Health Economics, Policy and Law (2025), page 1 of 13
doi:10.1017/S1744133125100182

HEALTH ECONOMICS, POLICY and LAW

ARTICLE

Health system sustainability and resilience: a preliminary provision of measurement through a "mash-up" index

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(Received 19 April 2025; revised 12 June 2025; accepted 13 June 2025)

Abstract
We present a methodology for a new composite, quantitative "mash-up" index of health system sustainability and resilience, drawing on a qualitative framework developed to assess these dimensions of the health system. The paper summarises quantifiable measures of sustainability and resilience, with sustainability defined through 7 domains and 50 indicator variables, while health system resilience is based on 6 domains and 23 variables. Each domain is captured by a separate index. A composite index is constructed through aggregation across the two dimensions, and their associated domains and indicators. All indices are aggregated through estimation of a geometric means, and are bound between 0 and 100. We pilot across 5 countries over 23 years, with the ultimate aim of identifying health policy strategies for improving national health system capacities and performances; as well as facilitating policy responses to address problematic issues of sustainability and resilience. Face validity suggests that the index captures the non-resilience to the COVID-19 pandemic. The pilot study reveals considerable differences at both the dimension and domain levels within and between the examined countries, while suggesting scope for improvement in both dimensions across all countries. The index thus provides an indicative approach for temporal and spatial yardstick comparison.

Keywords: health system sustainability; health system resilience; health policy

1. Introduction

The objective of this paper is to present a methodology for developing a composite, quantitative measure of sustainability and resilience within healthcare systems. This measure builds upon a qualitative framework designed to assess these dimensions. The COVID-19 pandemic underscored the necessity of constructing sustainable and resilient health systems capable of preventing, preparing for, responding to, and learning from disease outbreaks and other extreme shocks while maintaining essential health services and reinforcing resilience for future disturbances. Before the pandemic, limited attention was given to defining and measuring health system sustainability and resilience. To effectively investigate these dimensions of the healthcare system, it is crucial first to define them appropriately. Once defined, qualitative support must be provided to illustrate their policy relevance before attempting to quantify them.

To improve the assessment of health system sustainability and resilience, operational definitions were developed to form a qualitative framework that provides a conceptual basis for

understanding these dimensions, their components, and their interrelationships. This framework, derived from the work of the Partnership for Health System Resilience and Sustainability (PHSSR), was designed to enhance knowledge and comprehension of sustainability and resilience in healthcare systems.[1] The PHSSR has defined *health system sustainability* as the ability of a health system to continuously improve population health by delivering the key functions of providing services, generating resources, financing, and stewardship, incorporating principles of financial fairness, equity in access, responsiveness, and efficiency of care, while minimising its environmental impact. This dynamic capability involves adapting to changing contexts to maintain and enhance performance. *Health system resilience*, on the other hand, refers to the system's capacity to absorb, adapt, and recover from crises (whether born of short-term shocks or long-term stresses) while minimizing negative impacts on population health and service disruption. A resilient system incorporates lessons learned and makes necessary transformations to reduce its exposure to future shocks (Wharton & McGuire, 2024).

A scoping review as well as an independent rapid evidence assessment were conducted to identify relevant domains and indicators of sustainability and resilience for a qualitative assessment framework (Wharton *et al.*, 2021, McGuire *et al.*, 2022). The original framework was structured around the domains of the World Health Organization's (WHO) health system 'building blocks' framework: governance, financing, workforce, medicines and technology, and service delivery, with information treated as a cross-cutting domain (Wharton *et al.*, 2021, WHO 2007). In recognition of emerging challenges and evolving priorities, the PHSSR subsequently expanded the framework to include two additional domains: population health and social determinants, and environmental impact. These additions reflect a growing consensus on the need to address upstream determinants of health and environmental sustainability as integral components of resilient and sustainable health systems. This qualitative framework has been successfully applied in 25 countries since 2020 and continues to be expanded globally (see www.phssr.org for country reports).

Building upon this qualitative framework, we developed a composite measure of health system sustainability and resilience which is outlined and piloted in this paper. This measure aggregates multiple domains and indicators into an index, providing policymakers with a comprehensive tool to assess health system performance.

The demand for such multidimensional measures has been long recognized, with various organisations producing indices to evaluate health system performance, including the Human Development Index (HDI), the Universal Health Coverage (UHC) Service Coverage Index, and the Global Health Security (GHS) Index (UNDP, 2024, WHO, 2025, Global Health Security Index, 2021). However, none of these indices focus explicitly on health system sustainability and resilience.

To construct the PHSSR Index, we draw on the work of Wagstaff *et al.* (2016) and the typology of index construction outlined by Ravallion (2005; 2010; 2012). While traditional indices are grounded in economic theory and index number theory, a second set of indices of direct relevance here are referred to by Ravallion (2010) as *mash-up* indices. These are aggregates of multiple dimensions based on conceptual assumptions and intuitions rather than formal theoretical foundations. The HDI, for example is perhaps the most well-known of such indices, and combines income, longevity, and knowledge into a single measure to provide a broader socio-economic perspective of a country's well-being than simple GDP comparison.

Of course, disputes arise over both sets of index aggregation. For example, GDP or price indices are criticised as not being comprehensive enough to capture all aspects of a countries well-being or productivity, the measurement of quality changes in commodities may not be adequately captured, and there may be disputes over which methodology of weighting (chain, Laspeyres,

[1]*See www.phssr.org for full information on the aims, partners and activities of the partnership. LSE Health, specifically two of the authors, A. McGuire and G.Wharton, are founding members of the PHSSR.*

Paasche, etc.) should be applied. While *mash-up* indices may be criticized for their subjective selection of dimensions and weightings, we build our measures from our explicit qualitative framework and ensure transparency in our methodology by explicitly defining our dimensions, domains, indicators, and weighting system. This approach allows for the flexible adaptation of weights to reflect different policy priorities.

The paper proceeds as follows: we provide some context to our approach; we then outline our methodology for constructing the PHSSR Index, apply the methodology to a set of pilot countries for empirical testing, and discuss the findings and policy implications.

2. Contextual background

There are many indicators of individual countries health care, documenting many dimensions across countries and time. Given the range of capabilities and dimensions there is an understandable desire to aggregate dimensionality and produce an aggregate index. In doing so there is the obvious danger of reducing many complexities to a single number. It is therefore important to outline the method used to construct an aggregate and document limitations. The PHSSR Index draws on an established methodology of "mash-up" indices, which draw on aggregates of moving parts that are re-scaled and ranked to produce a component-based series reflecting the analysts' weights. Ravallion (2010) refers to this as a mash-up index. One of the major criteria he promotes is transparency, and to this end the PHSSR index is a build of various domains that allows them to provide information in index form within each domain, as well as allowing contribution to the final aggregate index, based publicly available data. In this way transparency is promoted, as well as the ability to track separate indicators of a countries' health care system within domain movements. Moreover, the aggregation is built in such a manner that the trade-offs across different indicators and domains through changing the geometric weights used to produce the final index. This transparency and manipulability, based as it is on secondary data, provides policy makers with a flexible tool to assess the sustainability and resilience of their own health care systems, to benchmark against other systems and to monitor the impact that their own policies have in altering their own systems.

These mash-up indices are not meant to provide causal estimates of the impact that health system characteristics have on policy outcomes, but rather to indicate the way in which different dimensions of sustainability and resilience track over time and across countries. The use of secondary data is deliberate to promote transparency and ease of use and development. The use of the build across indicators and variables is also deliberate to allow analytical traction at the disaggregate level through the reliance on a dashboard approach, while still arriving at a meaningful set of aggregate measures of sustainability and resilience. This removes the need for the calculation to be based on black-box, statistical measures, such as principal components or autoregressive models that provide implicit weights to different dimensions and which cannot be easily manipulated.

Our approach builds on a growing development of mash-up type indices, including the Human Development Index (United Nations Development Program, 2023), the Universal Health Coverage index (Wagstaff, Cotlear, Eozenou *et al.*, 2016) and the Global Health Security (Global Health Security Index, 2021) index. All have their individual perspectives and uses. All are open to the criticism that they tend to be illustrative and subjectively based on analyst choices of inputs. By building the PHSSR index from an explicit policy framework, based on a review of multiple competing frameworks which identified 80 potential attributes relevant to a health system's sustainability and resilience that has subsequently been used in over 20 countries globally to assess their health care systems by local researchers, we contend that the index has both some traction and is useful when combined with this framework to highlight trends and shocks (Wharton and McGuire, 2024).

3. Methods

The definitions and domains of sustainability and resilience, as noted earlier, were derived from a qualitative analysis that informed the development of a framework for health system assessment (Wharton *et al.*, 2021). This framework supported structured assessments of health system strengths and weaknesses, drawing on systematic literature reviews, grey literature analyses, and semi-structured interviews with policymakers.[2]

It was designed to be adaptable across various country contexts, enabling local researchers to conduct independent assessments while generating preliminary country-specific policy recommendations (see Online Appendix Table 1 for further details).

Through the review of the application of the framework to multiple countries, we identified a range of indicators relevant to health system sustainability and resilience, organized into seven domains. These domains include five WHO health system building blocks: governance, financing, workforce, medicines and technologies, and service delivery, plus environmental sustainability and population health. A structured questionnaire was developed to guide local researchers in conducting country assessments. Between 2020 and 2025, 25 country reports have been successfully completed worldwide, some leading to direct policy uptake.[3]

For the quantitative measurement of indicators, data were drawn from multiple sources identified in reviews and country assessments for an initial set of five pilot countries: the United Kingdom, Germany, France, Poland, and Japan (2000–2023). Data were collected from organizations such as the World Health Organization, UNICEF, the World Bank, the International Monetary Fund, Our World in Data, the International Labour Organization, OECD Health Statistics, Transparency International, and Eurostat. Missing data were addressed through linear interpolation and extrapolation, and variables with missing values across all years were excluded (see Online Appendix Table 2. for further details).

The quantitative composite index was developed by integrating separate indices for sustainability and resilience, as based on multiple indicators spanning the seven domains identified within the qualitative framework. These domains and their associated indicators were selected based on their relevance to each health system dimension (see Online Appendix Table 3 for further details on the overall process).

The Sustainability Dimension Index encompasses seven domains and is constructed from a defined set of 32 indicators and over 50 variables (too many to detail here but see the online Appendices). Each of these domains varies in the number of indicators and underlying variables it includes, and each indicator comprises either a varying number of variables:

- Domain 1: Health System Governance – Three indicators which draw on three prior indices to form the indicators: A Corruption Perception index developed by Transparency

[2]The English language literature review to define concepts of health system sustainability and resilience and to identify relevant domains was based on a search of PubMed, Google Scholar and the LSE library catalogues to identify relevant reports, policy documents and academic papers indexed in Web of Science, Medline, Scopus and EconLit, (amongst others), to capture literature and analysis from different research perspectives (economic, public health, medical and others) over the period 01/01/2010 to 01/12/2023. A non-systematic search was conducted on grey literature. Targeted reviews were also carried undertaken of the websites of major health organizations, such as WHO, OECD, The European Observatory on Health Systems and Policies, and the World Bank (details given in online Appendix 1 and 2). Relevant data was collected from several databases, including from the World Health Organization, UNICEF, World Bank, International Monetary Fund, Our World in Data (Oxford), ILO, the OECD Health Statistics, Transparency International and Eurostat. on initial search produced 2430 articles. After screening titles and abstracts, 42 articles were read in full, and a further 18 were excluded. A further rapid review on relevant domain measures was undertaken. The framework was further validated through conducting semi-structured interviews with a sample of policy makers within international agencies. Full details available at www.phssr.org.

[3]The core research team was based at the LSE and while having responsibility for developing core methodology to be applied at the country level, it was not felt appropriate that they led the individual country team reports. Country teams had the local knowledge providing them with the best means of insight to apply the core developed method. A further aim was to develop local research infrastructure. All the country reports are publicly accessible at www.phssr.org.

International and Eurostat; a Trust in Government indicator developed by the OECD, and the Gini Index developed by the World Bank.
- Domain 2: Health System Financing – Six indicators drawing on secondary sources: GDP per capita (reported by the OECD); Health Care expenditure (reported by the OECD and drawing on five separate variables; Total health expenditure per capita, Public sector health spending, Private sector health spending, Out-of-pocket payments/Total health expenditure, Public debt/GDP ratio); and an Investment indicator based on Investment gross fixed capital formation (drawn from the OECD)
- Domain 3: Health System Workforce – Seven indicators: The number of health professions per capita (based on the number of doctors and number of nurses per capita); Long term care workers per 1,000 population; Job satisfaction/well-being (well-being in the population and a measure of perceived health); Salary levels based on health service remuneration levels; Staff migration (based on in-flows of doctors and nurses); Staff training (based on numbers of domestically trained doctors and nurses); Education skills (based on the numbers of medical and nursing graduate data)
- Domain 4: Medicines and Technology – Three indicators: Technology adoption; Domestic R&D expenditure; Uptake of digital health (all reliant on national figures)
- Domain 5: Health Service Delivery – Four indicators: Hospital readmission rates; Hospital lengths of stay; Patient satisfaction measures and waiting times; Hospital bed numbers.
- Domain 6: Population Health and Social Determinants – Five indicators: Life expectancy; Maternal mortality; Infant mortality; Chronic disease rates; Fertility rates; Income and Wealth levels.
- Domain 7: Environmental Sustainability – Four indicators: Indicators of environmental epidemiological and health risks; Extreme weather events; Earthquakes; Greenhouse gas emissions.

The Resilience Dimension Index is derived from six domains, excluding the environmental sustainability domain, which was considered not relevant. It comprises 20 indicators and again each indicator comprises either a single or several variables:

- Domain 1: Health System Governance – Five indicators: based on indicators of System surveillance and monitoring and coordination; Transparency; Education; Government capacity and Immunization coverage.
- Domain 2: Health System Financing – Three indicators: Protection of health funding; Progressive and regressive financing; Relative inflation of the health care sector.
- Domain 3: Health System Workforce – Three indicators: Staff training; Staff burn-out levels; Staffing ratios.
- Domain 4: Medicines and Technology – Two indicators: Digital/Telemedicine uptake; Early health care product development.
- Domain 5: Health Service Delivery – Two indicators: ICU and general hospital beds; Remote consultation levels.
- Domain 6: Population Health and Social Determinants – Five indicators: Maternal mortality; Stillbirth levels; Income inequality; Poverty levels; Educational attainment levels.

This structured build, developed from the qualitative framework, ensures that the composite index captures the multifaceted nature of health system sustainability and resilience. It provides a comprehensive basis for assessing performance across diverse health systems. Figure 1 illustrates the structure of the indices construction, outlining the seven domains within the sustainability dimension and six domains within the resilience dimension.

To standardize variable values across different units of measurement, we adopt the methodology used in constructing the GHS Index (Global Health Security Index, 2021).

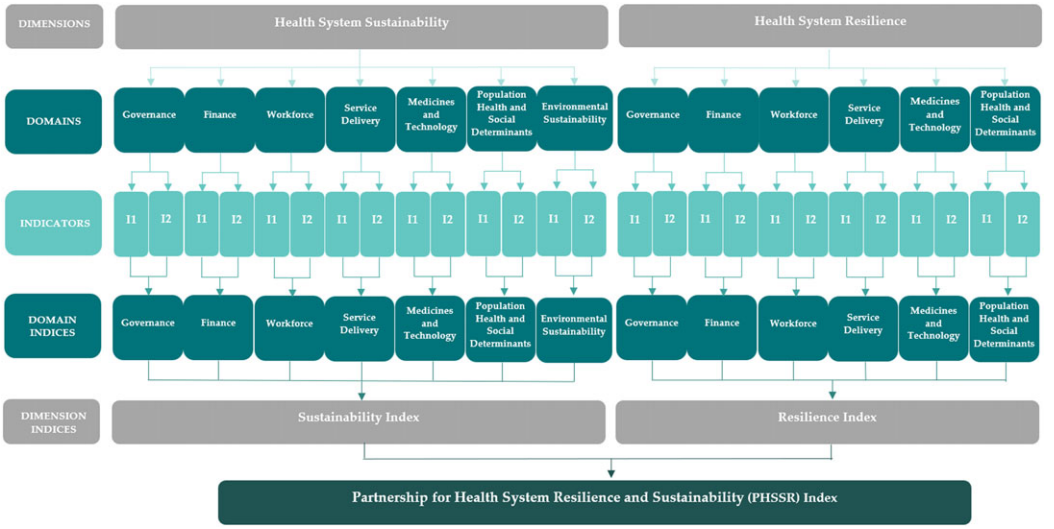


Figure 1. Outline of structural build of the PHSSR Index. This Figure gives defines the relationship between the domains used within the sustainability and resilience indices and the indicators, the build to the individual domain indices and the aggregation to the sustainability and resilience indices and the overall PHSSR index.

Variables positively associated with sustainability and resilience are rescaled using:

$$\frac{actual\ value - mnimum\ value}{maximum\ value - minimum\ value} x100$$

Conversely, variables negatively associated with sustainability and resilience are rescaled as:

$$\frac{actual\ value - maximum\ value}{minimum\ value - maximumm\ value} x100$$

Each domain is then captured by a separate index, aggregated using geometric means. For instance, for the Sustainability Dimension Index the indicator "health expenditure" in the Health Finance domain that has 7 variables the geometric average is calculated as:

$$Indicator_{Health\ Financing} = (\text{Variable}_1 * \text{Variable}_2 * \text{Variable}_3 * \text{Variable}_4 * \text{Variable}_5 * \text{Variable}_6 * \text{Variable}_7)^{1/7}$$

and then integrated further with the other two variables within that domain through a further geometric mean calculation:

$$Indicator_{Health\ Financing} = (\text{Indicator}_1 * \text{Indicator}_2 * \text{Indicator}_3)^{1/3}$$

While the domain index for Health System Governance within the Sustainability Dimension Index is characterized by three indicators, based on a single variable within each indicator and is calculated as:

$$\text{Domain Index}_{\text{Health System Governance}} = (\text{Indicator}_1 * \text{Indicator}_2 * \text{Indicator}_3)^{1/3}$$

These formulas are applied and repeated accordingly to the rest of the domains and dimensions depending on how many variables and indicators require aggregation for each of the Sustainability and Resilience Domains and are used to construct the aggregate PHSSR Index (see Appendix 3 for the precise build).

For the base case analysis, equal weighting is applied to all indicators within a domain, and domain indices are combined using geometric means to construct the Sustainability and Resilience Dimension indices. The final PHSSR Index is derived as the geometric mean of these two dimensions:

$$\text{PHSSR index} = (\text{DSust} * \text{DRes})^{1/2}$$

A sensitivity analysis of the PHSSR Index is conducted to assess its robustness by varying the inclusion of variables, applying alternative scaling methods, and testing different weightings. The methodology ensures that the *mash-up* PHSSR Index provides a transparent, adaptable, and empirically grounded measure of health system sustainability and resilience. Detailed calculations will be uploaded on the PHSSR website in due course (www.phssr.org).

4. Results

A detailed overview of the domain indices is provided in Online Appendices Tables 4–6, covering the sustainability dimension (Online Appendix Table 4), the resilience dimension (Online Appendix Table 5), and the aggregate PHSSR Index (Online Appendix Table 6).

Several key findings emerge from this analysis. Despite significant heterogeneity in health system performance across the sampled countries, all exhibit room for improvement in both sustainability and resilience. Overall, Germany and Japan recorded the highest PHSSR Index scores between 2000 and 2023. However, it is important to note that Japan had the highest proportion of missing data, which was not penalised in the base analysis, and therefore should be interpreted with caution. France outperformed the UK and all countries outperformed Poland over the study period analysed.

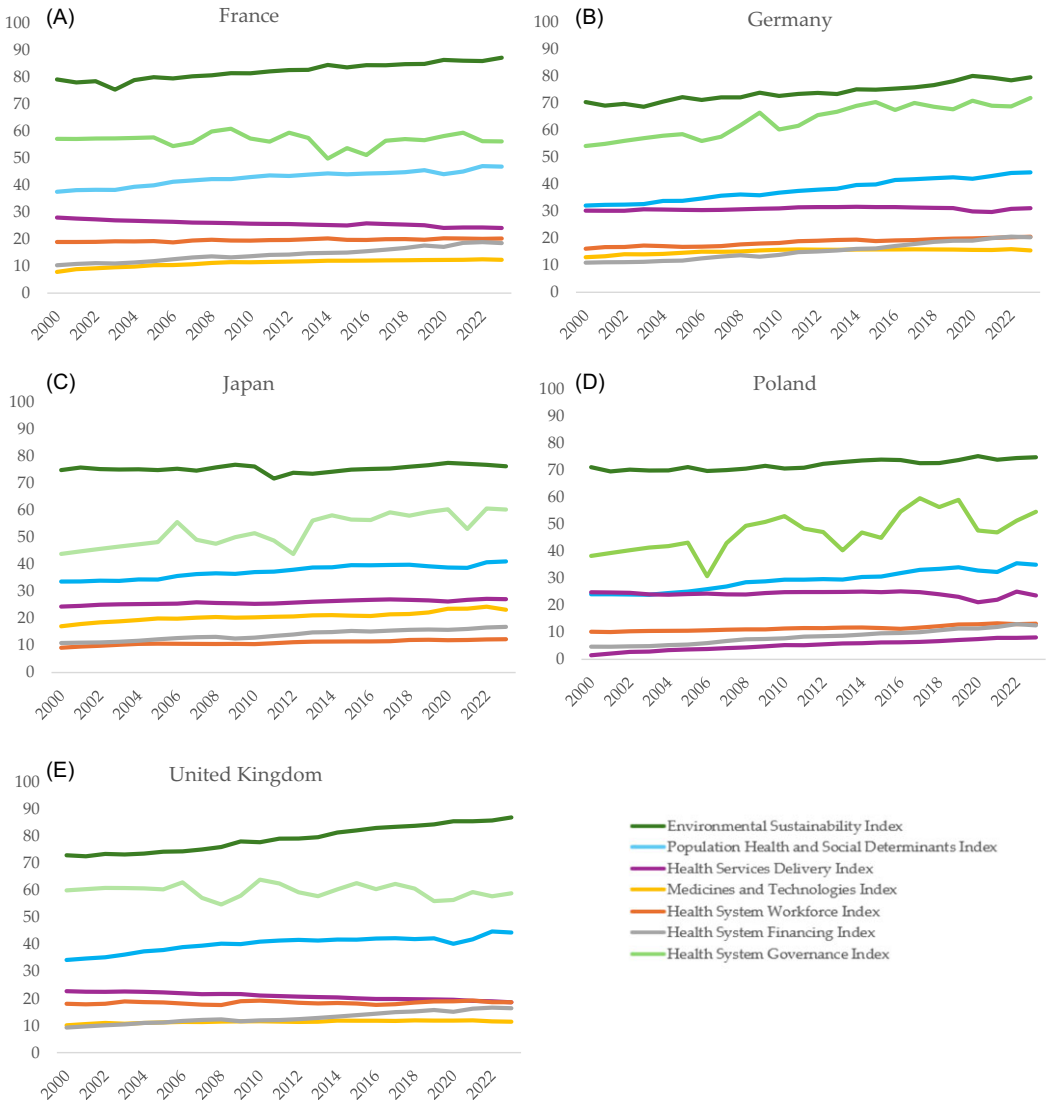
Drawing on the data given in Appendix 6 regarding health system sustainability, France, Germany and Japan demonstrate the highest index scores among the countries studied. The UK shows average performance across the sample, with its health service delivery domain index ranking lowest among the five countries. Poland lags significantly in terms of health system sustainability, exhibiting a considerable gap in the sustainability index compared to the top-ranked countries, i.e., Germany and France. However, Poland's sustainability index has shown notable improvement over time, increasing over the study period by approximately 68%.

In contrast, Japan performs better in terms of health system resilience, leading across several domains. Germany also performs well in this dimension, with France and the UK being average across the board, while Poland's resilience domain indices are considerably lower than those of the other countries. A sensitivity analysis, based around dropping indicator variables, had minimal impact on the overall trends observed in these data.

These broad trends are illustrated in Figures 2–4 which graphically present temporal trends and relationships between the aggregate sustainability and resilience domain indices, as well as the overall PHSSR Index for each country over the study period (2000–2023). At an aggregate level, all countries demonstrate substantial scope for improvement. Figures 2 and 3 show the sustainability and resilience indices separately, while Figure 4 maps the sustainability and resilience domain indices alongside the overall PHSSR Index.

In terms of broad trends, the sustainability domain indices (Figure 2) show that, overall, the delivery and financing domain performs less well than the governance and workforce domain. The UK, in particular, exhibits relatively weak performance in these aeras. Governance scores are consistently strong across all countries. Notably, the environmental sustainability index – driven largely by metrics on weather events and earthquakes – emerges as the highest quality component overall, which highlights its limited relevance for these countries.

With regards to the resilience domain indices (Figure 3), there is a greater variability in trends over time. The health system delivery domain shows a general downward trajectory in most countries, with a remarkable decline during the COVID pandemic years. Similarly, the health



Figures 2. A–E: Sustainability domain indices. This Figure presents the estimated sustainability individual domain indices for each of the 5 pilot countries (France, Germany, Japan, Poland and the UK).

system governance domain also dips across most countries between 2019 and 2021, reflecting widespread systemic pressures during these years.

Turning to the aggregate indices shown in Figure 4, the overall sustainability indices display an upward trend - albeit modest in some cases - across the five pilot countries. The aggregate resilience index shows a decline during the COVID-19 pandemic period, followed by a subsequent recovery. This pattern is mirrored in the overall PHSSR indices, lending face validity to the constructed measures. Over time, the PHSSR indices exhibit relatively moderate increases, reflecting the significant influence of the resilience dimension on aggregate outcomes.

The data aggregation process is critical in determining the information captured by these indices. To assess whether the indices accurately reflect various domains of health system functionality with respect to sustainability and resilience, multiple correlation matrices were estimated to evaluate potential redundancies across levels. The correlations between the two

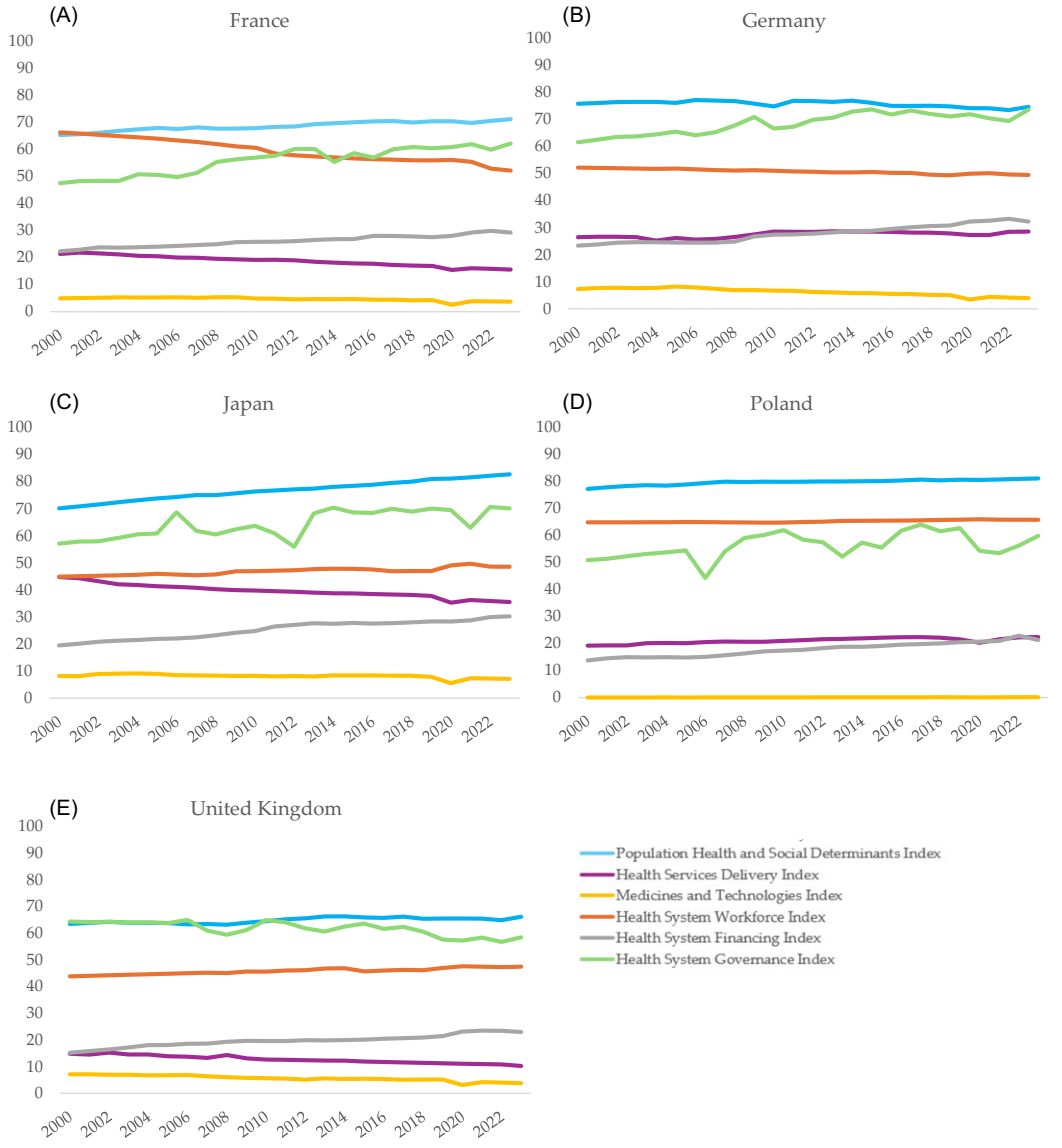
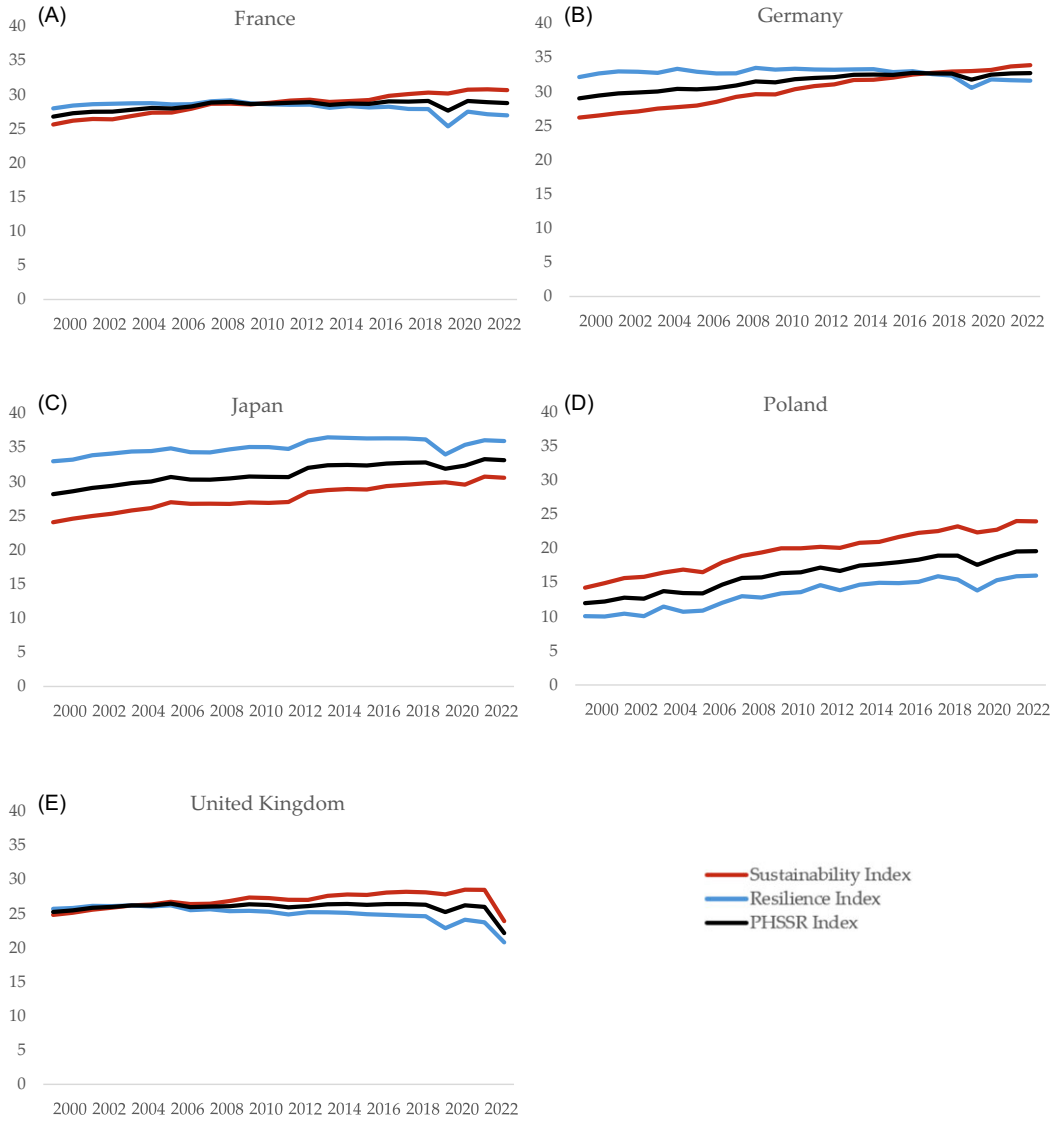


Figure 3. A–E: Resilience domain indices. This Figure presents the estimated resilience individual domain indices for each of the 5 pilot countries (France, Germany, Japan, Poland and the UK).

highest levels of sustainability and resilience for the five countries are as follows: –0.531 for France, –0.395 for Germany, 0.814 for Japan, 0.971 for Poland, and –0.767 for the UK. The degree of differentiation is notable, as the within-country correlations highlight the interconnection between sustainability and resilience at the national level.

To further elucidate index construction, additional correlation matrices were estimated for variables within the sustainability and resilience domains. Representative examples for the UK are presented in Tables 1 and 2. Table 1 reports the correlations across the sustainability domains. While there is a wide range of correlation values, no particularly strong or unexpected patterns emerge. However, the indicators of the finance and delivery domain appear to be strongly correlated, as does the general environmental domain with both the indicators of the finance and



Figures 4. A–E: Aggregate Resilience and Sustainability indices and overall PHSSR index. This Figure presents the estimated aggregated sustainability and resilience indices and the overall aggregated PHSSR index for each of the 5 pilot countries (France, Germany, Japan, Poland and the UK).

delivery domain. In contrast, Table 2 presents the correlations across the resilience indicators from which few definitive conclusions can be drawn.

Analysis of the correlation matrices across all five pilot countries reveals no clear overarching pattern. This suggests that the indicators capture both spatial and temporal variations in health care system responses to shocks, national contexts, and recurring policy phases. Moreover, when certain data were excluded from the analysis, the specific index values shifted slightly, but the relative country rankings remained stable.[4]

[4]All matrices can be obtained from the authors. At a future date all data will be made publicly available and all correlations, with updates, will appear on the website www.phssr.org.

Table 1. UK sustainability domain correlation matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) Health system governance	1.000						
(2) Health system financing	−0.271	1.000					
(3) Health system workforce	0.066	0.239	1.000				
(4) Medicines and technology	−0.121	0.799	0.234	1.000			
(5) Health service delivery	0.201	−0.971	−0.238	−0.784	1.000		
(6) Population health and social determinants	−0.161	0.878	0.205	0.841	−0.899	1.000	
(7) Environmental sustainability	−0.215	0.964	0.290	0.793	−0.989	0.869	1.000

This Table presents an example from the UK pilot of the correlations between the estimated sustainability individual domain indices over time.

5. Conclusion

One objective of this study is to stimulate discussion on whether a composite index encompassing the two fundamental dimensions of a country's health care system—sustainability and resilience—can be constructed through an integrated qualitative and quantitative approach. While health system resilience has received substantial attention, we argue that sustainability and resilience are interrelated, and that policy trade-offs are often made when allocating resources between these dimensions.

Although several efforts have been made to rank national health systems (e.g., the Commonwealth Fund, n.d.); none have developed a composite index that integrates sustainability and resilience within a structured qualitative framework. By disaggregating composite indices and grounding them in contextual qualitative frameworks, more meaningful comparisons can be drawn - both over time and across countries. This process necessitates clearly defined qualitative frameworks, extensive experimentation, and the construction of a comprehensive dashboard of indicators that can be meaningfully aggregated into a composite index. This study represents an initial step in that direction.

The constructed PHSSR indices reveal substantial variation across the sustainability and resilience dimensions and their seven domains in the five examined countries (UK, France, Germany, Poland, and Japan). While these indices are indicative rather than definitive, they point to opportunities for strengthening health system capacities and performance. The PHSSR indices may serve as an exploratory tools to assess system strengths and weaknesses, inform national policy strategies, and guide responses to challenges related to sustainability and resilience. The cross-country differences observed in the indices reflect each nation's unique context - including cultural, political, and health system characteristics, as well as national policy priorities.

Undoubtedly, the selection of indicators can be debated, and the approach itself is subject to valid criticism. A single index may risk oversimplifying of complex health system dynamics. However, we contend that these indices - when used in conjunction with the underlying qualitative framework (Wharton *et al.*, 2021) – offer valuable insights into system performance.

The pilot countries were selected non-randomly, as they were among the first to apply the qualitative framework and were expected to have the most accessible and transparent data. Despite this expectation, missing data were encountered, particularly for Japan – a notable finding in itself given the well-developed nature of its health care system. The PHSSR index appears to demonstrate face validity: the resilience and composite indices reflect the impact of the COVID-19 pandemic, with a marked decline in resilience during 2020–2021 across all five countries. They also show a gradual improvement from 2020 to 2023, despite the continuing effects of the

Table 2. UK resilience indicators correlation matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
(1) Surveillance system and monitoring	1.000																	
(2) Transparency	0.383	1.000																
(3) Education	0.844	0.328	1.000															
(4) Government Capacity	0.466	0.346	0.451	1.000														
(5) Immunization coverage	0.896	0.305	0.815	0.409	1.000													
(6) Protection of health funding	−0.923	−0.388	−0.862	−0.430	−0.962	1.000												
(7) Monetary aspects of the healthcare sector	−0.804	−0.365	−0.730	−0.521	−0.832	0.881	1.000											
(8) Progressive and regressive financing	0.804	0.189	0.692	0.358	0.943	−0.867	−0.762	1.000										
(9) Staff training	0.908	0.316	0.860	0.444	0.942	−0.972	−0.888	0.852	1.000									
(10) Staff working conditions and burnout	0.541	−0.016	0.519	0.271	0.752	−0.577	−0.440	0.768	0.561	1.000								
(11) Staff	−0.913	−0.390	−0.811	−0.459	−0.979	0.976	0.855	−0.902	−0.960	−0.647	1.000							
(12) Digital health/telemedicine	0.889	0.288	0.807	0.406	0.994	−0.965	−0.842	0.935	0.944	0.732	−0.978	1.000						
(13) Early-stage product development	0.567	0.452	0.444	0.332	0.492	−0.599	−0.588	0.432	0.571	−0.116	−0.558	0.490	1.000					
(14) ICU and general beds	0.878	0.279	0.753	0.358	0.989	−0.943	−0.796	0.943	0.931	0.732	−0.969	0.981	0.515	1.000				
(15) Remote consultations	0.266	0.074	0.207	−0.144	0.257	−0.244	−0.251	0.242	0.216	0.151	−0.265	0.240	0.071	0.251	1.000			
(16) Maternal mortality	−0.687	−0.244	−0.643	−0.179	−0.822	0.732	0.453	−0.784	−0.690	−0.703	0.794	−0.814	−0.365	−0.832	−0.263	1.000		
(17) Stillbirths	−0.825	−0.167	−0.880	−0.382	−0.895	0.853	0.653	−0.827	−0.846	−0.700	0.878	−0.895	−0.402	−0.865	−0.227	0.878	1.000	
(18) Poverty Level	−0.304	−0.357	−0.082	0.071	−0.469	0.426	0.332	−0.473	−0.369	−0.238	0.474	−0.470	−0.490	−0.527	−0.204	0.562	0.263	1.000

This Table presents an example from the UK pilot of the correlations between the estimated resilience individual domain indices over time.

pandemic, suggesting scope for ongoing system adaptation and strengthening. These trends provide intuitive support for the validity of the constructed indices.

Nonetheless, considerable work remains. A health system sustainability and resilience index dashboard could be further refined through sensitivity analysis, and revisions to indicator selection to improve stability. Future research should investigate the key drivers of health system performance by identifying context-relevant variables and should examine the effects of alternative weighting schemes on index construction. Expanding the analysis to include additional countries would allow for more robust cross-national comparisons. Further research is also needed to address the theoretical and methodological challenges of composite index design - particularly in the context of evaluating policy trade-offs across countries over time.

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/S1744133125100182

Acknowledgements. We acknowledge comments given on the paper at presentations in the University of Barcelona and Pompeu Fabra, Barcelona in 2023, and at the International Health Economics Conference, Cape Town, 2023

Financial support. The study was partly financed through research funding from the Partnership for Health System Sustainability and Resilience (www.phssr.org).

Competing interests. A. McGuire is part of the PHSSR Steering Committee; G. Wharton is part of the PHSSR Management Group.

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Cite this article: McGuire A, Wharton G, Hodgson S, Kourouklis D, Jofre-Bonet M and Tran DL (2025). Health system sustainability and resilience: a preliminary provision of measurement through a "mash-up" index. *Health Economics, Policy and Law* 1–13. https://doi.org/10.1017/S1744133125100182