undertook a double-check control of potential erroneous outliers and these errors and typos were corrected during this phase (see Step 2 in Section 3).

Before discussing methods and results it is important to note that the uncertainty analysis cannot inform on the quality of the framework underpinning the SBA principles. This was the aim of the analysis carried out in Section 4. Instead, the results in this section can only provide some insights on the validity and stability of inferences associated with the country scores on the SBA principles. Given the multidimensionality of the SBA principles (any aggregate measure of the underlying indicators could only capture 28-55% of the total variance), it is not recommended to base the assessment of countries' performance on their exact rankings (on a given principle). Instead, it is better to discuss the country performance in relation to the remaining EU countries by assigning a country into one of the following performance brackets: "below EU", "close to EU", "above EU"[19].

Table 9: Uncertainty parameters (winsorization, normalization, weights, aggregation)

Type of uncertainty	Reference	Alternative
A. Uncertainty in the treatment of outliers	winsorization	no winsorization
B. Uncertainty in the normalization method	Min-max	z-scores
C. Uncertainty in the aggregation function	arithmetic average	geometric average
D. Uncertainty intervals for the weights	Reference value for the weight	Distribution assigned for uncertainty analysis (± 25% reference value)
I. Entrepreneurship (# 9)	0.111	U[0.083 ,0.139]
II. 'Second chance' (# 5)	0.200	U[0.150 ,0.250]
III-IV. 'Think small first' & 'Responsive administration' (#13)	0.077	U[0.058 ,0.096]
V. State aid & public procurement (#4)	0.250	U[0.187 ,0.313]
VI. Access to finance (#10)	0.100	U[0.075 ,0.125]
VII. Single market (# 9)	0.111	U[0.083 ,0.139]
VIII. Skills and innovation (#12)	0.083	U[0.062 ,0.105]
IX. Environment (#5)	0.200	U[0.150 ,0.250]
X. Internationalisation (#6)	0.167	U[0.125 ,0.209]

Notes: (1) The number of indicators within a principle is given in the parenthesis. Highly correlated indicators are counted as one. This applies to one pair of indicators in dimension "Entrepreneurship".

The uncertainty analysis of the 2016 SBA principles was based on a combination of a Monte Carlo experiment and a multi-modelling approach (see Table 10). This type of assessment aims to respond to eventual criticism that the country scores associated with indices are frequently presented as if they were calculated under conditions of certainty,

[18] The estimation of missing data has no impact on countries' performance scores because it is based on real data (most recent available).
[19] The brackets are defined using median-based approach (to limit the influence of outliers) as follows: "below EU" – bottom 12 countries, "close to EU" – middle 5 countries, "above EU" – top 11 countries.

while by the very definition of the index it is never the case (Saisana et al., 2005; Saisana et al., 2011). The Monte Carlo simulation consisted of 1,000 runs related to the issue of weighting of the indicators, where different set of weights of the indicators were randomly sampled from uniform distributions centred in the reference values (± 25% of the reference value). The range for the weights' variation has been chosen to accommodate two conflicting needs: on the one hand, the need to ensure a wide enough interval for meaningful robustness checks; on the other hand, the need to respect the rationale of the SBA principles that no indicator dominates an SBA principle. Given these considerations, limit values of uncertainty intervals have been defined as shown in Table 9.

The Monte Carlo simulations were later combined with the multi-modelling approach, which involves combinations of the remaining three key assumptions on the winsorization, normalisation method and the aggregation formula. The winsorization which allows smoothening the distribution of scores prevents a situation where an outlier associated to a single country drives the scores of all the remaining countries. Nevertheless, it is an invasive method that reduces the amount of information available and the thresholds for winsorization are subjective choices that depend on particular structure of the data. Therefore, it seems reasonable to compare the results obtained via winsorization with those obtained with no winsorization being applied. Although there are arguments in favour of the min-max method for normalizing the indicators versus the z-scores approach, one may still argue that since countries achievements on a given SBA principle are seen in relation to the EU average, z-scores could have been used. Finally, decision-theory practitioners have challenged the use of arithmetic average as an aggregation function because of its fully compensatory nature, in which a comparative high advantage of a few variables can compensate a comparative disadvantage of many variables (see also comments in Section 3) (Munda, 2008). Hence, as an alternative to arithmetic average we considered the geometric average instead,[20] which belongs to a class of partially compensatory aggregations functions. Consequently, we tested 8 models (2^3) based on the combination of winsorization versus no winsorization, the min-max versus z-scores normalisation, or arithmetic versus geometric average. Combined with the 1,000 simulations to account for the uncertainty in the estimates for the weights of indicators, we carried out altogether 8,000 simulations for each SBA principle.

The uncertainty analysis results are shown in Table 10 to Table 16 with countries grouped by alphabetical order. In the following we give an example for Austria (first according to alphabetical order) of how these results should be interpreted.

On the 2016 SBA fact sheets, Austria is classified on Entrepreneurship as performing close to EU average, yet this is confirmed only in 17% of the simulated cases while in the remaining 83% of the simulations, Austria's performance is above the EU average. This divergence is signalled in the last column of Table 10, which highlights that the probabilistic assessment would forecast a better outcome ("Above EU") for 'Entrepreneurship' than the SBA actual score. Undoubtedly though, Austria is above the EU average on four principles – Single Market, Skills and Innovation, Environment, Internationalisation. On the opposite side, Austria's performance below the EU average on Access to Finance is certain (100% of the probabilistic assessment simulations place Austria below the EU average).

Overall, when comparing country positioning with respect to the EU average, the statistical robustness and coherence analysis confirmed that 92% of countries' positioning are statistically reliable, i.e. divergence is found in 21 cases out of the pool of 252 possible cases (9 dimensions covered for each 28 country).

[20] In the geometric average, indicators are multiplied as opposed to summed in the arithmetic average. Indicator weights appear as exponents in the multiplication. To avoid close to zero values biasing the geometric average, we re-scaled linearly the indicators scores to a minimum of 0.1.

The uncertainty analysis presented herein can disentangle a country's performance from the methodological judgments made in the development of the SBA principles and reliably provide information on a country's strengths or weaknesses compared to the EU average. Thus, this type of analysis is critically helpful for policy makers and experts to understand existing successes and areas of improvement in each country. Needleless to emphasize again that this should be done in conjunction with the detailed information on the indicators within each principle, as this is provided in the specific country fact sheets of DG GROW.

Table 10: SBA principles: Simulations for Austria, Belgium, Bulgaria and Croatia

Austria	**SBA score**	**Probabilistic Assessment**			**Divergence**
		Below EU	Close to EU	Above EU	
Entrepreneurship	Close to EU	0%	17%	83%	X
Second chance	Close to EU	0%	96%	4%	
Responsive administration	Close to EU	26%	74%	0%	
State aid & public procurement	Close to EU	42%	50%	8%	
Access to finance	Below EU	100%	0%	0%	
Single market	Above EU	0%	15%	85%	
Skills & innovation	Above EU	0%	0%	100%	
Environment	Above EU	0%	0%	100%	
Internationalisation	Above EU	0%	0%	100%	
Belgium					
Entrepreneurship	Below EU	76%	24%	0%	
Second chance	Above EU	1%	81%	18%	X
Responsive administration	Below EU	100%	0%	0%	
State aid & public procurement	Below EU	100%	0%	0%	
Access to finance	Above EU	100%	0%	0%	X
Single market	Above EU	0%	0%	100%	
Skills & innovation	Above EU	0%	0%	100%	
Environment	Close to EU	0%	100%	0%	
Internationalisation	Above EU	0%	0%	100%	
Bulgaria					
Entrepreneurship	Below EU	100%	0%	0%	
Second chance	Close to EU	0%	87%	13%	
Responsive administration	Below EU	99%	1%	0%	
State aid & public procurement	Below EU	96%	4%	0%	
Access to finance	Above EU	9%	30%	61%	
Single market	Below EU	100%	0%	0%	
Skills & innovation	Below EU	100%	0%	0%	
Environment	Below EU	100%	0%	0%	
Internationalisation	Below EU	100%	0%	0%	
Croatia					
Entrepreneurship	Below EU	100%	0%	0%	
Second chance	Below EU	100%	0%	0%	
Responsive administration	Below EU	100%	0%	0%	
State aid & public procurement	Above EU	0%	0%	100%	
Access to finance	Close to EU	99%	1%	0%	X
Single market	Below EU	100%	0%	0%	
Skills & innovation	Below EU	100%	0%	0%	
Environment	Close to EU	51%	49%	0%	
Internationalisation	Above EU	0%	0%	100%	

Table 11: SBA principles: Simulations for Cyprus, Czech Republic, Denmark and Estonia

Cyprus	SBA score	Probabilistic Assessment			Divergence
		Below EU	Close to EU	Above EU	
Entrepreneurship	-	-	-	-	
Second chance	Above EU	0%	31%	69%	
Responsive administration	Close to EU	0%	60%	40%	
State aid & public procurement	Close to EU	75%	7%	18%	X
Access to finance	Below EU	100%	0%	0%	
Single market	Close to EU	13%	87%	0%	
Skills & innovation	Close to EU	0%	100%	0%	
Environment	Above EU	0%	0%	100%	
Internationalisation	Below EU	100%	0%	0%	
Czech Republic					
Entrepreneurship	Below EU	87%	13%	0%	
Second chance	Close to EU	95%	5%	0%	X
Responsive administration	Below EU	100%	0%	0%	
State aid & public procurement	Above EU	0%	0%	100%	
Access to finance	Close to EU	16%	52%	32%	
Single market	Close to EU	0%	85%	15%	
Skills & innovation	Close to EU	2%	98%	0%	
Environment	Above EU	0%	0%	100%	
Internationalisation	Below EU	100%	0%	0%	
Denmark					
Entrepreneurship	Close to EU	27%	37%	36%	
Second chance	Above EU	0%	6%	94%	
Responsive administration	Above EU	0%	0%	100%	
State aid & public procurement	Above EU	0%	0%	100%	
Access to finance	Above EU	31%	44%	25%	X
Single market	Above EU	0%	0%	100%	
Skills & innovation	Above EU	0%	0%	100%	
Environment	Close to EU	0%	51%	49%	
Internationalisation	Above EU	0%	0%	100%	
Estonia					
Entrepreneurship	Above EU	0%	0%	100%	
Second chance	Close to EU	31%	69%	0%	
Responsive administration	Above EU	0%	0%	100%	
State aid & public procurement	Above EU	15%	33%	52%	
Access to finance	Above EU	0%	1%	99%	
Single market	Above EU	0%	0%	100%	
Skills & innovation	Below EU	100%	0%	0%	
Environment	Above EU	0%	9%	91%	
Internationalisation	Close to EU	0%	6%	94%	X

Table 12: SBA principles: Simulations for Finland, France, Germany and Greece

Finland	SBA score	Probabilistic Assessment			Divergence
		Below EU	Close to EU	Above EU	
Entrepreneurship	Above EU	13%	12%	75%	
Second chance	Above EU	0%	0%	100%	
Responsive administration	Above EU	0%	0%	100%	
State aid & public procurement	Below EU	100%	0%	0%	
Access to finance	Above EU	0%	1%	99%	
Single market	Above EU	0%	0%	100%	
Skills & innovation	Above EU	0%	0%	100%	
Environment	Above EU	0%	5%	95%	
Internationalisation	Below EU	95%	5%	0%	
France					
Entrepreneurship	Close to EU	32%	68%	0%	
Second chance	Close to EU	74%	26%	0%	X
Responsive administration	Close to EU	62%	38%	0%	
State aid & public procurement	Above EU	0%	2%	98%	
Access to finance	Below EU	78%	22%	0%	
Single market	Below EU	100%	0%	0%	
Skills & innovation	Below EU	0%	75%	25%	X
Environment	Below EU	100%	0%	0%	
Internationalisation	Close to EU	0%	99%	1%	
Germany					
Entrepreneurship	Below EU	100%	0%	0%	
Second chance	Above EU	0%	0%	100%	
Responsive administration	Below EU	87%	13%	0%	
State aid & public procurement	Below EU	51%	40%	9%	
Access to finance	Close to EU	18%	78%	4%	
Single market	Close to EU	12%	78%	10%	
Skills & innovation	Above EU	0%	0%	100%	
Environment	Below EU	100%	0%	0%	
Internationalisation	Close to EU	0%	13%	87%	
Greece					
Entrepreneurship	Close to EU	4%	85%	11%	
Second chance	Below EU	99%	1%	0%	
Responsive administration	Below EU	100%	0%	0%	
State aid & public procurement	Above EU	0%	0%	100%	
Access to finance	Below EU	100%	0%	0%	
Single market	Below EU	100%	0%	0%	
Skills & innovation	Below EU	100%	0%	0%	
Environment	Below EU	100%	0%	0%	
Internationalisation	Below EU	100%	0%	0%	

Table 13: SBA principles: Simulations for Hungary, Ireland, Italy and Latvia

Hungary	SBA score	Probabilistic Assessment			Divergence
		Below EU	Close to EU	Above EU	
Entrepreneurship	Below EU	84%	16%	0%	
Second chance	Below EU	100%	0%	0%	
Responsive administration	Below EU	100%	0%	0%	
State aid & public procurement	Above EU	0%	47%	53%	
Access to finance	Close to EU	0%	12%	88%	X
Single market	Below EU	83%	17%	0%	
Skills & innovation	Below EU	100%	0%	0%	
Environment	Below EU	100%	0%	0%	
Internationalisation	Close to EU	100%	0%	0%	X
Ireland					
Entrepreneurship	Above EU	0%	0%	100%	
Second chance	Above EU	0%	1%	99%	
Responsive administration	Above EU	0%	0%	100%	
State aid & public procurement	Above EU	14%	22%	64%	
Access to finance	Close to EU	1%	60%	39%	
Single market	Above EU	0%	0%	100%	
Skills & innovation	Above EU	0%	0%	100%	
Environment	Close to EU	50%	50%	0%	
Internationalisation	Below EU	100%	0%	0%	
Italy					
Entrepreneurship	Below EU	100%	0%	0%	
Second chance	Below EU	100%	0%	0%	
Responsive administration	Below EU	100%	0%	0%	
State aid & public procurement	Below EU	100%	0%	0%	
Access to finance	Below EU	100%	0%	0%	
Single market	Below EU	100%	0%	0%	
Skills & innovation	Close to EU	99%	1%	0%	X
Environment	Below EU	100%	0%	0%	
Internationalisation	Above EU	0%	3%	97%	
Latvia					
Entrepreneurship	Above EU	0%	0%	100%	
Second chance	Above EU	0%	0%	100%	
Responsive administration	Above EU	0%	0%	100%	
State aid & public procurement	Above EU	0%	0%	100%	
Access to finance	Above EU	0%	1%	99%	
Single market	Close to EU	0%	93%	7%	
Skills & innovation	Below EU	100%	0%	0%	
Environment	Above EU	0%	28%	72%	
Internationalisation	Close to EU	69%	31%	0%	

Table 14: SBA principles: Simulations for Lithuania, Luxembourg, Malta and the Netherlands

Lithuania	SBA score	Probabilistic Assessment			Divergence
		Below EU	Close to EU	Above EU	
Entrepreneurship	Above EU	0%	0%	100%	
Second chance	Below EU	100%	0%	0%	
Responsive administration	Above EU	0%	0%	100%	
State aid & public procurement	Above EU	0%	0%	100%	
Access to finance	Close to EU	46%	48%	6%	
Single market	Close to EU	0%	96%	4%	
Skills & innovation	Below EU	100%	0%	0%	
Environment	Above EU	0%	0%	100%	
Internationalisation	Below EU	100%	0%	0%	
Luxembourg					
Entrepreneurship	Close to EU	0%	36%	64%	
Second chance	Below EU	100%	0%	0%	
Responsive administration	Close to EU	0%	96%	4%	
State aid & public procurement	Below EU	24%	50%	26%	X
Access to finance	Close to EU	40%	56%	4%	
Single market	Above EU	0%	0%	100%	
Skills & innovation	Above EU	0%	25%	75%	
Environment	Above EU	0%	0%	100%	
Internationalisation	Above EU	0%	0%	100%	
Malta					
Entrepreneurship	Close to EU	-	-	-	
Second chance	Below EU	100%	0%	0%	
Responsive administration	Close to EU	75%	25%	0%	X
State aid & public procurement	Below EU	21%	53%	26%	X
Access to finance	Above EU	13%	11%	76%	
Single market	Above EU	0%	19%	81%	
Skills & innovation	Close to EU	0%	100%	0%	
Environment	Below EU	99%	1%	0%	
Internationalisation	Close to EU	4%	91%	5%	
Netherlands					
Entrepreneurship	Above EU	0%	0%	100%	
Second chance	Above EU	0%	0%	100%	
Responsive administration	Above EU	0%	0%	100%	
State aid & public procurement	Below EU	100%	0%	0%	
Access to finance	Below EU	100%	0%	0%	
Single market	Above EU	0%	0%	100%	
Skills & innovation	Above EU	0%	0%	100%	
Environment	Close to EU	100%	0%	0%	
Internationalisation	Above EU	0%	1%	99%	

Table 15: SBA principles: Simulations for Poland, Portugal, Romania and Slovakia

Poland	SBA score	Probabilistic Assessment			Divergence
		Below EU	Close to EU	Above EU	
Entrepreneurship	Below EU	75%	25%	0%	
Second chance	Below EU	100%	0%	0%	
Responsive administration	Close to EU	0%	19%	81%	X
State aid & public procurement	Above EU	0%	43%	57%	
Access to finance	Above EU	0%	0%	100%	
Single market	Below EU	100%	0%	0%	
Skills & innovation	Below EU	100%	0%	0%	
Environment	Above EU	0%	10%	90%	
Internationalisation	Close to EU	100%	0%	0%	X
Portugal					
Entrepreneurship	Above EU	0%	0%	100%	
Second chance	Above EU	0%	0%	100%	
Responsive administration	Above EU	0%	0%	100%	
State aid & public procurement	Below EU	100%	0%	0%	
Access to finance	Below EU	100%	0%	0%	
Single market	Above EU	0%	1%	99%	
Skills & innovation	Above EU	0%	0%	100%	
Environment	Close to EU	0%	100%	0%	
Internationalisation	Close to EU	27%	73%	0%	
Romania					
Entrepreneurship	Above EU	0%	0%	100%	
Second chance	Close to EU	42%	58%	0%	
Responsive administration	Below EU	47%	53%	0%	
State aid & public procurement	Close to EU	17%	75%	8%	
Access to finance	Close to EU	100%	0%	0%	X
Single market	Below EU	100%	0%	0%	
Skills & innovation	Below EU	100%	0%	0%	
Environment	Below EU	100%	0%	0%	
Internationalisation	Below EU	100%	0%	0%	
Slovakia					
Entrepreneurship	Close to EU	0%	73%	27%	
Second chance	Below EU	100%	0%	0%	
Responsive administration	Below EU	100%	0%	0%	
State aid & public procurement	Close to EU	0%	93%	7%	
Access to finance	Above EU	0%	52%	48%	
Single market	Close to EU	84%	16%	0%	X
Skills & innovation	Below EU	100%	0%	0%	
Environment	Above EU	0%	0%	100%	
Internationalisation	Below EU	100%	0%	0%	

Table 16: SBA principles: Simulations for Slovenia, Spain, Sweden and United Kingdom

Slovenia	**SBA score**	**Probabilistic Assessment**			**Divergence**
		Below EU	Close to EU	Above EU	
Entrepreneurship	Below EU	100%	0%	0%	
Second chance	Close to EU	58%	40%	2%	
Responsive administration	Below EU	100%	0%	0%	
State aid & public procurement	Below EU	100%	0%	0%	
Access to finance	Close to EU	48%	32%	20%	
Single market	Below EU	98%	2%	0%	
Skills & innovation	Close to EU	0%	100%	0%	
Environment	Above EU	0%	7%	93%	
Internationalisation	Close to EU	0%	88%	12%	
Spain					
Entrepreneurship	Below EU	100%	0%	0%	
Second chance	Above EU	0%	0%	100%	
Responsive administration	Close to EU	4%	96%	0%	
State aid & public procurement	Below EU	100%	0%	0%	
Access to finance	Below EU	100%	0%	0%	
Single market	Below EU	100%	0%	0%	
Skills & innovation	Below EU	99%	1%	0%	
Environment	Below EU	100%	0%	0%	
Internationalisation	Close to EU	0%	67%	33%	
Sweden					
Entrepreneurship	Close to EU	2%	94%	4%	
Second chance	Above EU	0%	0%	100%	
Responsive administration	Above EU	0%	0%	100%	
State aid & public procurement	Above EU	25%	1%	74%	
Access to finance	Above EU	0%	0%	100%	
Single market	Close to EU	0%	0%	100%	X
Skills & innovation	Above EU	0%	0%	100%	
Environment	Close to EU	1%	89%	10%	
Internationalisation	Above EU	0%	0%	100%	
United Kingdom					
Entrepreneurship	Above EU	0%	0%	100%	
Second chance	Above EU	0%	0%	100%	
Responsive administration	Above EU	1%	24%	75%	
State aid & public procurement	Below EU	100%	0%	0%	
Access to finance	Above EU	0%	0%	100%	
Single market	Below EU	100%	0%	0%	
Skills & innovation	Above EU	0%	0%	100%	
Environment	Below EU	100%	0%	0%	
Internationalisation	Close to EU	0%	27%	73%	

6 Conclusion

The SBA country fact sheets are produced each year, since 2008, by the European Commission's Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs (DG GROW), and since 2011, with the scientific support of the European Commission Joint Research Centre (JRC). The main goal of the fact sheets is to capture the performance of the SMEs across the EU28 MSs by a collection of quantitative indicators covering ten conceptual principles derived from the Small Business Act for Europe (SBA): (1) 'Entrepreneurship', (2) 'Second chance', (3) 'Think small first', (4) 'Responsive administration', (5) State aid & public procurement, (6) Access to finance, (7) Single market, (8) Skills and innovation, (9) Environment, and (10) Internationalisation. Due to technical consideration regarding the statistical coherence of the framework the aforementioned principles have been grouped into nine statistical dimensions by merging the principles: (3) 'Think small first' and (4) 'Responsive administration' into a single statistical dimension. Thus, the SMEs are assesses across nine quantitative dimensions, where each dimension is composed of between four to twelve indicators. For the 2016 release of the SBA fact sheets, a total of 74 indicators were selected from 20 data sources, including the Flash Eurobarometer on Entrepreneurship, the World Bank Doing Business, the OECD Product market regulations database, the European Payment Index, the European Central Bank database on interest rates, and other. The respective indicators are aggregated into nine dimension scores and the aggregation stops there with the nine dimensions being presented together in a form of a scoreboard.

The JRC's Competence Centre on Composite Indicators and Scoreboards (COIN) at the Unit Modelling, Indicators & Impact Evaluation has calculated and analysed the 2016 SBA dimensions based on international standards and the in-house methodology in order to ensure their transparency and reliability. The aim of this analysis was to enable policymakers and other relevant stakeholders to derive accurate and in-depth conclusions from the available quantitative information.

In this report we have scrutinized the nine-dimensional framework of assessing the SMEs, which is derived from ten principles of the SBA be describing the rationale behind each principle and the underlying indicators and the methodological approach used to calculate the SBA scoreboard. The raw data were checked to assure no reporting errors or potentially troublesome outliers remain in the indicator framework. Next, the influence of missing entries in the data set was analysed and the missing data have been estimated using a hybrid approach, where the expert knowledge has been combined with the state-of-art numerical algorithms. The following step involved compilation of the SBA dimensions by aggregating normalized indicators (with min-max approach) with a simple arithmetic average for years 2001-2016. Furthermore, the compound annual growth rates were calculated per principle and country.

The multiple steps based analysis of the covariance structure has been performed within and across the statistical dimensions to investigate the statistical coherence of the SBA framework. In course of the analysis the statistical multidimensionality of the SBA scoreboard has been confirmed. Indeed, the SBA principles are highly diverse, with the underlying indicators capturing broad aspects of the SMEs characteristics with little overlap of information between them. Furthermore, the analysis of principal components (PCA) revealed that the first component describes only 35% of the total variance, which means that any linear aggregate of the nine SBA dimensions would capture at most one-third of the total variance in the principles. This diversity is a strong indication that, from a statistical point of view, the SBA dimensions should not be further aggregated into a single composite index.

The analysis also revealed the existence of three-dimensional "statistical" grouping of data, which gives deeper insight into the relationships between the SBA principles. The first latent dimension is described by six principles: Entrepreneurship, 'Think small first' & 'Responsive administration', State aid & public procurement, Access to finance, and Single market (35% explained variance), the second latent dimension is described by six principles: 'Second chance', 'Think small first' & 'Responsive administration', Access to finance, Single market, and Skills and Innovation (16% explained variance), and the third latent dimension is described by Environment and Internationalisation (12% explained variance). Further insight is gained by analysing the components' loadings that reveals that for four SBA principles: 'Think small first' & 'Responsive administration', Access to finance, and Single market there is no clear-cut way of assignment into a given principal component. Indeed, the strengths of association to either of the components, determined be the components' loadings, are very close to each other to the point of being undistinguishable.

The robustness assessment of country classifications, relative to the EU average, for each statistical dimension was undertaken to examine to what extent the results depend on methodological choices such as: the selected set of indicators or on the methodological judgments on outliers treatment, normalization, weighting and aggregation. Overall, country classifications, relative to the EU average, in the 2016 SBA fact sheets are supported by the simulations.

Overall, the assessment of the methodology behind the 2016 edition of the SBA fact sheets is positive, confirming it to be a sound tool for measuring the SMEs performance across countries. The analyses carried out have confirmed that measuring the SMEs achievements is a complex and multi-dimensional issue that, at least at the current stage of development, cannot be easily reduced to a single number (composite index). The report does not provide the country specific recommendations nor the policy analyses as, in light of the aforementioned complexities, these require deeper investigation of patterns across countries and across all ten principles of SBA. Such analysis is performed in the independent report on cluster analysis where countries of similar performance have been identified in order to derive appropriate policy messages that take into account country-specific characteristics.

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