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Methodological assessment of the SME Scoreboard 2017

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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's 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 for the quantitative measurement of these principles. It discusses the methodological approach to calculate how countries perform in the outlined principles. This takes into account the choice of the indicators, the data quality controls (including missing data and outliers), normalization and weightings, and the statistical coherence and robustness checks of the 2017 edition.

1 Introduction

In 2008 the EU Council of Ministers officially endorsed the Small Business Act for Europe (SBA), a document that recognizes the central role of SMEs in the EU-28 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. 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 SMEs. It also tries 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.

Since 2008 the European Commission's Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs (DG GROW) has produced 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 covering the broad range of the ten SBA principles: (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. Principles (3) 'Think small first' and (4) 'Responsive administration have been merged into a single statistical dimension, due to statistical affinities between the indicators they include.' dimension. Consequently, the ten 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 as a scoreboard and the attention is focused on the individual principles and the indicators that define them. Since 2011, the SBA Fact sheets have been produced by DG GROW with scientific support by the Joint Research Centre (JRC).

The report is structured as follows.

Section 2 reports a literature review on indicators and composite indices, used across the world, measuring aspects relevant to the ten SBA principles. It is an only slightly revised version of Section 2 in the previous report (Stano and Ghisetti, 2016).

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 selected by DG GROW after consultation with national experts. A total of 77 indicators were selected from about 20 different sources, such as Flash Eurobarometer on Entrepreneurship, World Bank Doing Business, European Payment Index, European Central Bank database on interest rates, DG GROW internal market scoreboard and others.

Section 4 discusses the methodological approach used to calculate the SBA principles. It deals with data quality issues (missing data, potential outliers), choice of normalization, weighting and aggregation formula. Raw data were first checked for reporting errors, and then outliers that could strongly bias the results were treated. Missing data were estimated using a hybrid approach combining 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, with highly correlated indicators being counted as a single indicator.

Section 5 studies the statistical coherence of the SBA framework by analysing 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. On the one hand such diversity can be considered as

advantageous, but 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 between 76% to 90% of countries' positionings are statistically reliable.

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

2 Literature review[1]

A scoreboard of indicators is a quantitative tool that aims to measure a latent complex phenomenon. Usually, this requires simplification of 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 a certain intermediate level, in which case a multivariate scoreboard is produced. In both cases, 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, & 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 has been 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 one 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 related to each SBA principle based on governmental self-assessments and local consultants' evaluations. This index is a benchmarking tool for emerging economies to guide policies towards SMEs. It allows comparisons in the evolution of country policies over time 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). These have been developed by the European Commission, DG CNECT 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*. This is 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 also possible to identify simple or composite indicators built in the EU as well as in other non-European countries to assess each dimension. This Section explains how aspects related to the SBA principles have

[1] As this report is the update of the 2016 report, where the analysis are carried out on an updated framework of analysis but are undergoing the same rationale and methodological choices, this section is a slightly revised repetition of the one available in the previous report (Stano and Ghisetti, 2016).

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
1. Entrepreneurship	Global Entrepreneurship Index	GEDI
	Female Entrepreneurship Index	GEDI
	OECD-Eurostat Entrepreneurship Indicators Programme	OECD
	Global Entrepreneurship Monitor	Global Entrepreneurship Research Association
2. 'Second chance'	World Bank "Doing Business"	World Bank
3. 'Think small first'	World Bank "Doing Business"	World Bank
4. Responsible Administration	World Bank "Doing Business"	World Bank
5. 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
6. 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
7. Single Market	Global Entrepreneurship Monitor	Global Entrepreneurship Research Association
	Digital Economy and Society Index (DESI)	European Commission
8. Skills and Innovation	European Innovation Scoreboard	European Commission
	Innovation Output Indicator	European Commission
	Global Innovation Index	Cornell University, INSEAD and WIPO
9. Environment	Eco-Innovation Scoreboard	Eco-Innovation Observatory for European Commission, DG Environment
10. 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 the 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[2].

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. The OECD (2016) report is extended by new data extracted from an online SME 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, but it collects and reports indicators from multiple data sources[3].

The *Global Entrepreneurship Monitor* (GEM) is used as a source for several indicators in the SBA (even in next 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 EU-28, 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 the entrepreneurial attitude of more than 2000 adults in every country, and on the National Expert Survey (NES), administered to selected experts to assess the Entrepreneurial Framework Conditions. It does not summarize indicators into a composite indicator.

The **'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 enhancing business activity and those constraining 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 also represented by the *World Bank "Doing Business"* (World Bank, 2017). In particular, the report provides a country-based 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 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, for a pilot of 78 countries, it assesses the government indicators that have been

[2] 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.

[3] 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

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, the presence of specific legal provisions or policies to promote fair access for SMEs to government. Source for single indicators is DG MARKT's study on "*SMEs access to and demand aggregation in public procurement*" that reports, 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*[4], 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 are made by the public authorities, and it is available for 25 European countries.

Intrum Justitia also provides single indicators on the **Access to Finance** principle, namely the 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) also provides indicators which are coherent to this principle. They are 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 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)[5] is a composite index that summarises MSs' 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 eight, nine and eight indicators. The scoreboard presents a regionalized extension, 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

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

fast-growing enterprises. It covers EU Member States, Japan, Switzerland, United States, Iceland, Norway and Turkey.

The *Global Innovation Index (GII)* (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 each country are provided to allow for benchmarking and international comparisons. An independent statistical assessment of the Global Innovation Index has been 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[6].

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. UNCTAD (UNCTAD, 2016) presents *Internationalisations statistics* for the largest non-financial multinational firms in the world although its focus is not applicable to Small and Medium Enterprises.

[6] 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 the ten SBA principles have been 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, with changes including aspects such as removing/incorporating indicators, merging dimensions, revising data collection methodologies for indicators, etc.

3.1 Framework and rationale

In the 2017 edition of the fact sheets, the SBA profiles are calculated for all 28 EU Member States plus 11 non-Member State [7] 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, the ten SBA principles are grouped into nine statistical dimensions as follows: (1) Entrepreneurship, (2) 'Second chance', (3) 'Think small first' and 'Responsive administration', (4) State aid & Public procurement, (5) Access to finance, (6) Single market, (7) Skills & Innovation, (8) Environment, and (9) 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)
1. Entrepreneurship	To create an environment in which entrepreneurs and family businesses can thrive and entrepreneurship is rewarded
2. 'Second chance'	To ensure that honest entrepreneurs who have faced bankruptcy quickly get a second chance
3. 'Think small first' & 'Responsive administration'	To design rules according to the 'Think small first' principle To make public administrations responsive to SMEs' needs
4. 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
5. Access to finance	To facilitate SMEs' access to finance and develop a legal and business environment supportive to timely payments in commercial transactions
6. Single market	To help SMEs to benefit more from the opportunities offered by the Single Market
7. Skills and innovation	To promote the upgrading of skills in SMEs and all forms of innovation
8. Environment	To enable SMEs to turn environmental challenges into opportunities
9. Internationalisation	To encourage and support SMEs to benefit from the growth of markets

[7] 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 the USA, which 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 seven non-member states (Albania, FYROM, Iceland, Moldova, Montenegro, Serbia, Turkey)

The 2017 version of the SBA fact sheets summarizes information on the ten SBA principles, each of them being composed of several individual indicators, with a total of 77 indicators that have been selected by DG GROW in consultation with national experts, refined as described int the next Section "*Refinement of the SBA framework*". Around 20 sources of information were used, including: the Flash Eurobarometer "Businesses' attitudes towards corruption in the EU", the Flash Eurobarometer on Entrepreneurship, former DG MARKT's study on "SMEs access to and demand aggregation in public procurement", the Global Entrepreneurship Monitor (GEM), the World Bank Doing Business, the Global Competitiveness Report, DG GROW's 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, Eurostat structural business statistics, 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, the Eurostat report on Venture Capital, the Comext database on international trade, the Internal market scoreboard, the Eurostat Community Innovation Survey, CVT survey and the OECD trade facilitation indicators. Table 3 lists the 77 indicators underlying the 2017 SBA profiles.

The first principle on **Entrepreneurship** is captured by eleven 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, the share of high growth enterprises and finally media attention for entrepreneurship.

The second principle on **Second chance** is described by four indicators, time and cost to close a business and 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 and 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

1. Entrepreneurship (11 indicators)	6. 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 (%) 1.9 Entrepreneurship Education (the extent to which training in creating or managing SMEs is incorporated within the education and training system at basic school) 1.10 Entrepreneurship Education (the extent to which training in creating or managing SMEs is incorporated within the education and training system at post-secondary levels) 1.11 Share of high growth enterprises (%)	6.1 Number outstanding single market directives (directives not notified or not transposed into national legislation) (-) 6.2 Average transposition delay- overdue directives (months) (-) 6.3 Number of pending infringement proceedings (-) 6.4 Public contracts secured abroad (by total value of contracts) 6.5 SMEs with intra-EU imports (%) 6.6 SMEs with intra-EU exports (%) 6.7 Selling Online Cross-border to other EU countries (% of SMEs) 6.8 New and growing firms can easily enter new markets (1=worst, 5=best) 6.9 New and growing firms can enter markets without being unfairly blocked by established firms (1=worst, 5=best)
2. 'Second chance' (4 indicators)	**7. 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 Fear of Failure (% of pop. who indicate that fear of failure would prevent them from setting up a business) (-) 2.4 Strength of insolvency framework index (0-16)	7.1 SMEs innovating in-house (%) 7.2 Innovative SMEs collaborating with others (%) 7.3 SMEs introducing product or process innovations (%) 7.4 SMEs introducing marketing or organizational innovations (%) 7.5 Sales of new-to-market and new-to-firm innovations (% turnover) 7.6 SMEs selling online (% of SMEs) 7.7 SMEs purchasing online (% of SMEs) 7.8 Enterprises providing training to their employees (%) 7.9 Turnover from e-commerce 7.10 Digital skills and e-leadership: Percentage of total persons employed that have ICT specialist skills 7.11 Digital skills and e-leadership Enterprise provided training to their personnel to develop/upgrade their ICT skills 7.12 R&D Transfer
3. 'Think small first' & 'Responsive administration' (13 indicators)	**8. 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. 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	8.1 SMEs that have introduced resource-efficiency measures (%) 8.2 SMEs that have benefitted from public support measures for resource-efficiency actions (%) 8.3 SMEs that offer green products or services (%) 8.4 SMEs with more than 50% turnover generated by green products or services (%) 8.5 SMEs that have benefitted from public support measures for production of green products (%)

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)	
4. Public procurement (4 indicators)	**9. Internationalisation (9 indicators)**
4.1 SME's share in total value of public contracts awarded (%) 4.2 Share of businesses having taken part in a public tender of public procurement procedure (%) 4.3 Average delay in payments from public authorities (days) (-) 4.4 Enterprises submitting a proposal in a public electronic tender system (eProcurement)	9.1 Extra-EU online exporters (%) 9.2 Information availability (0 - 2) 9.3 Involvement of trade community (0 -2) 9.4 Advance rulings (0 - 2) 9.5 Formalities – automation (0 - 2) 9.6 Formalities – procedures (0 -2) 9.7 Border Agency Co-operation (internal) (0 -2) 9.8 SMEs with extra-EU imports of goods (%) 9.9 SMEs with extra-EU exports of goods (%)
5. Access to finance (10 indicators)	
5.1 Venture capital investments (% of GDP) 5.2 Strength of legal rights (0=worst, 12=best) 5.3 Total duration to get paid (number of days) (-) 5.4 Bad debt loss (% of total turnover) (-) 5.5 Cost of borrowing for small loans (relative to large loans) (-) 5.6 Rejected loan applications and loan offers (% of loan applications by SMEs) (-) 5.7 Access to public financial support including guarantees (% of respondents who indicated a deterioration) (-) 5.8 Willingness of banks to provide a loan (% of respondents who indicated a deterioration) (-) 5.9 Equity funding available for new and growing firms (1=worst, 5=best) 5.10 Professional Business Angels funding available for new and growing firms (1=worst, 5=best)	

The fifth principle on **State aid and Public procurement** draws on four indicators, which measure the SMEs' 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 on 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 internationalization based on extra-EU online exporters, information availability, degree of involvement of trade community, advance rulings, formalities – automation, formalities – procedures, border Agency Co-operation and SMEs with extra-EU imports/ exports of goods.

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 2017 edition of the fact sheets has undergone a major refinement of the framework in comparison with the 2016 edition. Overall eight indicators have been dropped from the framework due to a discontinued methodology in the data collection. Overall eight new indicators have been introduced in the framework and in the calculations, seven of them (for the principle Internationalization) as a result of new data sets becoming available to replace the previous source which changed the methodology or new indicators relevant to SMEs performances being developed. Table 4 summarizes the changes with respect to the previous framework.

Table 4: Updates of the SBA framework in 2016-2017

Indicator dropped from the SME 2016 fact sheets	SBA principle	Old/ New	Reason for removal from the framework
Degree to which school education helped develop an entrepreneurial attitude	1. Entrepreneurship	Old	Insufficient data coverage: no new data available after 2012
Share of high growth firms	1. Entrepreneurship	New	
Documents to export (number)	9. Internationalization	Old	Conceptual reasons: due to methodological refinements the indicator was no longer comparable (World Bank)
Time to export (days)	9. Internationalization	Old	Conceptual reasons: due to methodological refinements the indicator was no longer comparable (World Bank)
Cost to export (US$ per container)	9. Internationalization	Old	Conceptual reasons: due to methodological refinements the indicator was no longer comparable (World Bank)
Documents to import (number)	9. Internationalization	Old	Conceptual reasons: due to methodological refinements the indicator was no longer comparable (World Bank)
Time to import (days)	9. Internationalization	Old	Conceptual reasons: due to methodological refinements the indicator was no longer comparable (World Bank)
Documents to export (number)	9. Internationalization	Old	Conceptual reasons: due to methodological refinements the indicator was no longer comparable (World Bank)
The anti-trust legislation is effective and well enforced (Likert scale 1-5)	9. Internationalization	Old	Conceptual reasons: due to methodological refinements the indicator was no longer comparable (World Bank)
EU online exporters	9. Internationalization	New	
Information availability (0 worst - 2 best)	9. Internationalization	New	

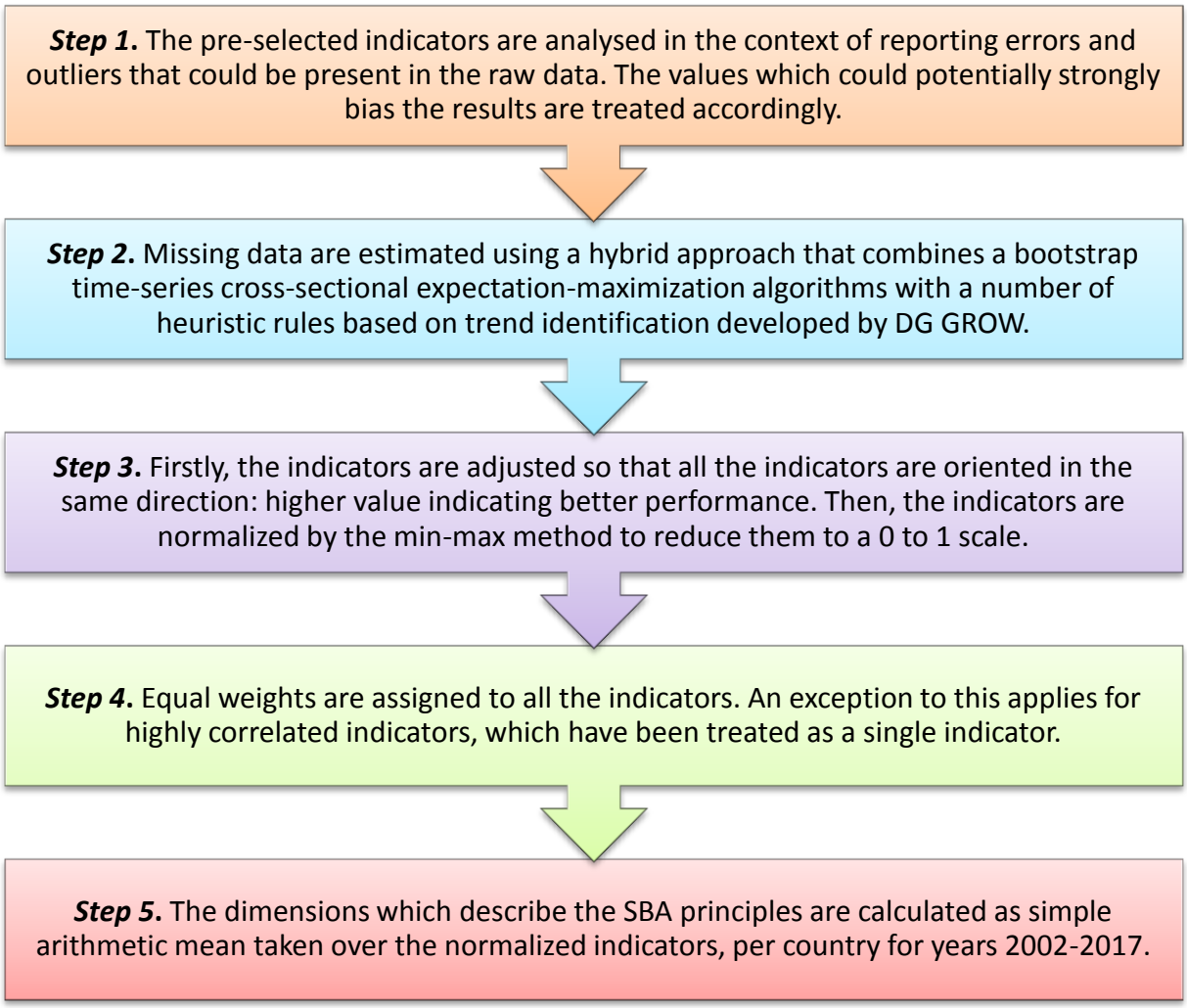
Involvement of trade community (0 worst - 2 best)	9. Internationalization	New
Advance rulings (0 worst - 2 best)	9. Internationalization	New
Formalities– automation (0 worst - 2 best)	9. Internationalization	New
Formalities– procedures (0 worst - 2 best)	9. Internationalization	New
Border Agency Co-operation (internal) (0 worst - 2 best)	9. Internationalization	New

In addition to this, the inclusion of an indicator of "Annual average of interest rate for small loans" was evaluated for the current edition. It was suggested not to be included it in the framework, due to its very poor statistical coherence with dimension '6. Access to Finance',

The SBA principles are calculated for each year from 2001-2017 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 17% of the timeliest indicators used in the framework refer to 2017, 37% to 2016, 37% to the period 2014-2015, 8% to the period 2012-2013 and only 4% from earlier years.

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 necessarily involves a number of normative choices about parameters for the model. In this section we describe the methodological choices made jointly by the JRC and DG GROW back in 2012 for 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:



These steps are described in details in the following sections

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 2002. 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 widely adopted in the context of composite indicators to detect potential

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

outliers. Yet, as they are only heuristic rules of thumb, 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 the 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, the notable shortcoming of this approach might be the discouraging of countries from reporting low data values[10]. For this reason since the 2012 edition of the fact sheets the data set has been complemented with a multiple steps imputation algorithm that combines a data-driven bootstrap time-series cross-sectional expectation-maximization approach[11] with heuristic trend-based imputation rules developed by the experts in the field[12]. Finally, Likert scale data have been re-scaled to a 0-5 scale after the imputation.

4.3 Step 3: Normalisation

Given that the indicators used to measure achievement in each principle are expressed in different units[13], 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 for the re-scaling were determined in the "complete" dataset after the imputations in the 2002-2017 period.

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[9] Outliers can polarize the findings and bias the results. For this reason in the presence of outliers a winsorization process was adopted. On the basis of skewness or kurtosis, values that were 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 the following two indicators: Cost to start a business (3.2) and access to public financial support including guarantees (5.7).

[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] In most of the cases when a trend was available but not reasonable (e.g. too high to be reasonable or negative for indicators which are only positive) it was set to the oldest available data for the past or to the most recent year for the future.

[13] For instance, in dimension '3. 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.

The direction of the indicators' effect was taken into account at this stage. For indicators where 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 where 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 (-) in Table 3.

Since the current edition of the framework, normalization is based on EU-28 values only. In other words, minimum and maximum values for normalizing the data are those reported by EU-28 countries.

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[14] 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[15].

4.5 Step 5: Aggregation

The 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 on 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 and do not result in a single index (as suggested in the Section 6), but 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 2017, with the exception of the two highly correlated pairs previously identified for 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 EU-28 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)[16].

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[14] Highly correlated indicators (i.e., Pearson correlation coefficients greater than ~ 0.90 over 2001-2016) were treated as a single indicator. 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 1. Entrepreneurship.

[15] 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.

[16] In the case of indicators from Eurostat, the geographical aggregates (e.g. EU-28, EU-15, EA-18) 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

This choice is to assure the consistency between the EU Member 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 any 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 analysis of SMEs' performance, progress rates per country and dimension are calculated. Calculations are done over the period of 2009-2017 when data are available. To limit the influence of noise in the data, when computing the compound annual growth rates three years averages are taken as the basis of the calculations. Therefore, growth rates are calculated between the average 2015-2017 and the average 2009-2011 considering that there are six periods in between. This is the case for dimensions '2. Second Chance' and '3. Think small first & Responsive administration'.

The formula for growth rates is:

$$\left(\frac{(y_{2017}+y_{2016}+y_{2015})/3}{(y_{2009}+y_{2010}+y_{2011})/3}\right)^{1/6}-1,$$

where *y* refers to the country score on a given principle.

When data for 2017 is not available, growth rates are calculated between the average 2014-2016 and the average 2008-2010.

This is the case for dimensions 1. Entrepreneurship and 6. Single market, where the formula for growth rates is:

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

The previous SME framework (Stano and Ghisetti, 2016) used four instead of six years to compute growth rates for dimensions 5. Access to finance and 6. Single market because of data availability.

For those two dimensions, growth rates are calculated between the average 2014-2016 and the average 2010-2012 to allow better comparability with the previous edition. The following rule is applied:

$$\left(\frac{(y_{2016}+y_{2015}+y_{2014})/3}{(y_{2010}+y_{2011}+y_{2012})/3}\right)^{1/4}-1,$$

Table 5 summarizes all the above and offers additional information about imputed values.

inconsistencies in national data, e.g. the totals were revised with a different cycle than their breakdowns. For more details on Eurostat methodology see http://ec.europa.eu/eurostat/data/metadata

Table 5: Summary of construction rules for growth rates

Color legenda	Description	Additional note
2009-2017 (3y average)	When data for 2017 are available: growth rates are calculated with respect to average 2015-2017 and the average 2009-2011. This is the case for dimensions 2. and 3.	For '2. Second chance' 2017 is available for 3 out of the 4 indicators building the dimension. For '3. Think Small First & Responsive Administration' 6 out of the 13 indicators are available for 2017, for the remaining imputed values for 2017 are used to construct the average.
2008-2016 (3y average)	When data for 2017 are not available, growth rates are calculated between the average 2014-2016 and the average 2008-2010. This is the case for dimensions 1. and 6., where 2016 calculation rule has been applied	For 1. Entrepreneurship the latest available year for indicator 1.11 (internal id 18) is 2014, so only 2014 is used for computing the 2014-2016 average. For Single Market 5 indicators are available at 2016 as latest available year, whereas the remaining 4 building this dimensions have been imputed for the construction of the growth rate.
2010-2016 (3y average)	When data for 2017 are not available, growth rates are calculated between the average 2014-2016 and the average 2010-2012. This is the case for dimensions 4., 5. and 7. where the 2016 rule has been applied to improve the comparability with the past (2016) growth rates	For 6. Access to Finance only one indicator was available (out of 9) at 2017, thus suggesting to use the 2014-2016 time span. For only one indicator the last available year is 2015 and not 2016 (id 46). For 7. Skills & Innovation 9 of the 12 indicators are available up to 2016, whereas for the remaining 3 imputed values are used for the construction of growth rates.
not computed	Given the insufficient data coverage over the period 2008-2017, growth rates for these dimensions are not computed.	

Whenever for a given country the share of missing indicators in the time-frame 2002-2017 exceeded a certain threshold - identified by the experts in DG GROW as 40% - growth rates for the dimension are not computed. That is the reason why growth rates have not been calculated for dimensions 4. State aid and public procurement, 8. Environment and 9. Internationalisation.

Table 6 reports such coverage per country and dimension, the percentage of observations available as a proportion of the maximum number of observations possible (the number of indicators per dimension from 2002 to last available year).

Table 6: Coverage of indicators per country in years 2002-2017

Country	1. Entrepreneurship	2. 'Second chance'	3. 'Think small first' & 'Responsive administration'	4. State aid & Public procurement	5. Access to finance	6. Single market	7. Skills & Innovation	8. Environment	9. Internationalization
Austria	24%	68%	80%	40%	74%	51%	48%	26%	26%
Belgium	70%	80%	82%	40%	78%	53%	44%	26%	29%
Bulgaria	21%	65%	79%	30%	59%	51%	47%	26%	32%
Croatia	85%	83%	77%	20%	59%	38%	48%	26%	23%
Cyprus	12%	58%	73%	35%	50%	48%	47%	26%	30%
Czech Republic	17%	65%	79%	40%	67%	50%	48%	26%	30%
Denmark	43%	75%	81%	40%	71%	53%	38%	26%	32%
Estonia	46%	73%	80%	40%	61%	53%	45%	26%	26%
Finland	84%	83%	85%	40%	84%	64%	47%	26%	23%
France	72%	80%	82%	40%	78%	58%	51%	26%	30%
Germany	84%	83%	85%	40%	86%	66%	45%	26%	29%
Greece	82%	83%	85%	38%	86%	64%	39%	26%	28%
Hungary	83%	83%	84%	40%	79%	63%	53%	26%	30%
Ireland	75%	80%	84%	40%	84%	57%	49%	26%	10%
Italy	75%	80%	84%	40%	84%	63%	53%	26%	32%
Latvia	73%	80%	84%	40%	71%	64%	52%	26%	32%
Lithuania	36%	70%	81%	40%	63%	54%	50%	26%	32%
Luxembourg	39%	70%	81%	18%	52%	51%	42%	26%	20%
Malta	3%	40%	56%	18%	32%	42%	43%	26%	27%
Netherlands	81%	83%	83%	40%	82%	61%	52%	26%	30%
Poland	57%	75%	82%	40%	75%	59%	43%	26%	28%
Portugal	58%	78%	83%	40%	82%	62%	51%	26%	32%

Romania	67%	80%	81%	28%	62%	52%	49%	26%	30%
Slovakia	57%	75%	82%	40%	67%	58%	52%	26%	28%
Slovenia	85%	83%	85%	30%	65%	64%	43%	26%	23%
Spain	85%	83%	85%	40%	84%	63%	53%	26%	30%
Sweden	64%	78%	83%	40%	77%	59%	48%	26%	30%
United Kingdom	83%	83%	84%	40%	78%	60%	48%	26%	30%
Albania	0%	60%	61%	0%	20%	0%	0%	26%	13%
Former Yugoslav Republic of Macedonia	55%	75%	65%	8%	32%	18%	33%	26%	17%
Iceland	25%	68%	62%	23%	40%	6%	22%	26%	1%
Israel	55%	75%	65%	0%	26%	13%	5%	16%	7%
Liechtenstein	0%	0%	0%	0%	3%	0%	0%	16%	0%
Moldova	0%	60%	59%	0%	10%	0%	0%	10%	13%
Montenegro	9%	63%	61%	0%	26%	6%	1%	26%	11%
Norway	72%	80%	67%	30%	57%	26%	53%	26%	17%
Serbia	18%	65%	62%	5%	26%	4%	22%	26%	12%
Turkey	55%	75%	67%	3%	40%	19%	18%	26%	14%
United States of America	69%	83%	67%	0%	26%	18%	7%	26%	13%

Note: Red cells highlight a coverage below the threshold 40%.

It is important to note that, although growth rates have not been calculated for dimensions with more than 40% missing data, some growth rates still rely on few imputed values. Especially for countries characterized by relatively poor coverage of data (Table 6), growth rates on SBA dimensions should be taken rather indicatively. In such cases, the main analysis should be carried out at the disaggregated level of individual indicators.

Lastly, the EU average scores are computed as average of the EU-28 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 anyways. By computing the EU averages on disaggregated indicators level we also assure the consistency of the EU growth rate with the combined growth rates individual EU member states.

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): the good conceptual grouping and the coherence of the indicators within their dimension, the absence of silent indicators in the framework, i.e. indicators that are so poorly correlated with the others in their dimension that are lost in the aggregation 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 7 shows the amount of indicators' variance explained by the first principal component[17] (else termed latent dimension) and by the SBA principle. The first latent dimension in each principle captures between 29% 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 the 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 emerging from Table 7, 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

[17] 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.

information and discussion in the SBA fact sheets relates to the individual indicators that populate the SBA framework.

Table 7: Variance explained the SBA principles and the principal components

SBA principle	Variance explained by the first principle component	Variance explained by the SBA principle
1. Entrepreneurship	29%	23%
2. 'Second chance'	39%	39%
3. 'Think small first' & 'Responsive administration'	29%	23%
4. Public procurement	37%	32%
5. Access to Finance	38%	32%
6. Single Market	37%	33%
7. Skills and Innovation	55%	52%
8. Environment	38%	37%
9. Internationalisation	30%	28%

A more detailed analysis of the correlation structure within and across the SBA principles confirms in most of the cases 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. An example of such an assessment is reported in Table 8.

Table 8: Example of coherence test in the 'Second chance' principle

	1	2	3	4	5	6	7	8	9
Time to resolve insolvency	0.12	**0.71**	0.35	-0.28	0.22	0.37	0.61	0.12	0.31
Cost to resolve insolvency	0.24	**0.72**	0.61	-0.06	0.17	0.31	0.46	0.07	0.31
Degree of support for allowing for a second chance	0.23	**0.53**	0.10	-0.01	0.38	-0.13	0.01	-0.09	0.19
Fear of Failure Rate	0.02	**0.51**	-0.01	-0.16	0.09	-0.30	-0.22	-0.27	-0.10
Strength of insolvency framework index	0.12	**0.71**	0.35	-0.28	0.22	0.37	0.61	0.12	0.31

Notes: (1) Pearson correlation coefficients between the indicators included in the 'Second chance' principle and the ten SBA principles. (2) 1st row legend: 1. Entrepreneurship, 2. 'Second chance', 3. 'Think small first' & 'Responsive administration', 4. State aid & Public procurement, 5. Access to Finance, 6. Single Market, 7. Skills and Innovation, 8. Environment, 9. Internationalisation. (3) The numbers highlighted in light blue are the correlation coefficients of the indicators with their own SBA principle, in this example 'Second Chance'.

In few cases, statistical analysis based on the coherence test described before would suggest that indicators would better fit a dimension other than the one they have been assigned. Table 9 reports those cases where a significant statistical improvement could be achieved by moving indicators to an alternative dimension, summarized in the last column. Only significant statistical improvements are highlighted, i.e. those where either

the indicator would overcome the threshold of 0.3 in the correlation coefficient after the move or where the indicator can improve of at least 0.1 its correlation coefficient[18].

For instance, indicator 1.4 "Improvement-Driven Entrepreneurial Activity" is assigned to 1. Entrepreneurship where it has a correlation coefficient of 0.3. This would largely increase (to 0.52) if moved to dimension 7. Skills and Innovation, as reported by the light green highlight and by the last column in Table 7.

However, as the experts (in DG GROW) outlined that there were no strong conceptual reasons to reposition indicators based on the aforementioned statistics, no indicator has been moved to an alternative dimension.

Table 9: Example of coherence test in the 'Second chance' principle

Indicators	1	2	3	4	5	6	7	8	9	Statistical better fit
1.4	0.30	0.47	0.48	0.03	0.35	0.50	0.52	0.44	0.16	7. Skills and Innovation
1.9	0.54	0.33	0.64	0.01	0.34	0.28	0.17	-0.02	0.29	3. 'Think small first' & 'Responsive administration'
1.11	0.08	0.00	0.27	0.27	0.52	0.22	0.19	0.09	0.08	5. Access to Finance
3.2	0.24	0.29	0.28	0.50	0.36	0.06	-0.08	-0.07	0.10	4. Public procurement
3.3	0.31	0.10	0.20	-0.04	-0.10	-0.17	-0.01	-0.21	0.10	1. Entrepreneurship
3.13	0.14	0.28	0.39	-0.09	0.33	0.53	0.48	0.41	0.30	6. Single Market
5.1	0.30	0.22	0.55	0.12	0.41	0.44	0.47	0.51	0.29	3. 'Think small first' & 'Responsive administration'
5.10	0.20	-0.10	0.07	-0.17	0.17	0.43	0.35	0.45	0.12	8 Environment
6.2	-0.08	-0.34	-0.11	0.33	0.20	0.15	-0.14	0.26	-0.13	4. State aid & Public procurement
9.5	0.29	0.11	0.31	0.03	0.16	0.14	0.32	0.24	0.17	7. Skills and Innovation
9.8	0.02	0.46	0.39	-0.27	0.09	0.41	0.49	-0.01	0.36	7. Skills and Innovation
9.9	0.12	0.25	0.40	-0.07	0.22	0.71	0.44	0.25	0.43	6. Single Market

Notes: (1) Pearson correlation coefficients between the indicators included in the 'Second chance' principle and the ten SBA principles. (2) 1st row legend: 1. Entrepreneurship, 2. 'Second chance', 3. 'Think small first' & 'Responsive administration', 4. State aid & Public procurement, 5. Access to Finance, 6. Single Market, 7. Skills and Innovation, 8. Environment, 9. Internationalisation. (3) The numbers highlighted in light blue are the correlation coefficients of the indicators with their own SBA principle, the numbers highlighted in light green are the best alternative correlation available to another dimension, listed in the last column.

Based on the correlation structure, few "cosmetic indicators" have been identified. These are the ones having a very weak (practically random) association to the SBA principle they have been conceptually assigned to. A suggestion was formulated based on the full correlation matrix either to remove them from the framework, or, if possible, to move them to a dimension where they would better fit in terms of correlations. No indicator was however removed for the framework because of this "cosmetic" nature and

[18] There are in addition few cases where the indicator could slightly improve if moved to another dimension, but improvements of 0.01, 0.02, … to 0.09 points in the Pearson correlation coefficient are not reported to draw the attention only on the relevant cases.

no indicator was moved elsewhere. This is reflected in very weak implicit weights (marked with asterix) for certain indicators as described in the next Section.

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 squared Pearson correlation coefficient.

In principle, for indicators that are supposed to be equally important, their implicit weights should not differ too much. Results of this sensitivity test are reported in Table 8 and show that instead implicit weights do differ substantially.

1. 'Entrepreneurship' is mostly explained by the two indicators: "1.1 Total early-stage Entrepreneurial Activity", weighting 51% and "1.2 Total early-stage Entrepreneurial Activity for Female Working Age Population", weighting 46%, while the remaining indicators account for around one half of them. "1.3 Established Business Ownership Rate", "1.5 Entrepreneurial intention", "1.6 Entrepreneurship as desirable Career Choice", "1.7 High-status to successful entrepreneurship" and "1.11 share of high growth enterprises" account, respectively, for 14%, 9%, 19%, 19%, 8% and 1%. This means that those indicators have only half – or even less - of the implicit weights of the first indicators. The one with higher weights will account larger than the others in constructing 1. Entrepreneurship, which will then be shaped mostly by the former and weakly by the latter. If the goal is to reach an equal contribution of the indicators to the overall variance of the Entrepreneurship scores, then the weights attached to the indicators should be adjusted accordingly.

When looking at '2.Second Chance' in Table 10, it is also noted that two (out of the four indicators) have double the weight of the remaining two. Again, this dimension's implicit weights are far from being equal. The same hold true for all the dimensions in the framework with the only exception of 4. State aid & Public procurement, which is well balanced.

This remark would be highly relevant if the goal was to produce a ranking of the countries based on the SBA principles scores. This is not the case, as in the context of the SBA fact sheets, the emphasis is given on the underlying indicators and the SBA scores are exploited to compare country's performance with respect to the EU average.

Table 10: Implicit weights of the indicators in the ten SBA principles

	1	2	3	4	5	6	7	8	9
#.1	0.51	0.50	0.02*	0.22	0.17	0.11	0.76	0.31	0.41
#.2	0.46	0.52	0.08*	0.36	0.31	0.02*	0.57	0.60	0.51
#.3	0.14	0.28	0.04*	0.36	0.67	0.15	0.70	0.33	0.40
#.4	0.09*	0.26	0.29	0.33	0.64	0.26	0.65	0.13	0.25
#.5	0.19		0.02*		0.02*	0.34	0.04*	0.48	0.03*
#.6	0.19		0.28		0.08*	0.48	0.50		0.26
#.7	0.08*		0.32		0.49	0.48	0.42		0.39
#.8	0.28		0.01*		0.61	0.56	0.69		0.13
#.9	0.29		0.56		0.17	0.53	0.43		0.19
#.10	0.33		0.61		0.03*		0.35		
#.11	0.01*		0.28				0.72		
#.12			0.30				0.42		
#.13			0.15						

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. (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) 1st row legend: 1. 'Entrepreneurship', 2. 'Second chance', 3. 'Think small first' & 'Responsive administration', 4. 'State aid & Public procurement', 5. 'Access to Finance', 6. 'Single Market', 7. 'Skills and Innovation', 8. 'Environment', 9. 'Internationalisation'.

5.3 The 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 the ten principles of the SBA into a single composite measure, providing a summary measure of SBA performance. To answer this question the statistical properties of dimensional scores across ten principles were explored. We concluded that, from a statistical point of view, 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. This is the same recommendation of the previous editions.

There are three latent dimensions in the ten SBA principles (grouped into nine dimensions) that altogether capture most of the total variance, 64% of it. In addition to this, the first principal component (*unrotated*) describes 34% of the total variance, which means that any aggregate of the nine SBA dimensions would capture about one-third 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.

'Second chance', 'Think small first' & 'Responsive administration' and Internationalization are described by the same latent dimension which altogether explains 23% of the total variance[19]. The second grouping would regard the principles Single Market, Skills and Innovation and Environment and would explain 21% of the variance. The last latent dimension is described in three dimensions: Entrepreneurship, State aid & public procurement and Access to finance (19% explained variance).

This grouping is not stable over time. Instead, it differs substantially from the one of the previous framework, as Entrepreneurship, Environment and Internationalization would be grouped differently than they were in the past edition.

Table 11: Principal Components Analysis results for the SBA principles

	Principal Component 1	Principal Component 2	Principal Component 3
1. Entrepreneurship	0.4382	0.1331	0.5328
2. 'Second chance'	0.7675	0.1152	-0.0006
3. 'Think small first' & 'Responsive administration'	0.7298	0.2341	0.329
4. State aid & public procurement	-0.0736	-0.0773	0.8218
5. Access to finance	0.1053	0.3322	0.6708
6. Single market	0.3002	0.7423	0.1802
7. Skills and innovation	0.3232	0.7889	-0.1796
8. Environment	-0.1936	0.7429	0.3827
9. Internationalisation	0.7024	0.0513	-0.0552
Explained variance (% total)	**23%**	**21%**	**19%**

Note: The 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. The analysis restricts the components to 3 and loadings are reported after a *varimax* rotation.

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 selected indicators, 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 either by

[19] The values reported refer to the factor loadings after a rotation following Kaiser normalized varimax option.

theoretical reasons, or by the data properties, namely the min-max normalization of the indicators, the equal weights attached to the indicators and the aggregation formula (simple mean)[20]. We dealt with these uncertainties simultaneously in order to assess their joint influence on the final results. Regarding smoothing of outliers (via winsorization), we did not test it, because the number of winsorized observation is negligible. 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 29-55% 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 to one of the following performance brackets: "below EU", "close to EU", "above EU"[21].

Table 12: Uncertainty parameters (winsorization, normalization, weights, aggregation)

Type of uncertainty	Reference	Alternative
A. Uncertainty in the normalization method	Min-max	z-scores
B. Uncertainty in the aggregation function	arithmetic average	geometric average
C. Uncertainty intervals for the weights	Reference value for the weight	Distribution assigned for uncertainty analysis (± 25% reference value)
1. Entrepreneurship (# 10[22])	0.100	U[0.075 ,0.125]
2. 'Second chance' (# 4)	0.250	U[0.187 ,0.313]
3. 'Think small first' & 'Responsive administration' (#13)	0.077	U[0.058 ,0.096]
4. State aid & public procurement (#4)	0.250	U[0.187 ,0.313]
5. Access to finance (#10)	0.100	U[0.075 ,0.125]
6. Single market (# 9)	0.111	U[0.083 ,0.139]
7. Skills and innovation (#12)	0.083	U[0.062 ,0.105]
8. Environment (#5)	0.200	U[0.150 ,0.250]
9. Internationalisation (#9)	0.111	U[0.075 ,0.125]

Note: 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 1. Entrepreneurship.

[20] The estimation of missing data has no impact on countries' performance scores because it is based on real data (most recent available).
[21] 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.
[22] Entrepreneurship dimension is originally based on 11 indicators, two indicators having weight 0.5 have been merged into 1 for simplicity of the calculation.

The uncertainty analysis of the 2017 SBA principles was based on a combination of a Monte Carlo experiment and a multi-modelling approach (see Table 12). This type of assessment aims to respond to possible criticism that the country scores associated with indices are frequently presented as if they were calculated under conditions of certainty, while, by the very definition of the index, this 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 12.

The Monte Carlo simulations were later combined with the multi-modelling approach, which involves combinations of the remaining two key assumptions on 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. It is an invasive method that reduces the amount of information available and the thresholds for winsorization are subjective choices that depend on the particular structure of the data. However, as shown in section 4.1, only two indicators were winsorized. Therefore, we are not comparing the results obtained via winsorization with those obtained with no winsorization. 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. In addition, 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[23], which belongs to a class of partially compensatory aggregations functions. Consequently, we tested four models (2^2) based on the combination of 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 4,000 simulations for each SBA principle.

The uncertainty analysis results are shown in Tables 13 to 22 with countries in alphabetical order. In the following we give an example of how these results should be interpreted for Austria (first in alphabetical order).

In the 2017 SBA fact sheets, Austria is classified on Entrepreneurship as performing close to EU average, yet this is confirmed only in 49% of the simulated cases, while in the remaining 51% of the simulations, Austria's performance is below the EU average. This divergence is signalled in the last column of Table 13, which highlights that the probabilistic assessment would forecast a different outcome ("below EU") for 'Entrepreneurship' than the SBA actual score. Undoubtedly though, Austria is close to the EU average in the following four dimensions - Second Chance, Think Small first, State Aid and Public Procurement and Access to Finance (77% of the probabilistic assessment simulations place close to EU average in the first one and 100% in the remaining three). Austria is clearly above the EU average on the remaining four principles – Single Market, Skills and Innovation, Environment, Internationalisation

[23] 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.

(100% of the probabilistic assessment simulations place Austria above the EU average in the first three and 69% in the last one).

Overall, when comparing country's positioning with respect to the EU average, the statistical robustness and coherence analysis confirmed that 90,08% of countries' positioning are statistically reliable, i.e. divergence is found in **25 cases** out of the pool of **252 possible** cases (9 dimensions covered for each EU-28 country). There are **33** additional cases for which two different outcomes, the SBA and another one, have the same probability. If we consider these cases as divergence, we can confirm that 76,98% of countries' positioning are statistically reliable. This is especially relevant for Finland and Denmark. For five and four indicators respectively, a different outcome has the same probability as the SBA outcome. The SBA calculation seems to slightly overestimate the performance of both countries. 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 13: Uncertainty Analysis (Austria – Bulgaria)

Austria	SBA	Below EU		Close to EU		Above EU	Divergence
Entrepreneurship	Close to EU	51%		49%		0%	x
Second chance	Close to EU	0%		77%		23%	
Think small first & Responsive Administration	Close to EU	0%		100%		0%	
State aid and public procurement	Close to EU	0%		100%		0%	
Access to finance	Close to EU	0%		100%		0%	
Single market	Above EU	0%		0%		100%	
Skills and innovation	Above EU	0%		0%		100%	
Environment	Above EU	0%		0%		100%	
Internationalization	Above EU	0%		31%		69%	
Belgium	**SBA**	**Below EU**		**Close to EU**		**Above EU**	**Divergence**
Entrepreneurship	Below EU	100%		0%		0%	
Second chance	Above EU	0%		66%		34%	x
Think small first & Responsive Administration	Below EU	100%		1%		0%	
State aid and public procurement	Below EU	96%		4%		0%	
Access to finance	Close to EU	0%		84%		16%	
Single market	Above EU	0%		2%		99%	
Skills and innovation	Above EU	0%		0%		100%	
Environment	Close to EU	0%		100%		0%	
Internationalization	Below EU	100%		0%		0%	
Bulgaria	**SBA**	**Below EU**		**Close to EU**		**Above EU**	**Divergence**
Entrepreneurship	Below EU	100%		0%		0%	
Second chance	Above EU	0%		58%		42%	x
Think small first & Responsive Administration	Close to EU	63%		37%		0%	x
State aid and public procurement	Close to EU	1%		100%		0%	
Access to finance	Above EU	0%		65%		35%	x
Single market	Below EU	89%		11%		0%	
Skills and innovation	Below EU	100%		0%		0%	
Environment	Below EU	100%		0%		0%	
Internationalization	Close to EU	50%		50%		0%	=

Table 14: Uncertainty Analysis (Croatia – Czech Republic)

Croatia	SBA	Below EU		Close to EU		Above EU	Divergence
Entrepreneurship	Below EU	100%		0%		0%	
Second chance	Below EU	51%		49%		0%	
Think small first & Responsive Administration	Below EU	100%		0%		0%	
State aid and public procurement	Above EU	0%		30%		70%	
Access to finance	Below EU	28%		72%		0%	x
Single market	Below EU	100%		0%		0%	
Skills and innovation	Below EU	100%		0%		0%	
Environment	Close to EU	0%		100%		0%	
Internationalization	Above EU	0%		50%		50%	=
Cyprus	**SBA**	**Below EU**		**Close to EU**		**Above EU**	**Divergence**
Entrepreneurship	Close to EU	50%		50%		0%	=
Second chance	Close to EU	62%		38%		0%	x
Think small first & Responsive Administration	Close to EU	6%		94%		0%	
State aid and public procurement	Close to EU	13%		87%		0%	
Access to finance	Below EU	100%		0%		0%	
Single market	Below EU	91%		9%		0%	
Skills and innovation	Close to EU	50%		50%		0%	=
Environment	Above EU	0%		0%		100%	
Internationalization	Above EU	0%		27%		73%	
Czech Republic	**SBA**	**Below EU**		**Close to EU**		**Above EU**	**Divergence**
Entrepreneurship	Below EU	98%		2%		0%	
Second chance	Close to EU	0%		100%		0%	
Think small first & Responsive Administration	Below EU	49%		51%		0%	x
State aid and public procurement	Above EU	0%		0%		100%	
Access to finance	Above EU	0%		50%		50%	=
Single market	Close to EU	0%		100%		0%	
Skills and innovation	Above EU	0%		49%		51%	
Environment	Above EU	0%		43%		57%	
Internationalization	Below EU	100%		0%		0%	

Table 15: Uncertainty Analysis (Denmark - Finland)

Denmark	SBA	Below EU		Close to EU		Above EU	Divergence
Entrepreneurship	Close to EU	50%		50%		0%	=
Second chance	Above EU	0%		13%		87%	
Think small first & Responsive Administration	Above EU	0%		38%		62%	
State aid and public procurement	Above EU	0%		50%		50%	=
Access to finance	Above EU	50%		0%		50%	=
Single market	Above EU	0%		0%		100%	
Skills and innovation	Above EU	0%		0%		100%	
Environment	Close to EU	0%		90%		10%	
Internationalization	Above EU	0%		50%		50%	=
Estonia	**SBA**	**Below EU**		**Close to EU**		**Above EU**	**Divergence**
Entrepreneurship	Above EU	0%		0%		100%	
Second chance	Close to EU	0%		100%		0%	
Think small first & Responsive Administration	Above EU	0%		0%		100%	
State aid and public procurement	Close to EU	3%		94%		3%	
Access to finance	Above EU	0%		35%		65%	
Single market	Above EU	0%		45%		55%	
Skills and innovation	Below EU	100%		0%		0%	
Environment	Close to EU	50%		48%		2%	x
Internationalization	Below EU	90%		10%		0%	
Finland	**SBA**	**Below EU**		**Close to EU**		**Above EU**	**Divergence**
Entrepreneurship	Above EU	50%		0%		50%	=
Second chance	Above EU	0%		0%		100%	
Think small first & Responsive Administration	Above EU	0%		50%		50%	=
State aid and public procurement	Below EU	98%		2%		0%	
Access to finance	Above EU	0%		50%		50%	=
Single market	Close to EU	0%		100%		0%	
Skills and innovation	Above EU	0%		0%		100%	
Environment	Above EU	0%		50%		50%	=
Internationalization	Above EU	0%		50%		50%	=

Table 16: Uncertainty Analysis (France - Greece)

France	SBA	Below EU		Close to EU		Above EU	Divergence
Entrepreneurship	Close to EU	9%		91%		0%	
Second chance	Close to EU	0%		100%		0%	
Think small first & Responsive Administration	Below EU	96%		4%		0%	
State aid and public procurement	Above EU	0%		50%		50%	=
Access to finance	Close to EU	2%		98%		0%	
Single market	Below EU	100%		0%		0%	
Skills and innovation	Above EU	0%		65%		35%	x
Environment	Close to EU	50%		50%		0%	=
Internationalization	Close to EU	0%		96%		4%	
Germany	**SBA**	**Below EU**		**Close to EU**		**Above EU**	**Divergence**
Entrepreneurship	Below EU	98%		2%		0%	
Second chance	Above EU	0%		0%		100%	
Think small first & Responsive Administration	Below EU	97%		3%		0%	
State aid and public procurement	Close to EU	0%		100%		0%	
Access to finance	Close to EU	0%		100%		0%	
Single market	Close to EU	50%		50%		0%	=
Skills and innovation	Above EU	0%		9%		91%	
Environment	Close to EU	27%		73%		0%	
Internationalization	Close to EU	0%		97%		3%	
Greece	**SBA**	**Below EU**		**Close to EU**		**Above EU**	**Divergence**
Entrepreneurship	Below EU	93%		7%		0%	
Second chance	Below EU	100%		0%		0%	
Think small first & Responsive Administration	Below EU	84%		16%		0%	
State aid and public procurement	Above EU	0%		27%		73%	
Access to finance	Below EU	100%		0%		0%	
Single market	Below EU	100%		0%		0%	
Skills and innovation	Close to EU	39%		61%		0%	
Environment	Below EU	100%		0%		0%	
Internationalization	Below EU	100%		0%		0%	

Table 17: Uncertainty Analysis (Hungary - Italy)

Hungary	SBA	Below EU		Close to EU		Above EU	Divergence
Entrepreneurship	Below EU	82%		18%		0%	
Second chance	Below EU	100%		0%		0%	
Think small first & Responsive Administration	Below EU	100%		0%		0%	
State aid and public procurement	Above EU	0%		68%		32%	x
Access to finance	Close to EU	50%		50%		0%	=
Single market	Close to EU	0%		100%		0%	
Skills and innovation	Below EU	100%		0%		0%	
Environment	Below EU	100%		0%		0%	
Internationalization	Below EU	100%		0%		0%	
Ireland	**SBA**	**Below EU**		**Close to EU**		**Above EU**	**Divergence**
Entrepreneurship	Above EU	0%		50%		50%	=
Second chance	Above EU	0%		57%		43%	x
Think small first & Responsive Administration	Above EU	0%		35%		65%	
State aid and public procurement	Above EU	0%		52%		48%	x
Access to finance	Above EU	0%		50%		50%	=
Single market	Above EU	0%		11%		89%	
Skills and innovation	Above EU	0%		0%		100%	
Environment	Close to EU	0%		100%		0%	
Internationalization							
Italy	**SBA**	**Below EU**		**Close to EU**		**Above EU**	**Divergence**
Entrepreneurship	Below EU	100%		0%		0%	
Second chance	Below EU	100%		0%		0%	
Think small first & Responsive Administration	Below EU	100%		0%		0%	
State aid and public procurement	Below EU	100%		0%		0%	
Access to finance	Below EU	100%		0%		0%	
Single market	Below EU	52%		48%		0%	
Skills and innovation	Below EU	77%		23%		0%	
Environment	Below EU	100%		0%		0%	
Internationalization	Close to EU	25%		75%		0%	

Table 18: Uncertainty Analysis (Latvia - Luxembourg)

Latvia	SBA	Below EU		Close to EU		Above EU	Divergence
Entrepreneurship	Above EU	0%		2%		98%	
Second chance	Close EU	0%		100%		0%	
Think small first & Responsive Administration	Above EU	0%		50%		50%	=
State aid and public procurement	Above EU	0%		0%		100%	
Access to finance	Above EU	0%		13%		87%	
Single market	Close EU	0%		100%		0%	
Skills and innovation	Below EU	100%		0%		0%	
Environment	Close EU	0%		91%		9%	
Internationalization	Close EU	0%		100%		0%	
Lithuania	**SBA**	**Below EU**		**Close to EU**		**Above EU**	**Divergence**
Entrepreneurship	Above EU	0%		50%		50%	=
Second chance	Below EU	100%		0%		0%	
Think small first & Responsive Administration	Above EU	0%		50%		50%	=
State aid and public procurement	Above EU	0%		35%		65%	
Access to finance	Close EU	0%		98%		2%	
Single market	Close EU	0%		100%		0%	
Skills and innovation	Close EU	0%		100%		0%	
Environment	Above EU	0%		52%		48%	x
Internationalization	Above EU	0%		0%		100%	
Luxembourg	**SBA**	**Below EU**		**Close to EU**		**Above EU**	**Divergence**
Entrepreneurship	Below EU	76%		25%		0%	
Second chance	Below EU	100%		0%		0%	
Think small first & Responsive Administration	Close EU	50%		50%		0%	=
State aid and public procurement	Close EU	0%		100%		0%	
Access to finance	Close EU	0%		100%		0%	
Single market	Above EU	0%		57%		44%	x
Skills and innovation	Close EU	0%		93%		7%	
Environment	Above EU	0%		0%		100%	
Internationalization	Below EU	100%		0%		0%	

Table 19: Uncertainty Analysis (Malta - Poland)

Malta	SBA	Below EU		Close to EU		Above EU	Divergence
Entrepreneurship							
Second chance	Below EU	100%		0%		0%	
Think small first & Responsive Administration	Close to EU	53%		47%		0%	x
State aid and public procurement	Close to EU	0%		100%		0%	
Access to finance							
Single market	Above EU	50%		0%		50%	=
Skills and innovation							
Environment	Close to EU	2%		98%		0%	
Internationalization	Above EU	0%		50%		50%	=
Netherlands	**SBA**	**Below EU**		**Close to EU**		**Above EU**	**Divergence**
Entrepreneurship	Above EU	0%		0%		100%	
Second chance	Above EU	0%		0%		100%	
Think small first & Responsive Administration	Above EU	0%		42%		58%	
State aid and public procurement	Below EU	100%		0%		0%	
Access to finance	Close to EU	58%		42%		0%	x
Single market	Above EU	0%		5%		95%	
Skills and innovation	Above EU	0%		0%		100%	
Environment	Close to EU	0%		100%		0%	
Internationalization	Above EU	0%		50%		50%	=
Poland	**SBA**	**Below EU**		**Close to EU**		**Above EU**	**Divergence**
Entrepreneurship	Close to EU	50%		50%		0%	
Second chance	Below EU	100%		0%		0%	
Think small first & Responsive Administration	Close to EU	0%		100%		0%	
State aid and public procurement	Close to EU	0%		81%		19%	
Access to finance	Close to EU	0%		98%		2%	
Single market	Below EU	100%		0%		0%	
Skills and innovation	Below EU	100%		0%		0%	
Environment	Close to EU	0%		100%		0%	
Internationalization	Close to EU	49%		51%		0%	

Table 20: Uncertainty Analysis (Portugal - Slovakia)

Portugal	SBA	Below EU		Close to EU		Above EU	Divergence
Entrepreneurship	Above EU	0%		50%		50%	=
Second chance	Above EU	0%		40%		61%	
Think small first & Responsive Administration	Above EU	0%		50%		50%	=
State aid and public procurement	Below EU	100%		0%		0%	
Access to finance	Close to EU	53%		47%		0%	x
Single market	Below EU	100%		0%		0%	
Skills and innovation	Close to EU	0%		100%		0%	
Environment	Close to EU	0%		100%		0%	
Internationalization	Below EU	100%		0%		0%	
Romania	**SBA**	**Below EU**		**Close to EU**		**Above EU**	**Divergence**
Entrepreneurship	Above EU	50%		1%		49%	x
Second chance	Close to EU	24%		76%		0%	
Think small first & Responsive Administration	Close to EU	20%		80%		0%	
State aid and public procurement	Close to EU	0%		100%		0%	
Access to finance	Close to EU	50%		50%		0%	=
Single market	Below EU	100%		0%		0%	
Skills and innovation	Below EU	100%		0%		0%	
Environment	Below EU	100%		0%		0%	
Internationalization	Close to EU	58%		43%		0%	x
Slovakia	**SBA**	**Below EU**		**Close to EU**		**Above EU**	**Divergence**
Entrepreneurship	Close to EU	3%		97%		0%	
Second chance	Below EU	100%		0%		0%	
Think small first & Responsive Administration	Below EU	100%		0%		0%	
State aid and public procurement	Close to EU	1%		99%		0%	
Access to finance	Above EU	0%		16%		84%	
Single market	Close to EU	54%		46%		0%	x
Skills and innovation	Below EU	85%		15%		0%	
Environment	Above EU	0%		49%		51%	
Internationalization	Below EU	85%		15%		0%	

Table 21: Uncertainty Analysis (Slovenia - Sweden)

Slovenia	SBA	Below EU		Close to EU		Above EU	Divergence
Entrepreneurship	Close to EU	0%		100%		0%	
Second chance	Above EU	0%		0%		100%	
Think small first & Responsive Administration	Below EU	85%		15%		0%	
State aid and public procurement	Below EU	90%		10%		0%	
Access to finance	Close to EU	0%		100%		0%	
Single market	Close to EU	0%		100%		0%	
Skills and innovation	Close to EU	0%		100%		0%	
Environment	Close to EU	0%		100%		0%	
Internationalization	Close to EU	51%		49%		0%	x
Spain	**SBA**	**Below EU**		**Close to EU**		**Above EU**	**Divergence**
Entrepreneurship	Below EU	100%		0%		0%	
Second chance	Close to EU	0%		100%		0%	
Think small first & Responsive Administration	Close to EU	0%		100%		0%	
State aid and public procurement	Below EU	100%		0%		0%	
Access to finance	Below EU	100%		0%		0%	
Single market	Below EU	100%		0%		0%	
Skills and innovation	Close to EU	0%		100%		0%	
Environment	Below EU	100%		0%		0%	
Internationalization	Close to EU	0%		100%		0%	
Sweden	**SBA**	**Below EU**		**Close to EU**		**Above EU**	**Divergence**
Entrepreneurship	Close to EU	0%		100%		0%	
Second chance	Close to EU	0%		100%		0%	
Think small first & Responsive Administration	Above EU	50%		1%		49%	x
State aid and public procurement	Close to EU	50%		33%		18%	x
Access to finance	Above EU	0%		49%		51%	
Single market	Close to EU	0%		100%		0%	
Skills and innovation	Above EU	0%		50%		50%	
Environment	Close to EU	0%		97%		3%	
Internationalization	Above EU	0%		50%		50%	=

Table 22: Uncertainty Analysis (UK)

United Kingdom	SBA	Below EU		Close to EU		Above EU	Divergence
Entrepreneurship	Close to EU	0%		100%		0%	
Second chance	Above EU	0%		5%		95%	
Think small first & Responsive Administration	Above EU	50%		0%		50%	=
State aid and public procurement	Below EU	100%		0%		0%	
Access to finance	Above EU	0%		50%		50%	=
Single market	Close to EU	18%		82%		0%	
Skills and innovation	Above EU	0%		0%		100%	
Environment	Close to EU	37%		63%		0%	
Internationalization	Above EU	0%		50%		50%	=

6 Conclusions

The SBA country fact sheets have been 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's Joint Research Centre (JRC). The main goal of the fact sheets is to capture the performance of the SMEs across the EU-28 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 assessed across nine quantitative dimensions, where each dimension is composed of between four to thirteen indicators.

For the 2017 release of the SBA fact sheets, a total of 77 indicators were selected from about 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) in the Unit Modelling, Indicators & Impact Evaluation calculated and analysed the 2017 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 policy-makers 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 by 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 were estimated using a hybrid approach, where the expert knowledge was 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 2002-2017. Furthermore, the compound annual growth rates were calculated per principle and country.

The multiple steps based analysis of the covariance structure was performed within and across the statistical dimensions to investigate the statistical coherence of the SBA framework. During the analysis, the statistical multi-dimensionality of the SBA scoreboard was 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 38% 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 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, the majority of country classifications, relative to the EU average, in the 2017 SBA fact sheets are supported by the simulations.

Overall, the assessment of the methodology behind the 2017 edition of the SBA fact sheets is positive, confirming it to be a sound tool for measuring SMEs's performance across countries. The analyses carried out have confirmed that measuring SMEs's 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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