Food and Agriculture Organization of the United Nations

Agriculture and food systems at a crossroads

Progress towards ending hunger and malnutrition

A cross-country cluster analysis

International Food Policy Research Institute

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Abstract

This report provides a quantitative assessment of progress made towards the sustainable development goal of ending hunger and all forms of malnutrition since 1990. Using a cluster analysis, it categorizes country performance along three dimensions: (1) food security and nutrition outcomes; (2) structural drivers of food security and nutrition; and (3) past and present policy interventions in support of food security and nutrition.

Key findings show that much progress has been made towards the goal of ending hunger. Yet, many countries continue to face moderate to high degrees of undernourishment, especially where economies made least progress in transitioning towards high-productivity, modern agriculture and non-farm economic development and where policy stances have been weak in promoting agricultural development, reducing gender inequalities, and improving infrastructure and basic social services.

The decline in undernourishment has come with a rise in the prevalence in overweight and obesity. The spread of this form of malnutrition has come with dietary shifts towards the consumption of more animal-sourced and processed foods that have accompanied urbanization and income growth. By 2015, the vast majority of countries faced moderate to high prevalence of adult overweight, and this form of malnutrition is also on the rise in countries with still significant rates of child undernourishment. No country in the world is showing declines in the rate of adult overweight.

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Acknowledgements

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IFPRI researchers acknowledge the financial support from FAO for undertaking the present study and from CGIAR's Policies, Institutions and Markets (PIM) research programme for the development of the initial framework of analysis and setup of the database, which also benefited the present study.

DATA AVAILABILITY

An interactive webpage at the Food Security Portal site allows to explore the main findings and download all data used for this study.

Key takeaways

- Food security and nutrition have greatly improved over the past 25 years, as reflected in sharp reductions in hunger and undernutrition in most parts of the world.
- Yet, the world is still far from achieving the SDG of ending hunger and all forms of malnutrition. Moderate to high rates of hunger and/or child undernourishment still affect 53 countries.
- At the same time, moderate to high overweight among adults has become the most important nutrition concern in more than half of all countries in the world.
- Only two countries, the Republic of Korea and Japan, have achieved zero hunger and child nutrition while also keeping adult overweight and obesity to a minimum.
- Most of the 21 countries of the EU and FAO's FIRST programme reviewed here face high levels of hunger and child undernutrition. FIRST countries in Central America have also seen a significant rise in adult overweight, creating a heavy double burden of malnutrition.
- Countries that made the most progress in shifting to high-productivity agriculture and advanced industrial and services sectors also show the greatest reductions in hunger and child undernourishment.
- Undernourishment is low where governments supported agricultural growth through market support and investments in research and development (R&D), ensured (near) universal coverage of electricity, drinking water and sanitation, improved access to education for all and reduced gender gaps. It is high in countries which did not manage to undertake or sustain such policy efforts.
- Many of the policy efforts to address problems of undernourishment and child wasting and stunting also seem to induce (probably indirectly) higher rates of overweight. Future food policy designs should be aware of this trade-off.

1 Conceptual framework and methodology

Assessing progress towards improved food security and nutrition (FSN) is complex. By their definitions, food security and nutrition are multi-dimensional phenomena and any FSN situation tends to have many drivers (including policies). While the drivers will be country-specific, a comparison of performance across countries over time and linking these to changes in socio-economic and demographic conditions in farm and non-farm sectors, as well as to degrees of support through policies may help identify key factors for successful food security and nutrition strategies.

1.1 Approach

As shown in Figure 1, the analysis is organized around three dimensions: (1) food security and nutrition outcomes; (2) structural drivers of food security and nutrition; and (3) past and present policy interventions in support of food security and nutrition. We seek to obtain a country typology across each dimension.

A country's structural characteristics and conditions (demography, institutions, biophysical endowments, economic structure, urbanization) will determine potential for food production and availability, income and employment generation, and dietary preferences. Those conditions will be influenced by policy choices, while at the same time the socio-economic conditions will influence available policy space (e.g., through impact on fiscal space, strength of institutions, etc.). Policies relevant to FSN performance include market price incentives, public investments in rural infrastructure, education and agricultural research and development (R&D), policies promoting gender equality and so on.

In applying the approach, we follow a methodology developed in the study by Laborde *et al.* (2018)[1], which focuses on identifying phases of agricultural transformation and associating these with FSN outcomes in terms of reducing hunger and child undernutrition. Laborde *et al.* (2018) use both qualitative and quantitative assessments for 117 countries over the period from 1970 to 2015. They also identify three families of clusters: a first set defines a performance scale for inclusive agricultural transformation,

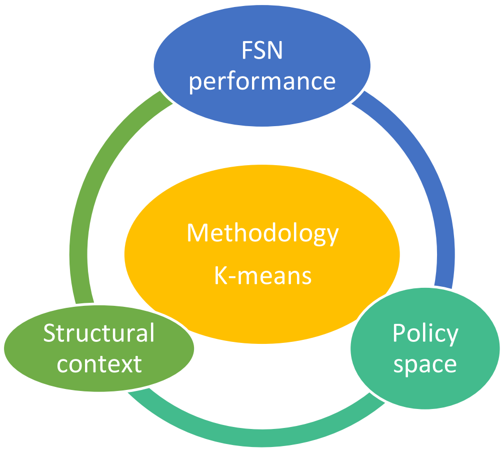

Figure 1 – Conceptual approach

[1] https://iisd.org/agricultural-transformation/

a second identifies the structural drivers in which the transformation process takes place and the third maps the policy space associated to this phenomenon. They use this approach to identify good performers in terms of broad-based economic development and identify which type of policy in a given context of structural conditions appears to have contributed to more inclusive agricultural transformation processes. On this basis, they provide recommendations for countries in earlier stages of transformation.

The approach taken here is very similar, but the problem definition is different. The focus here is on the achievements in terms of food security and nutrition in all dimensions. Also, the number of structural drivers and policy variables considered is much larger than that used in the Laborde *et al*. (2018) study. Importantly, while the degree of agricultural transformation of a country will impact on food security and nutrition, it is – *a priori* – neither a sufficient nor a necessary condition to end hunger and all forms of malnutrition.

1.2 Methodology

Cluster analysis is a way to classify data observations into groups, or "clusters." Data observations are grouped based on nearness to each other and distance from other groups. This can be made intuitive using an example of two dimensions of physical space. Imagine grouping homes in a rural area into villages. A cluster can be clearly identified when in one group homes stand close to each other and another group is at a clear distance.

In our case, we cluster observations for a country in a time period. For example, one characteristic of Kenya during the period 2003–2007 is one observation, referred to as "Kenya 2005." Country-periods are clustered using multiple variables (that is, multiple dimensions) to identify and define each of the three typologies. We implement clustering using a *k-means* technique, where **k** refers to the number of clusters and mean refers to the centroid, which is the mean location in multi-dimensional space of each group of points. The boundary of a cluster is where an observation would be equally far away from the two closest centroids. Through an iterative procedure, we determine the optimal number of clusters. Then, we perform robustness checks to assess the quality of our clustering.

For the three dimensions of our analysis, we experimented with up to 52 variables. However, for the final run of the cluster analyses we only use a subset. For the variable selection we take several factors into account. First, data for each variable should be available for a sufficient number of years and a large enough number of countries in order to include as many countries as possible in the analysis. If a country has no data for one or more of the variables necessary for the clustering into a typology, that country cannot be included. We consider data availability both for "FIRST programme" countries,[2] i.e., those countries of the FIRST programme for which country-level reports were reviewed, and for all countries globally, to ensure a reasonable frame of reference for global cross-country analysis. Second, we aim to select from the available variables those that are most important to the realm for which we are creating a

[2] The Food and Nutrition Security Impact, Resilience, Sustainability and Transformation (FIRST) programme represents a strategic partnership between FAO and the European Union (EU), whereby the EU is making an investment of nearly €8 billion in over 60 countries during the 2014–2020 period to improve food security and nutrition and promote sustainable agriculture. Through the FIRST programme, FAO is providing support to create a more enabling policy and institutional environment in which investments made by governments, EU, and other partners will have a more direct and tangible impact.

typology, based on what we know from existing economic theory, empirical evidence and expert opinion. Third, we aim to use variables that identify unique aspects of the realm; we avoid including two variables that are strongly correlated with one another because it could give excessive weight to that aspect in the cluster analysis. We use principal component analysis to quantify the uniqueness of sets of variables, experimenting with subsets of the variables that perform well on our first and second criteria.

In some cases of variable selection, we face trade-offs between these criteria. For example, child stunting and child wasting are correlated, such that by the third criterion only one should be included. However, because it is important to distinguish the two aspects for evaluating FSN performance, both were included as part of the FSN typology, in compliance with the second criterion.

The inclusion of FIRST programme countries influenced the *ex ante* design of the cluster analysis to some extent, given insufficient data availability for some variables for several of these countries. We dive deeper into what variables were considered for each typology and why particular variables were not used in Subsections 1.4, 1.5 and 1.6. The full list of considered variables for each typology and reasons for exclusion can be found in Appendices 7.1–3.

1.3 Data sources, coverage and processing

Data were collected for the period from 1990 to 2017 and for 249 countries and territories. Most data are provided by various United Nations agencies (WHO, UNCTAD, FAO, UNDESA, ILO and the World Bank). Minor territories and small sovereign entities are not included, such that the country sample is limited to 168 countries. As stated above, data availability required dropping some countries from parts of the analysis. Therefore, our sample varies over time and is contingent on the issue analysed. Among these 168 countries, 23 countries[3] are FIRST programme countries. Variables with less than 60 percent data coverage for these countries were discarded from the data set. Among the 23 countries, two did not meet this criterion: Cuba and Palestine. Where variables have coverage that is greater than 60 percent but less than complete, the data gap is addressed either using alternative sources or interpolation. We use linear interpolation between available data points, and keep the first, or last, available data for filling up the tails of the data series. These interpolation techniques are used for the cluster analysis but not when performing econometric regressions.

We harmonize variable units (e.g., as shares of GDP, in US$ or PPP$ per capita, etc.) within each topic for comparability. In addition, data expressed in monetary terms and having a wide numerical range are transformed to logarithms. Finally, where relevant, we compute the data as five-year averages for six periods (1990 = average for 1989 to 1992, 1995 = 1993 to 1997, 2000 = 1998 to 2002, 2005 = 2003 to 2007, 2010 = 2008 to 2012, and 2015 = 2013 to 2017) to smooth annual variations and maximize coverage (e.g., some data are collected only once every five years). With this, the cluster analysis was performed using pooled data sets for countries and time periods.

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[3] The list of countries is: AFG: Afghanistan; BFA: Burkina Faso; CIV: Côte d'Ivoire; COL: Colombia; CUB: Cuba; ETH: Ethiopia; FJI: Fiji; GTM: Guatemala; HND: Honduras; KEN: Kenya; KGZ: Kyrgyzstan; KHM: Cambodia; LBR: Liberia; MMR: Myanmar (Burma); NER: Niger; PAK: Pakistan; PSE: Palestinian Territories; SLB: Solomon Islands; SUR: Suriname; TCD: Chad; TLS: Timor-Leste; TZA: Tanzania; UGA: Uganda

1.4 Variable selection for the FSN typology

Various metrics exist for assessing food security and nutrition outcomes. However, few are available to provide consistent and internationally comparable measures for the 25-year period of our analysis. We considered **seven indicators**, taking into account the three criteria for variable selection outlined in Sub-section 1.2. The full list of considered variables for FSN outcomes can be found in Appendix 7.1. Four variables fulfil our needs:

1. the prevalence of **undernourishment** (caloric deficit over the course of a year) (FAO *et al.* 2018),
2. the prevalence of **stunting** among children under age five (WHO, 2019a),
3. the prevalence of **wasting** among children under age five (WHO, 2019b), and
4. the prevalence of **overweight** in the adult population (WHO, 2019c).

Three other variables were excluded because of low coverage over time and strong correlation with the included variables. As mentioned earlier, both child stunting and child wasting are included even though they are also correlated, given the high relevance of both to identify various dimensions of malnutrition and as both are SDG indicators. Other dimensions, such as micronutrient deficiency or acute hunger are not directly captured in the analysis, though likely are indirectly (and possibly incompletely) captured in child wasting and stunting.

1.5 Variable selection for structural drivers

The typology of structural drivers aims to capture economic and social conditions that are expected to influence FSN outcomes but are not expected to be affected directly by policies aimed at influencing FSN outcomes.

The initial review of evidence on possible drivers focused on **24 structural indicators across** five socio-economic domains: geography, demography, economic structure, institutional capacity and agricultural development potential.

After initial examination, the list of indicators was narrowed to ten elements:[4]

1. **Geographical constraints** were captured by whether country is **landlocked** or not. It captures the specific challenges faced by these economies in terms of access to foreign markets [1].

[4] Data for the selected indicators are available for most countries. Among the countries of the FIRST programme, Cuba, Fiji, Palestine, and Timor-Leste had to be dropped from this analysis because of insufficient data.

2. **Economic structure** is captured through two indicators: primary commodity dependence and the share of agriculture (both expressed as a percentage of GDP) [2]. [5]
3. **Institutional capacity and quality** identify the likelihood of a stable political environment and regulatory frameworks that would be beneficial to economic development and FSN. Two indicators best identified similarities and differences across countries: capacity to contain corruption and the political stability index, using World Bank data and definitions [2].
4. **Demographic pressures** are captured by the birth rate, as an indicator of both population growth and demographic transition [1].
5. **Agricultural potential:** in most developing countries, agriculture is a key source of income for the poor (food access) and the origin of food production (food availability). Hence, we identify two related structural conditions for the potential of agricultural development at the extensive margin (available agricultural land per capita) and the intensive margin (land quality as measured by potential land productivity). In addition, we look at *realized* potential through measures of actual farm productivity (cereal yields and agricultural labour productivity) [4].

In addition, beyond capturing the economic development level of a country and its structural assets (institutions and natural endowments), we also track two dimensions of social and environmental sustainability: income inequality and the use of chemical inputs in agricultural production. Both indicators had to be dropped in the end from the analysis for different reasons:

- Too few data were available to allow for consistent tracking of *income inequality* by country and over time. Yet, the available data show a clear picture: income inequality generally falls with agricultural productivity growth though, at closer inspection, in the shape of an inverse U-shaped curve; that is, at lower levels of development there may be an initial rise in overall inequality (especially if non-agricultural sectors expand faster) but to decline thereafter when reaching more advanced stages of agricultural transformation.

- The *use of chemical inputs* (fertilizers, pesticides) is strongly and positively correlated with growth in agricultural productivity, showing little differentiation within and across clusters. Hence, the indicator was dropped from the cluster analysis, but to the extent the use of such inputs is associated with environmental degradation, it could be argued that there may be a trade-off between short-term progress in reducing hunger and malnutrition with the help of yield growth and long-run sustainability of this progress, as these chemical inputs can negatively impact the environment.

1.6 Selection of policy variables

Our policy typology is intended to capture those broad policy areas that are understood to have the greatest effect on FSN outcomes. On the basis of other studies (see, for instance, Laborde *et al*. 2016), we identify a number of FSN-relevant policy categories: expenditures on agricultural R&D; agricultural price incentives and trade policies; and investment in basic rural infrastructure as critical for improving

[5] The United Nations' category of least-developed countries (LDCs) is in part based on the recognition of such features as structural impediments to growth (see https://www.un.org/development/desa/dpad/least-developed-country-category/ldc-criteria.html).

agricultural productivity, food availability and food access (through the impact on farm and rural household incomes). We also include public expenditures on education, water and sanitation, which tend to have positive impacts on nutrition outcomes, the more so if they empower women and reduce gender inequality.

Defining comparable policy indicators in an unambiguous way is notoriously difficult, as policies may have a positive or negative affect on FSN outcomes, depending on the context. For example, an increase in a price incentive indicator as the result of a subsidy on a staple food could help reduce the prevalence of undernourishment but, at the same time, may contribute to an increase in overweight.

Please note that the selected indicators are most explicitly linked with addressing problems of undernourishment. We were unable to identify policies that would explicitly aim to address overweight and obesity in any comparable way across countries.

In total, we reviewed **21 indicators** linked to the FSN policy agenda of various countries. The policy indicators represent **seven domains**: decentralization, farm policies (market price support and direct income transfers), human development (health, education and women's empowerment), agricultural R&D and rural infrastructure. From this review and given data availability, **four variables** were selected for the cluster analysis:[6]

1. the share of recurrent agricultural public expenditures as a share of agricultural value added as a proxy for the level of **agricultural incentives and farm support**;
2. coverage of **rural electrification**, which is a proxy for overall availability of rural infrastructure as this variable is strongly correlated with coverage of drinking water and sanitation infrastructure and road density;
3. the gender parity ratio in enrolment in tertiary education level, as a proxy for **gender equity** and women's empowerment, and
4. the average **rate of protection of agriculture** (market price support), as measured by the average tariff for agricultural imports.

While imperfect metrics, the selected variables have the best coverage across countries and over time. The lack of data is particularly acute for this realm, as compared to that for FSN outcome and structural context. Also, on this dimension, FIRST countries Cuba and Palestine had to be dropped due to insufficient data. For the same reason, FIRST countries Honduras, Cambodia, the Solomon Islands, Suriname, Chad, and Timor-Leste had to be left out for this part of the analysis.

[6] The scarcity of robust policy data was already pointed out by Laborde *et al.* (2018) and this was a strong motive to rely on extensive qualitative analysis and country-level case studies. For the present purpose, we consider that the policy cluster analysis could be pursued even while having to work with a smaller country sample. The purpose here is to identify a broader (cross-country) picture of policies that appear to have been of most influence in changes in food security and nutrition outcomes. However, this is in no way a substitute for in-depth country studies which will be needed to identify the effectiveness of policies in any given context.

2 Food Security and Nutrition (FSN) typology

The cluster analysis suggests countries can be classified into six types of food security and nutrition situations:

1. High hunger and high child undernutrition
2. Moderate hunger but high child undernutrition
3. Moderate hunger and moderate child undernutrition
4. Moderate child undernutrition and moderate adult overweight
5. Low child undernutrition and moderate adult overweight
6. No hunger, but high adult overweight

In Table 1 shows the median values for the four key food security and nutrition indicators for each cluster. Broadly, it shows a continuum from a high level of undernourishment (both in terms of lack of calorie intake and child stunting and wasting) to situations where hunger has been by and large eradicated, but which is also where high rates of overweight and obesity prevail.[7]

Table A.4 in Appendix 7.1 also shows the minimum and maximum values for each FSN indicator per cluster. To help the reader interpret the label of the groups, the qualification "high" is used for values in the range 35 percent to 70 percent when considering the prevalence of undernourishment (hunger), the prevalence of stunting for child undernutrition and the prevalence of overweight for overweight. "Moderate" refers to values in the range of 15 to 35 percent. "Low" refers to values from 0 to 15 percent.

Type 1: In 2015, there were eight countries (most in East and Central Africa) with both a high prevalence of undernourishment (median: 41 percent) and a high rate of child stunting (median: 42 percent), down from 23 countries in 1990 (see also Figure 2).

[7] Please note that the threshold (upper- and lower-bound) values for each FSN dimension are defined endogenously as part of the cluster analysis. These values may change if one or more countries are added or excluded. Furthermore, because FSN performance is defined on multiple dimensions, the FSN country typology from clusters 1 to 6 need not represent a smooth continuum on each single dimension, as may be read from Table 1.

Type 2: In 2015, seven countries (including India, Yemen and several countries in central and eastern Africa) still faced high hunger but had reduced child undernutrition to moderate levels. This group also has shrunk considerably in size: it consisted of 20 countries in 1990.

Type 3: Most countries that moved out of Types 1 and 2 since 1990 belonged to Type 3 in 2015, as both hunger and child stunting had fallen to moderate levels. This type expanded from 17 countries in 1990 to 28 countries in 2015.

Table 1 – Descriptive statistics, median value across time periods, for six FSN clusters*

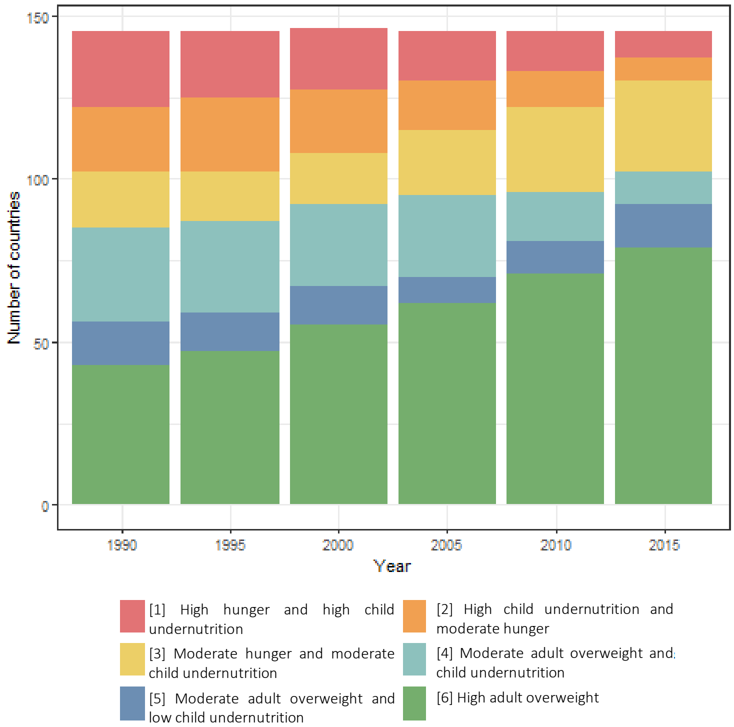
Code	Description	[1] High hunger and high child undernutrition	[2] High child undernutrition and moderate hunger	[3] Moderate hunger and child undernutrition	[4] Moderate adult overweight and child undernutrition	[5] Moderate adult overweight and low child undernutrition	[6] High adult overweight
OWGHT	Prevalence of overweight, % of adult population	18.30	14.74	19.96	42.80	32.12	55.46
PUNDP	Prevalence of undernourishment, %	41.68	27.18	20.17	14.39	5.44	2.00
STUNT	Prev. of stunting, % of children	40.69	45.00	35.24	23.49	4.87	2.00
WASTE	Prev. of wasting, % of children	7.43	15.02	8.37	3.30	2.43	2.00

Source*:* Authors' computation

Note: * See Table A.4 for the upper- and lower-bound values in each cluster. For undernutrition and undernourishment prevalence, a value of 2.0 is assumed for non-reporting high-income countries.

Type 4: Adult overweight and obesity had risen to notable levels (median: 43 percent) in ten countries by 2015, accompanied by moderate levels of child stunting (median 24 percent). The double burden of malnutrition is heaviest in this type. The number of countries in this type reached a high of 25 in 2000; since, it has shrunk, as many countries moved from Type 4 to Type 5.

Figure 2 – Evolution of size of FSN clusters over time, 1990-2015 (number of countries)



Source*:* Authors' computation

Type 5: This country grouping, having moderate adult overweight but low or no hunger and child undernutrition, is heterogeneous. It includes both middle-income economies that by and large have managed to resolve their undernourishment problem but are seeing a rising overweight problem. Only two economies in this type – and in the entire country sample – managed to contain increases in the prevalence of adult overweight (i.e., Japan and the Republic of Korea).[8]

Type 6: The last cluster contains most of the advanced economies, as well as a large portion of the countries in Latin America, the Middle East and northern Africa, and Central Asia. By 2015, the median of the prevalence of adult overweight in these countries had risen to over 55 percent. This type has grown most in size, increasing from 43 to 79 countries between 1990 and 2015. Thus, most countries in this group have reached low to zero undernourishment but are now facing high prevalence of overweight and obesity as their major malnutrition and health problem[9].

Figure 3 and Figure 4 show the six country types in two of the four dimensions: prevalence of undernourishment and prevalence of overweight.

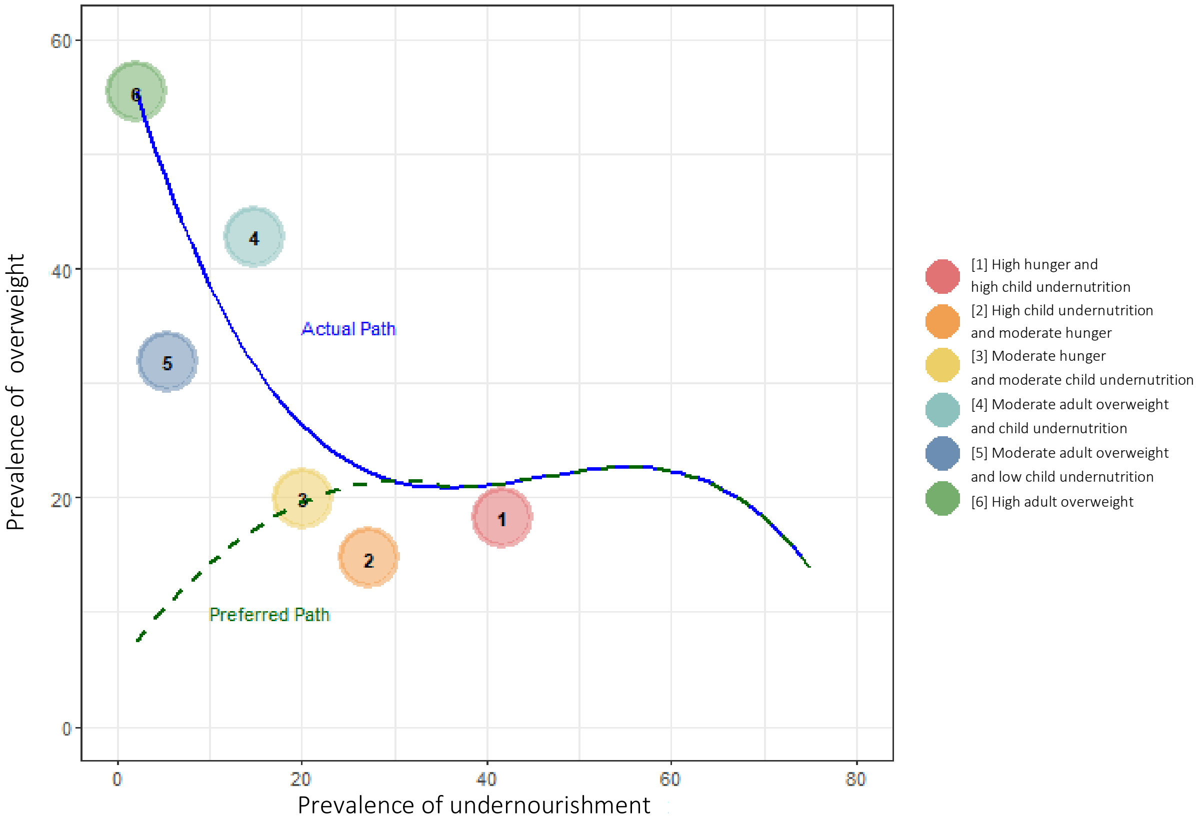
In the stylized presentation of Figure 3, the blue line shows the actual path that countries tend to take over time, estimated through a third degree polynomial on all observations, reducing the prevalence of undernourishment but increasing the prevalence of overweight. This is, of course, not the desired

[8] In the below, we will treat Japan and the Republic of Korea as outliers within the given typology. The sensitivity analysis conducted to test the robustness of the country typology suggests that the exclusion of Japan and the Republic of Korea would not affect the clustering in any significant way and thus would not affect the findings. See Appendix 7.5 for this sensitivity analysis.

[9] The evolution of the geographic distribution of Types 1–6 over the 1990-2015 period, can be found here.

pathway, as one would hope to see countries move along the preferred path represented by the green dotted line, reducing both the prevalence of undernourishment and the prevalence of overweight. Countries of type [3] and [4] especially tend to suffer from this double burden. At the country level, we also observe that many countries sit far in the NE-quadrant of the graph, suffering from a double burden of malnutrition.[10] Figure 4, in turn, shows the detailed, observed pathways by country and over time between 1990 and 2015.

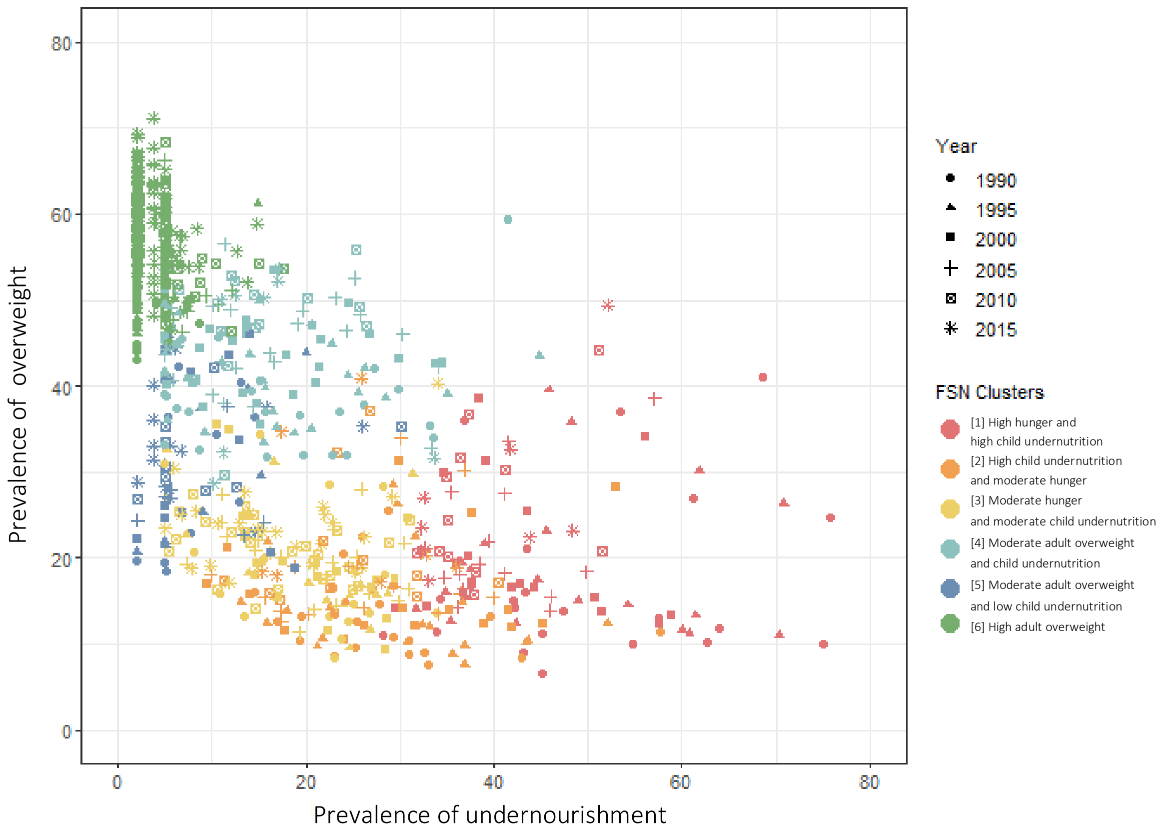
Figure 3 – Stylized pathways from undernourishment to overweight, 1990–2015



Source: Authors' calculations.

[10] See details in the scatter plots available at http://tools.foodsecurityportal.org/node/208/#dashboard

Figure 4 – Detailed observed pathways from undernourishment to overweight, 1990–2015



Source: Authors' calculations.

Note: Japan and the Republic of Korea are the countries in the bottom-left of the dots associated with the lowest level of both undernourishment and overweight in group 5.

To give a clearer illustration of trajectories over time, Figure 5 shows how FSN outcomes evolved in the case of six country cases – China, Colombia, Ethiopia, Kenya, as well as Japan and the Republic of Korea.

Ethiopia, starting with high levels of hunger (75 percent) in Type 1, has made great strides in reducing this problem over the 1990–2015 period without showing, as yet, much of a rise in overweight and obesity. Despite this progress, it still belonged to Type 1 by 2015, remaining among those countries with widespread hunger and child undernutrition.

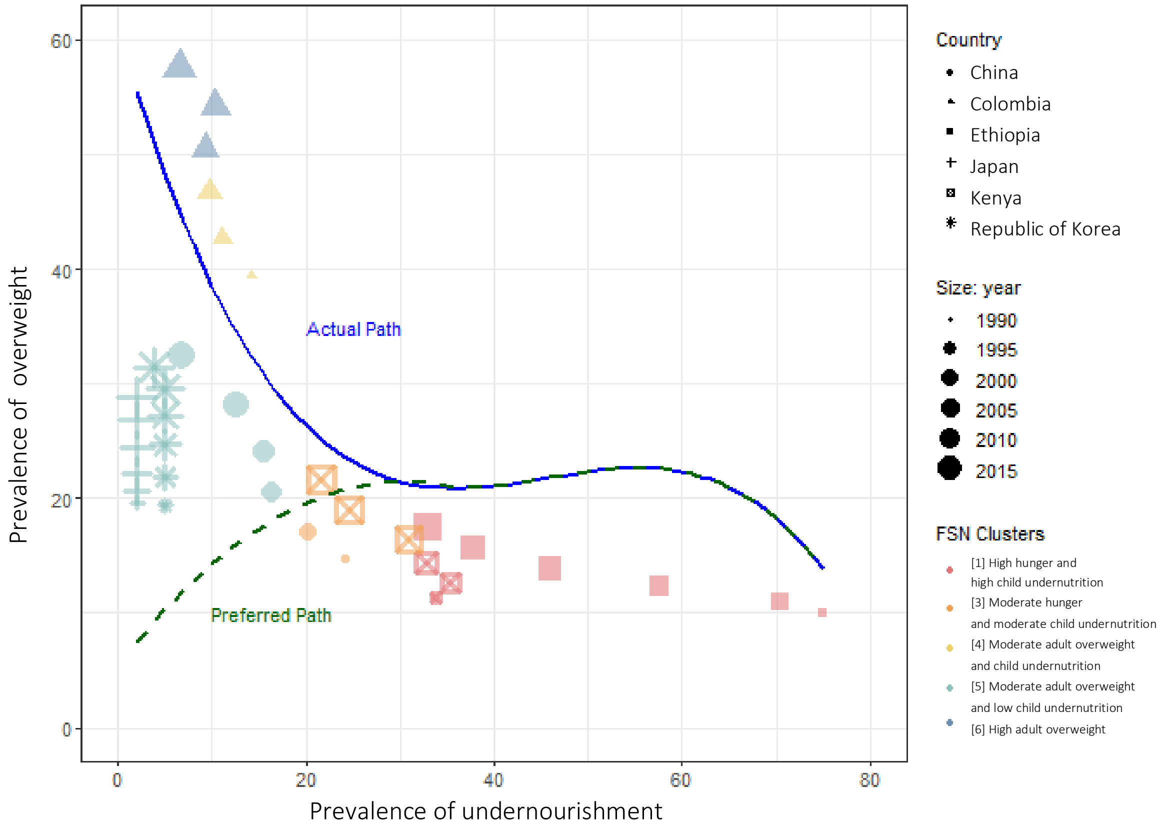
Kenya also belonged to Type 1 with high prevalence of undernourishment in 1990 but transitioned towards Type 3 as it had lowered hunger and child undernutrition levels to moderate levels, though already seeing rising prevalence of overweight by 2005.

China started in 1995 in Type 3 with moderate levels of hunger and child undernutrition. By 2000, it had transitioned to Type 5, having reduced undernutrition to low levels but seeing adult overweight and obesity having risen to moderate levels.

In 1990, Colombia belonged to Type 4 with already moderate prevalence of adult overweight but still moderate extent of child undernutrition. By 2005, the country had transitioned to Type 6, after having reduced child undernourishment to low levels, but seeing the prevalence of overweight increasing by almost 20 percentage points in fifteen years.

As mentioned above, Japan and the Republic of Korea are the only two countries in the sample which had already reached low to zero undernutrition by 1990, while showing low to moderate rates of adult overweight and obesity. Over the past twenty years, these countries did show an increase in the prevalence of overweight and obesity by ten points to reach around 30 percent of the adult population. While significant, this level remains low compared to other advanced economies where overweight and obesity affects between 45 and 70 percent of the adult population.

Figure 5 – Trajectory of nutrition transition in China, Colombia, Ethiopia, Kenya, Republic of Korea and Japan 1990–2015



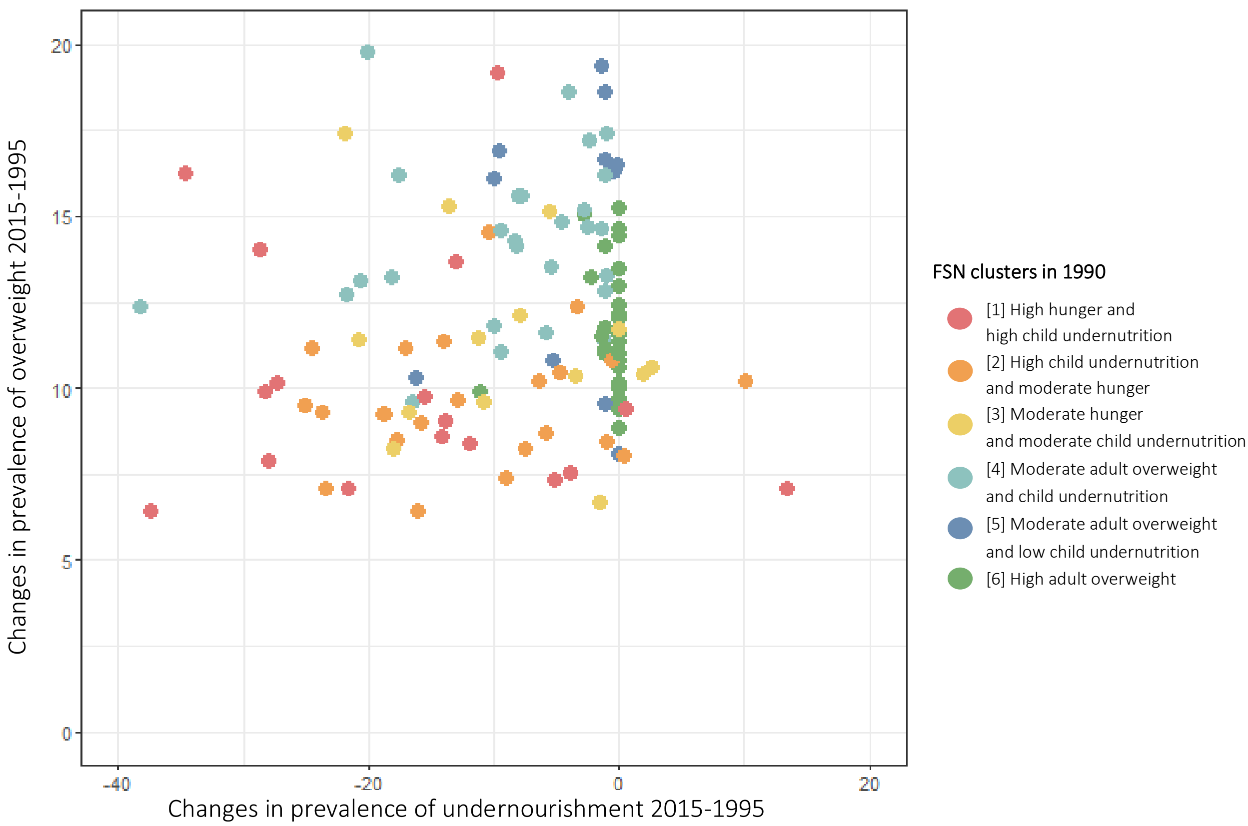
Source: Authors' calculations.

Note: interactive data allowing for tracking the evolution of other countries are available at http://tools.foodsecurityportal.org/node/208/#fsnMap

As shown in Figure 5, the trajectory of the prevalence of undernourishment and of adult overweight over the past 20 years confirms the earlier findings in that:

- Most countries belonging to Types 1 and 2 in 1995 managed to reduce the prevalence of undernourishment, though to varying degrees, without much increase in the prevalence of overweight; only North Korea, Zambia and Tajikistan experienced a rise in the prevalence of undernourishment.
- Countries with moderate adult overweight and child undernutrition (Type 4) in 1995, generally managed to reduce undernourishment, subsequently. However, they also witnessed steep rises in the prevalence of overweight and, as a result, moved either into Type 5 or Type 6. Likewise, most countries that were in Type 5 in 1995 saw significant increases in the rate of adult overweight.
- Very few countries belonging to Type 6 in 1995, having already high rates of adult overweight, managed to prevent further increases – most faced increases in the prevalence of overweight by ten percentage points or more.

Figure 6 – Changes, in percentage points, in the prevalence of undernourishment and adult overweight between 1995 and 2015 by FSN cluster in 2015



Source: Authors' calculations.

Finally, we used the cluster data to identify which countries have made most progress towards the goal of ending hunger and all forms of malnutrition. Table 2 identifies the countries that can be considered "good performers" in terms of shifting two stages or more in terms of the nutrition transition stages as identified by the six FSN types. Specifically, the progress is measured here in terms of moving from high to low levels of hunger and child undernutrition. Admittedly, this evolution is also associated with an increase in the prevalence of overweight and obesity and the notion of "progress" has to be interpreted in this context.

To raise awareness of this issue, in Table 2 we flag those countries that have seen a particularly strong increase in overweight during their transition. All countries that have strongly reduced hunger and undernutrition over the last twenty years have also seen increases of overweight by more than ten points. Increases in the Dominican Republic (+ 20 points) and in the North Africa and Near East regions have been notably strong.

Table 2 – Evolution in the FSN space: countries that progressed most towards ending hunger and child undernutrition

Period considered	Reduced hunger and child undernutrition to low levels	Group	Countries
Over last 5 years	Yes	non-FIRST Countries	Mongolia#; Namibia; Indonesia; Sri Lanka; Armenia; Ecuador; Ghana; Iraq; Peru; El Salvador
Over last 5 years	No	non-FIRST Countries	Zimbabwe; Mozambique; Tajikistan
Over last 10 years	Yes	non-FIRST Countries	Mongolia; Namibia; Indonesia; Sri Lanka; Albania; Armenia; Azerbaijan; Dominican Republic##; Ecuador; Egypt; Ghana; Iraq; Morocco; Panama; Peru; Paraguay; El Salvador; Turkmenistan; Venezuela (Bolivarian Republic of)*; South Africa
Over last 10 years	No	non-FIRST Countries	Zimbabwe ; Angola; Mozambique; Sierra Leone; Tadjikistan
Over last 10 years	No	FIRST Countries	Myanmar; Afghanistan
Over last 20 years	Yes	non-FIRST Countries	Mongolia###; Namibia; Botswana; Indonesia; Sri Lanka; Albania###; Armenia; Azerbaijan; China; Dominican Republic###; Algeria###; Ecuador; Egypt; Georgia; Ghana; Iran###; Iraq; Kazakhstan; Morocco###; Mexico; Mauritius; Panama; Peru; Paraguay; El Salvador; Thailand###; Turkmenistan; Turkey###; Venezuela (Bolivarian Republic of); South Africa
Over last 20 years	No	non-FIRST Countries	Cameroon; Nicaragua; Zimbabwe; Angola; Congo; Lesotho; Mozambique; Malawi; Sierra Leone
Over last 20 years	Yes	FIRST Countries	Colombia; Suriname
Over last 20 years	No	FIRST Countries	Kenya; Myanmar

Source: Authors' calculations.

Note: * Data for the Bolivarian Republic of Venezuela precede the more recent economic collapse and emerging food crisis in that country.

# indicates countries that have seen an increase in prevalence of overweight of four percent or more in the last five years,
indicates countries that have seen an increase in prevalence of overweight of eight percent or more in the last ten years,
indicates countries that have seen an increase in prevalence of overweight of 16 percent or more in the last 20 years.

With ten more years to go towards 2030, it is of interest to see which countries managed to make accelerated progress in ten years and managed to reach low (close to zero) prevalence of hunger and child undernutrition. According to the table below, twenty countries managed to do so over the past ten years (i.e., 2005–2015). No FIRST countries are among those "good performers", though two of them (Colombia and Suriname) did show accelerated progress to reach low undernourishment over a twenty-year period (1995–2015). Other FIRST countries, including Afghanistan, Myanmar and Kenya, showed accelerated progress in moving up at least two categories over the past ten or twenty years, but without yet reaching the key undernutrition targets.

Further detail on how countries have moved across the various types (clusters) of the nutrition transition can be found in Table 3. The country names marked in red include those that have not made much progress in reducing hunger and child undernutrition and/or did not manage to improve to a "higher" cluster over the past twenty years. The country names marked in blue, in contrast, may be considered as "good performers" in the sense of by end large eliminating hunger and child undernutrition, although most – as indicated – did see significant increases in the prevalence of overweight.

Table 3 – Country progress along nutrition transition types

Performance*	[1] High hunger and high child undernutrition	[2] High child undernutrition and moderate hunger	[3] Moderate hunger and child undernutrition	[4] Moderate adult overweight and child undernutrition	[5] Moderate adult overweight and low child undernutrition	[6] High adult overweight
-1	Democratic People's Republic of Korea					
0	Central African Republic; Ethiopia; Haiti; Liberia; Rwanda; United Republic of Tanzania; Zambia	Bangladesh; India; Madagascar; Chad; Timor-Leste; Yemen	Côte d'Ivoire; Gambia; Guinea-Bissau; Mauritania; Nepal; Philippines; Senegal; Tajikistan; Uganda	Bolivia (Plurinational State of); Guatemala; Honduras; Solomon Islands	Gabon; Japan; Republic of Korea; Malaysia	Not included: countries already belonging to Type 6 20 years ago
1		Djibouti	Afghanistan; Benin; Burkina Faso; Guinea; Cambodia; Lao; Mali; Niger; Nigeria; Pakistan; Togo; Vietnam	Guyana; Uzbekistan	Kyrgyzstan	Bosnia and Herzegovina; Brazil; Costa Rica; Fiji; Jamaica; Oman; Trinidad and Tobago; Tunisia
2			Angola; Congo; Kenya; Myanmar; Mozambique; Malawi; Sierra Leone	Lesotho	China; Ghana; Mauritius; Thailand	Albania; Armenia; Azerbaijan; Colombia; Dominican Republic; Algeria; Ecuador; Egypt; Georgia; Iran (Islamic Republic of); Iraq; Kazakhstan; Morocco; Mexico; Panama; Peru; Paraguay; El Salvador; Suriname; Turkmenistan; Turkey; Venezuela (Bolivarian Republic of); South Africa
3				Cameroon; Nicaragua; Zimbabwe	Botswana; Indonesia; Sri Lanka	
4					Namibia	
5						Mongolia

Source: Authors' calculations.

Notes: * Performance indicates the progress in terms of upward shifts across FSN clusters between 1995 and 2015.

** Data for the Bolivarian Republic of Venezuela precede the more recent economic collapse and emerging food crisis in that country.

3 Structural clusters

In an extensive review of the literature and evidence, Timmer (1998, 2014) identifies improvements in food security to follow different stages of transformation of agriculture and economies at large. Timmer's review highlights the vital, and precarious, period of structural transformation, when agriculture represents a declining share of the economy and labour moves to the cities. Historically, successful structural transformation has been the only sustainable pathway out of poverty, as labour productivity in the agricultural and non-agricultural sectors converges.

Timmer warns, however, that there are other possible outcomes, and that states should be wary of them. Much of Asia, he argues, may be heading into an inequality trap, where the income gap between the two sectors increases, leaving many in rural areas in conditions of food insecurity and undernutrition.

In sub-Saharan Africa, agriculture is dominated by ever smaller farms, further reducing the prospects for productivity increases. In these trying environments, targeted interventions by governments to improve access to food for poor households will not be enough, if they do not manage at the same time to improve the functioning of markets, resulting in greater investments in agriculture and more efficient use and allocation of resources in food systems.

Following Timmer, Laborde *et al.* (2018) identify six phases of agricultural transformation, based on a similar approach as that of the present study. The six phases range from an initial predominance of low-productivity subsistence agriculture with most people in society directly dependent on agriculture to industrialized economies with high productivity agriculture and with very few workers active in primary food production (see Box 1). Laborde *et al*. show that countries have taken different pathways of agricultural transformations as part of efforts to reach higher levels of economic development. These pathways are associated with different outcomes in terms of income growth, food security and inequality.

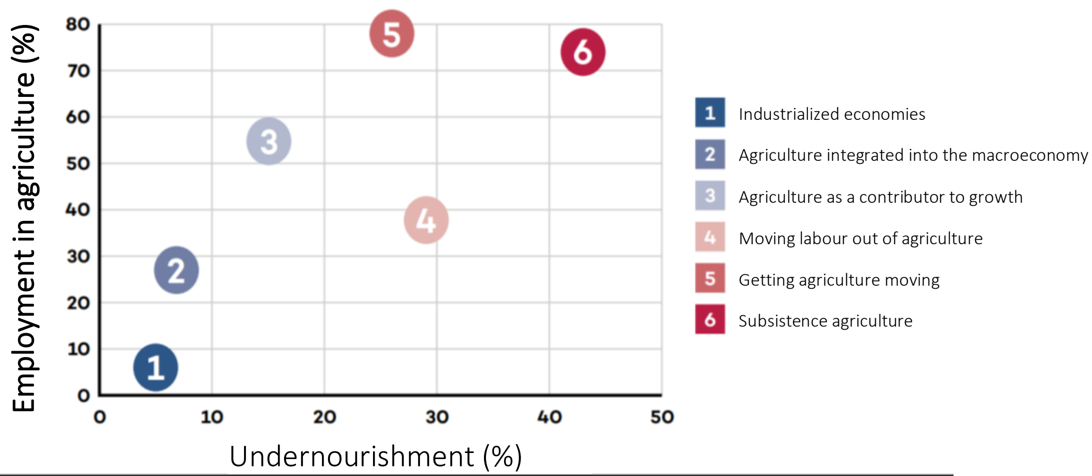
Table 4 shows how the country typology by FSN outcomes corresponds to the six agricultural transformation phases from the Laborde *et al*. study. It broadly confirms the correspondence between the stage of agricultural transformation and the progress made towards the goal of ending hunger. At the same time, countries in more advanced stages of agricultural transformation also face higher prevalence of overweight and obesity, as found in other studies which associate this form of malnutrition with dietary preferences in more urbanized societies with higher incomes and more industrialized food systems (Vos and Bellù, 2019). There are also numerous countries that are off the diagonal in Table 4, suggesting there is no linear relationship between agricultural transformation processes and nutrition outcomes. Hence, it is useful to dig deeper into the structural drivers of food security and nutrition.

BOX 1 – Stages of agricultural transformation

The agricultural transformation framework was developed by Peter Timmer (1988). It assesses the level of inclusive agricultural transformation by using data on the prevalence of undernourishment and the share of agricultural employment. Laborde *et al*. (2018) test this framework empirically with updated data and identify six non-linear phases of agricultural transformation, moving mostly from stage 6 to stage 1:

6. Subsistence agriculture: Stage 6 is the least advanced stage. Farmers consume most of what they produce, agricultural productivity is low, and agriculture is by far the main source of employment in the economy;
5. Getting agriculture moving: Stage 5 is characterized by agrarian economies where agriculture remains the dominant source of employment, but agricultural productivity is rising, allowing for broader economic growth, poverty reduction and improvements in nutritional status of the population;
4. Labour moving out of agriculture: Stage 4 represents non-inclusive structural transformation where labour is shifting into higher productivity sectors, while agricultural productivity is lagging and, hence, (rural-urban) inequality is increasing;
3. Agriculture as a contributor to growth: Stage 3 is characterized by more dynamic agriculture and expanding non-farm rural employment, which in turn are providing a basis for economy-wide, non-agricultural growth, poverty reduction and reductions in hunger and undernutrition;
2. Agriculture integrated in the macro economy: Stage 2 represents those countries which have achieved large agricultural productivity gains, whose agricultural sectors have strong linkages with industrial and service sectors and still absorb a significant but not dominant share of employment. These countries typically have reduced undernourishment to low levels;
1. Industrialized economies: Stage 1 is where countries have reach high-levels of per capita income, agriculture is highly productive but only represents very low shares in GDP and employment, most of the population lives in cities, poverty and hunger are by and large eradicated (though other forms of malnutrition, like obesity, may be on the rise).

Laborde *et al*. confirm that countries have tended to solve their problems of undernourishment as they managed to make agriculture more productive and move labour into non-agricultural employment, as shown graphically in the figure below.



Source*:* Laborde *et al*. (2018)

Table 4 – A 6x6 Mapping: Six agricultural transformations and six types of food security and nutrition clusters. Number of countries

FSN CLUSTERS	1. Industrialized economy	2. Agriculture integrated in the economy	3. Agriculture as a contributor to growth	4. Moving labour out of agriculture	5. Getting agriculture moving	6. Subsistence farming
[6] High adult overweight	86	25	1	2		
[5] Moderate adult overweight and low child undernutrition	10	10	2	3		
[4] Moderate adult overweight and child undernutrition	4	13	7	8	1	
[3] Moderate hunger and child undernutrition		8	16	9	11	
[2] High child undernutrition and moderate hunger			6	6	6	7
[1] High hunger and high child undernutrition				4	5	18

Source: Authors computation based on Laborde *et al*. (2018)

Therefore, the second cluster analysis aims to provide a description of the initial structural conditions within which FSN strategies will need to be defined. While specific to each country, a cross-country comparison of such conditions can help us understand better the forces driving differences in FSN outcomes and the pace of progress towards SDG2. Since we include human-made elements like institutions and demographics, as well as biophysical and geographical elements, it is difficult to decide what should be included as a structural condition and what as a factor or option in the policy space. We discuss this issue further in the next section. The cluster analysis suggests five country types, representing a variation on the phases of the agricultural transformation typology. Table 5 provides the descriptive statistics for each cluster and key indicator.

Type A is mainly composed of advanced economies, which have passed the demographic transition to very low birth rates, have a low share of agricultural GDP, and have very high levels of agricultural land and labour productivity. Countries in this cluster typically have saturated their extensive margins of agricultural development, showing low land availability per capita. Their institutions are strong, as reflected in low levels of the indicators for corruption and political instability.

Type B consists of slightly less advanced economies, with relatively low dependence on agriculture and with improved food availability achieved through agricultural intensification and productivity growth. The quality of institutions is moderate.

Type C consists of countries with relative land abundance and high dependence on natural resources, including in metals and minerals. Non-agricultural commodity dependence defines much of the wealth and structural transformation in these economies. Corruption tends to be high, but fiscal space created by natural resource wealth appears to support relative political stability.

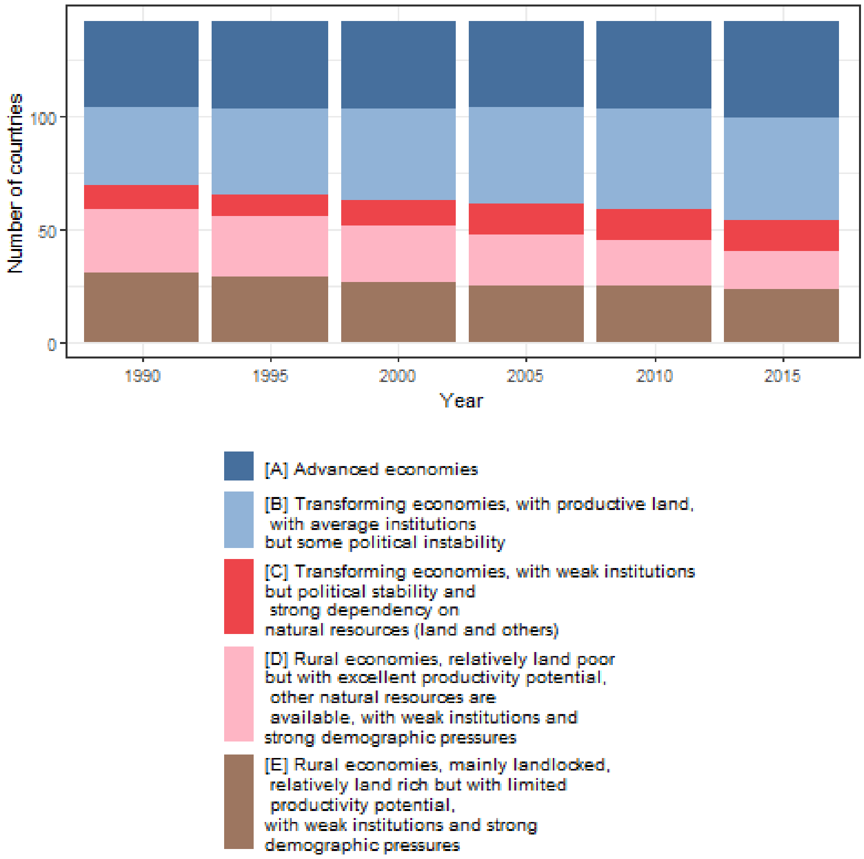
Table 5 – Structural drivers of FSN: descriptive statistics (median value) for key indicators across 5 clusters

Code	Description	[A] Advanced economies	[B] Transforming economies, with productive land, with average institutions but some political instability	[C] Transforming economies, with weak institutions but political stability and strong dependency on natural resources (land and others)	[D] Rural economies, relatively land poor but with excellent productivity potential, other natural resources are available, with weak institutions and strong demographic pressures	[E] Rural economies, mainly landlocked, relatively land rich but with limited productivity potential, with weak institutions and strong demographic pressures
LNCAP	Agricultural land per capita	0.39	0.53	3.90	0.65	1.06
SUITAB	Potential land productivity	803	963	360	1,813	926
AGVDW	Agriculture value added per worker	33,190	8,161	9,396	2,480	2,066
YIELD	Cereal yield	4,948	2,755	1,087	1,441	1,494
AGGDP	Agriculture, forestry and fishing, value added	2.52	9.79	7.49	27.35	28.77
NARSD	Dependency to natural resources (primary commodity exports to GDP)	1.92	2.52	34.50	4.40	0.93
LANDL	Landlocked country	0	0	0	0	1
CCORP	Control of corruption	86.00	41.31	21.03	23.75	26.55
PSIND	Political stability index	78.00	31.04	41.44	26.60	31.12
PGRWT	Population growth (birth rate)	11.78	20.58	29.92	39.20	34.93

Source: Authors' computation. See Appendix 7.2 for a detailed description of indicators, units of measurement and data sources.

Types D and **E** include the least advanced countries. They are still predominantly agrarian societies with high population growth and very weak institutions. The **Type E** is largely composed of low-income landlocked countries with still some potential for agricultural development at the extensive margin but constrained by relatively poor agro-ecological conditions and high transaction cost to trade. **Type D**, in contrast, consists of countries facing land scarcity, but having generally better agro-ecological conditions and trading options than Type E.

Figure 7 – Evolution of the number of countries per cluster of structural conditions (number of countries)



Source: Authors' computation

While defined as structural variables, the related conditions are not static and do change over time. Accordingly, countries have shifted from one cluster to the next depending on the processes of structural transformation.

Changes in the composition of the clusters over time are shown in several structural features are foremost time invariant, such as landlocked status or biophysical agricultural potential.[11]

Most other variables, however, are time variant, being linked to demographic transitions, economic diversification, improvement or deterioration of institutions, and conflicts clearly shows that the number of rural economies (clusters D and E) has fallen significantly (by one third) between 1995 and 2015.

This has happened at different speeds according to country. Unsurprisingly, the decline has been rapid among the rural economies with a good agricultural potential for intensification and potential for trade

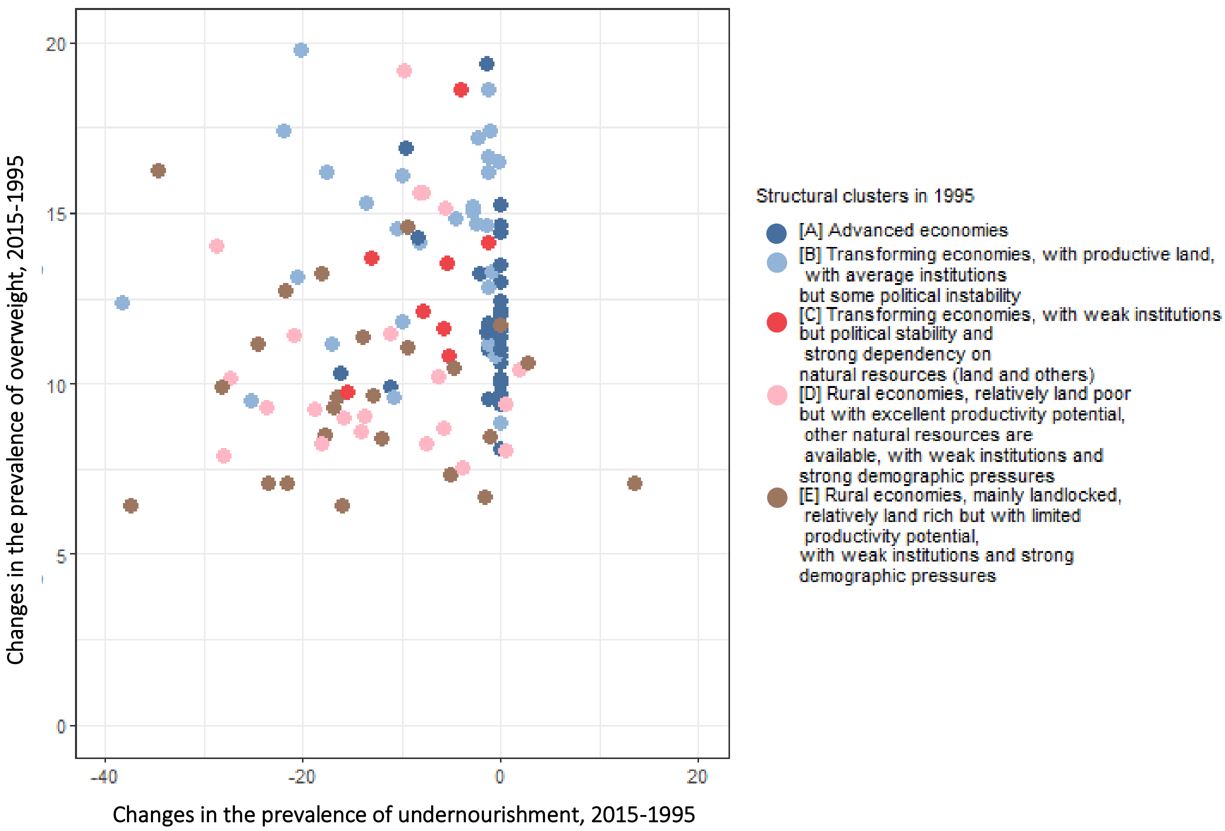
11 Of course, also the constraints related to such conditions can be lifted, e.g., through improvements in transborder infrastructure or new agricultural technologies.

(Type D), which has facilitated economic diversification, including through export-oriented strategies. Fewer countries have moved out of Type E, which consists of landlocked countries with poor agricultural potential and weak integration into regional and global value chains. Among countries moving out of Type E, a few have progressed towards Type C, but most have become part of Type B.

Few of the FIRST countries managed the degree of structural transformation required to shift between clusters. Myanmar and Honduras are among the few making such a shift, as they moved from Type D to Type B. The structural transformation of their economies facilitated income growth and helped improve FSN. Other FIRST countries have remained in the same cluster – either D or E – throughout the 1995–2015 period.

Figure 7 above shows the change in the prevalence of undernourishment and that in adult overweight between 1995 and 2015 by countries and their cluster position in 1995. As expected, it shows that the more advanced and transforming countries (Types A and B) tended to show increases in the prevalence of adult overweight, while maintaining low to zero rates of hunger and undernutrition. For the other structural clusters (C, D, and E), the figure shows a rather dispersed pattern of rates of reduction in undernutrition and increase in adult overweight, which could suggest that the impact of structural conditions is strongly mediated through policy.

Figure 8 – Changes in the prevalence of undernourishment and adult overweight between 1995 and 2015 by structural conditions in 1995



Source: Authors' computation.

4 Policy space

A cluster analysis of FSN policy interventions may help identify the extent to which government action has differed across countries and over time and how such differences are associated with differences in FSN outcomes. It should be emphasized once again that this remains an exploratory analysis and that the methodology deployed here does not allow for inference of any causal relationship.

Based on the analysis of the four selected policy variables (see Section 1.4), we classify countries into six types of policy cluster. The descriptive statistics (median) of each variable, and the results of the cluster analysis are shown in Table 6.

Table 6 – Policy variables: descriptive statistics (median value) for 5 policy clusters

Variable	Description	[α] Good infrastructure, average farm support, low tariffs	[β] Strong infrastructure, large farm support, average tariffs	[δ] Good infrastructure, average farm support, very high tariffs (♀)	[γ] Good infrastructure, average farm support, high tariffs	[κ] Strong infrastructure, very large farm support, average tariffs	[ω] Weak infrastructure, limited farm support, average tariffs (♀)
AGEXP	Percentage of public expenditure in agriculture GDP	5.00	18.99	7.13	8.36	36.79	3.51
ELRUR	Access to electricity, rural (% of rural population)	97	100	82	97	100	7
MFNAG	Agricultural tariffs (simple average, MFN, %)	10.28	14.52	50.68	20.30	16.54	15.67
TEGPI	Gender parity index in tertiary school enrolment	1.29	1.38	0.69	1.00	1.15	0.47

Source: Authors' computation

Note: (♀) indicates groups where gender policy outcome (gender parity in education) has a low score.

The six groups can be described as follows:

- **Type [α]** includes many large agricultural exporters (both among developed and developing countries in 2015) whose policies have been characterized by moderate public support and low tariffs. It is the level of protection of the agricultural sector that differentiates this group from the next:

- **Type [γ]** which has much higher tariffs and is currently (2015) comprised of several large middle-income countries, including India, Bangladesh and Mexico.
- **Type [β]** also shows, on average, a slightly higher degree of agricultural protection than Type [α], but countries in this type provided much stronger support to the agricultural sector through public spending allocations and investments in rural infrastructure, rather than through tariff protection. This group included most countries in Western Europe and China in 2015.
- **Type [κ]** includes countries where agriculture is heavily subsidized, such as in Japan, the Republic of Korea and some European countries.
- **Type [δ]** includes countries with relatively high tariffs on agricultural products but which provide limited farm support and already have broad, though still incomplete, coverage of rural infrastructure. Gender disparity was still great in this cluster. Over time, this type included India (though it migrated to Type [γ] in 2005), most countries in northern African and the Middle East, and Bhutan.
- Finally, **Type [ω]** includes most sub-Saharan African countries and least developed countries in Asia, such as Afghanistan. They are more protectionist than average, have invested relatively little in agriculture, have insufficient rural infrastructure, and still have large gender disparity.

Table 7 and Figure 9 show shifts in the size of the clusters, reflecting significant shifts in policy stances by countries over time. Mostly, shifts have been from Type [γ] to Type [α], reflecting significant lowering of tariffs on agricultural products. Seventeen countries made this shift over the past 25 years.

A second set of countries (14) increased farm support (both subsidies and import tariffs) and stepped up public investment in rural infrastructure, thus moving into Type [β]. A smaller number of countries (10) moved from cluster [γ] to [β], as they invested further in rural infrastructure, increased direct support to farmers, but reduced agricultural protection. Seven countries shifted from Type [δ] to Type [γ] after partially liberalizing agricultural trade, while eight countries increased protection and shifted from Type [α] to Type [γ].

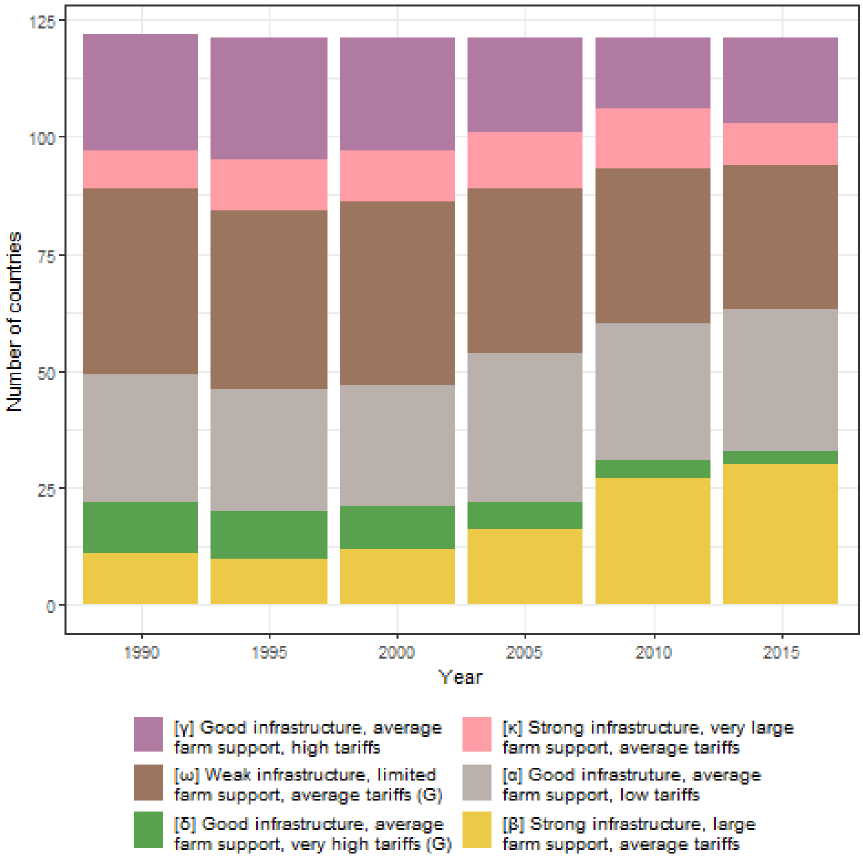
Table 7 – Shifts in policy stance (cluster) between 1990 (row) and 2015 (column) (number of countries)

From -> To	[α] Good infrastructure, average farm support, low tariffs	[β] Strong infrastructure, large farm support, average tariffs	[δ] Good infrastructure, average farm support, very high tariffs (♀)	[γ] Good infrastructure, average farm support, high tariffs	[κ] Strong infrastructure, very large farm support, average tariffs	[ω] Weak infrastructure, limited farm support, average tariffs (♀)
[α] Good infrastructure, average farm support, low tariffs	118	14	NA	8	NA	NA
[β] Strong infrastructure, large farm support, average tariffs	4	55	1	7	8	1
[δ] Good infrastructure, average farm support, very high tariffs (♀)	1	2	26	7	1	3
[γ] Good infrastructure, average farm support, high tariffs	17	10	3	76	4	NA
[κ] Strong infrastructure, very large farm support, average tariffs	NA	12	NA	NA	43	NA
[ω] Weak infrastructure, limited farm support, average tariffs (♀)	3	2	2	5	NA	172

Source: Authors' computation.

Note: (♀) indicates cluster with gender biases.

Figure 9 – Evolution of the size of policy clusters between 1990 and 2015 (number of countries)



Source: Authors' computation

5 Multi-dimensional analysis

Recent studies (Timmer, 2014; Laborde *et al*., 2018; Vos, 2018, 2019) conclude that policies have had a strong impact on the nature of agricultural transformation processes and, hence, also on FSN outcomes. Institutional reforms (e.g., in land tenure and lifting of public control of agricultural markets), agricultural trade policies, input and output price incentives, and investments in rural infrastructure have been instrumental in driving transformation processes. Yet, their importance and impact not only seem to differ widely across contexts but are also difficult to pin down in quantitative cross-country assessments. For instance, input subsidies may not have the same impact in countries with good infrastructure and access to markets for farmers as in the place where such conditions are less favourable. Likewise, pro-diversification trade policy may succeed in one context, but fail elsewhere if not properly accounting for the production potential.

Because determinants of food insecurity and different forms of malnutrition are context-specific and further influenced by household-level intrinsic factors, few studies exist that try to understand the determinants from cross-country studies and national averages, rather than through household or demographic and health survey data. The studies by Smith and Haddad (2000, 2015) are among the few taking the cross-country approach. Their more recent application uses data for 116 countries to estimate factors determining child stunting. Smith and Haddad (2015) find that that safe water access, sanitation, women's education, gender equality, and the quantity and quality of food available in countries have been key drivers of past reductions in stunting. They identify income growth and the quality of governance as additional factors.

Most explanatory variables used in the study by Smith and Haddad were also part of the larger set used for arriving at the FSN-related structural and policy typologies for the present study. However, as discussed in Section 1, not all were used to obtain those typologies – we found strong correlation among many of the factors influencing food security and nutrition outcomes. The existence of strong co-variance among determinants poses severe problems of specification and identification (*which are the true determinants?)* for econometric models that try to include all such variables in the same equation.

For the present exercise, we want to be both more ambitious and more modest. On the one hand, we are looking at four dimensions (undernourishment, child stunting and wasting, and overnutrition), rather than one dimension only. On the other hand, the objective of the present study is not to obtain rigorous answers to what determines food insecurity and malnutrition in all its forms and recommend specific policies on that basis. Rather, the clustering of countries by FSN outcomes, structural conditions, and policy effort is part of an exploratory assessment to identify how countries have progressed in terms of reducing hunger and all forms of malnutrition and which condition factors and policy efforts have been associated with that progress. It should also help position countries against the experience of others with either similar initial structural conditions or policy efforts. This then could point at directions for countries to take in addressing remaining food security and nutrition challenges.

We will use the three typologies – by FSN outcomes, policy space, and structural context – to further explore from a cross-country perspective what policy combinations seem to have been most effective in improving FSN outcomes, given structural conditions of countries. We emphasize that this is an exploratory analysis; the methodology deployed here does not allow for causal inference.

The assessment could be undertaken in a number of ways. For the purposes of the present analysis we will undertake three types of exploratory data analyses:

- First, we show the simple association between the policy clusters and FSN performance (in terms of reductions in undernourishment) across all countries in the sample.
- Second, we show simple correlates for each type of policy intervention and the degree of success in reducing undernourishment.
- Third, we try to identify where the FIRST countries stand in terms of the policy spectrum and compare those with "good FSN performers" with similar initial structural conditions of the FIRST countries.

5.1 Food security and nutrition outcomes and policy typology

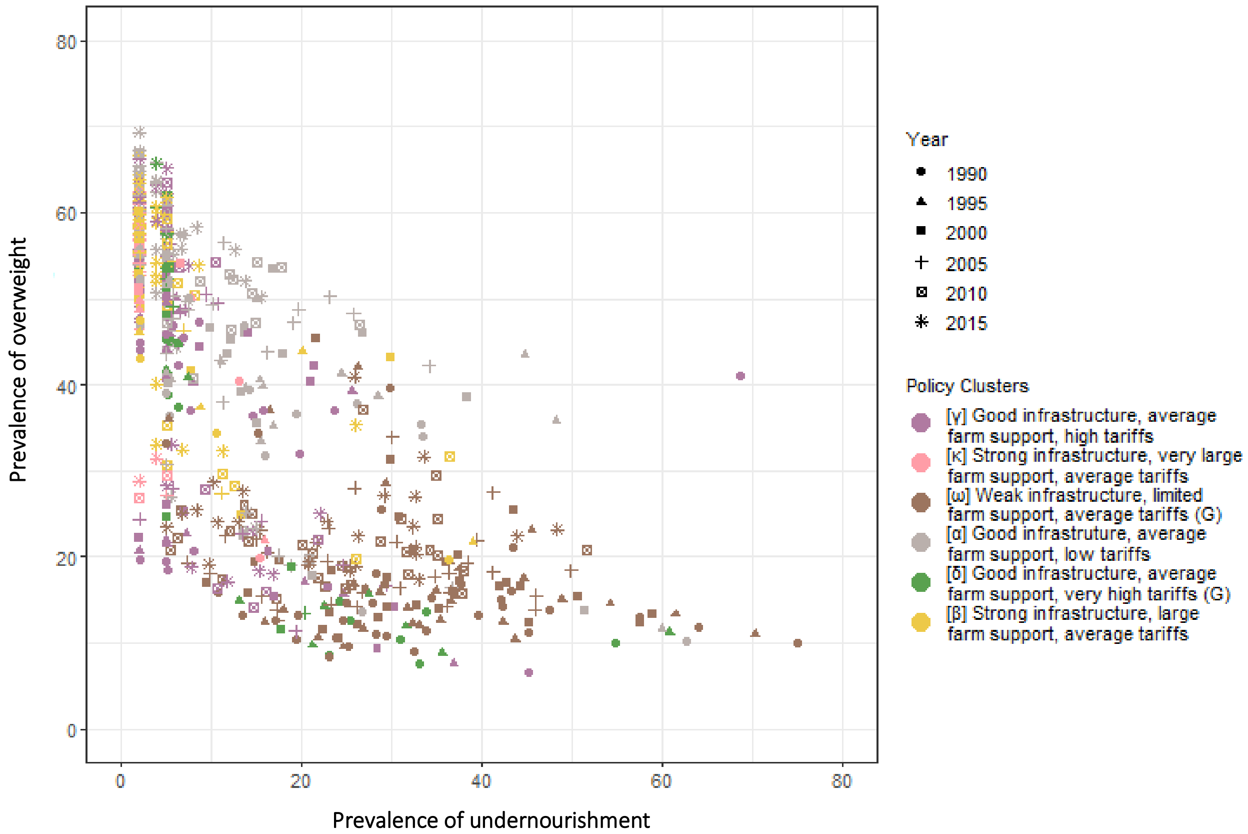
Figure 10 below shows a simple comparison for all countries between the prevalence of undernourishment and the prevalence of overweight, on the one hand, and the FSN policy stance (and changes therein), on the other. It clearly shows that – though also making progress – the countries in policy cluster [ω] and to a lesser extent those in Groups [δ] and [κ] continue to have the highest levels of undernourishment. Policy cluster [ω] has low investment in rural infrastructure, limited direct farm support, average protection of agriculture and wide gender disparities. Good performers in terms of lower rates of undernutrition have followed both more and less protective agricultural trade policies, though all have good to very good infrastructure and greater gender parity.

NOTE: Please bear in mind that, as mentioned before, the policy typology is mostly relevant to identify efforts at reducing food energy deficits (hunger) and child undernutrition, as we lack identifiers for policy efforts directed at reducing overweight and obesity.

5.2 Univariate correlations of hunger and child undernutrition reduction and policies

To obtain a more precise understanding of how specific policies (and changes therein) are correlated with FSN performance, we undertook two types of assessment. The first looks at progress in reducing hunger and child undernutrition in terms of whether a country has shifted towards FSN clusters with low(er) rates of hunger and child undernutrition, but also towards those with higher rates of adult overweight. As such this looks at the associated between policies and changes in FSN as a multi-dimensional phenomenon. The second assessment is more like that of Smith and Haddad (2015), looking at the association between individual policy variables and the degree of malnutrition on each dimension separately. It differs from Smith and Haddad (2015) in that we only look at univariate associations (one by one correlations) rather than at how multiple factors may explain malnutrition.

Figure 10 – Policy stance and FSN performance over time, 1990–2015



Source: Authors' calculations.

Policy factors associated with movements across FSN clusters

In Section 2, we identified six clusters of types of FSN outcome. Type one comprises countries with the highest hunger and child undernourishment and lowest overweight and obesity. At the other end of the spectrum, Type 6 comprises countries with (near) zero hunger and child undernutrition, but highest degrees of overweight and obesity. In the assessment here we wish to focus only on performance in terms of reducing undernourishment. Hence, we define "progress" in terms of moving up clusters in the typology from 1 to 6. Accordingly, we define two types of dependent variables for the progress made in reducing hunger and undernutrition: (a) when a country has moved up two clusters or more ("progress in reducing hunger") and (b) when a country has moved up at least two levels and belonged to clusters 5 or 6 in 2015 (or earlier) ("success in eradicating hunger"). As said, in doing so, we ignore poor performance on the other dimension of malnutrition (i.e., increases in the prevalence of adult overweight).

In the logit regression findings reported below, policies are assessed one by one, using values for each policy instrument for 2005 (mid period) and 2015 (end period), as well as the change in the policy stance between 1995 and 2015. The main findings are summarized in Table 8. We emphasize again, the findings refer to correlations and should not be read as an indication of policy effectiveness.

Some of the key findings from this exploratory analysis are:

- More spending on agricultural R&D is strongly correlated with lower rates of undernourishment and greater progress towards the end hunger goal.
- Governments with greater centralization of budget allocation in 2015 also show better FSN performance.
- In the mid-2000s, greater farm support (public spending on agriculture) showed a positive association with better FSN performance and improvement.
- The degree of agricultural protection (as measured through tariff levels) does not show any clear correlation with FSN performance.
- Greater public spending on education and health is positively correlated with better FSN performance, though the effect seems to have lost significance after 2005, possibly because of decreasing returns for FSN of such investments once higher levels of human development have been achieved.
- Improved coverage of basic services and infrastructure in rural area (drinking water, sanitation and electricity) is positively correlated with low levels of undernourishment and the progress towards the end hunger goal.

In the appendix (Figures A.2, A.4 and A.6) we have also correlation across policy variables that can explain some results.

As a third step in this part of the analysis, we identify the position of the FIRST countries in the two-dimensional space of the FSN and policy clusters in 2015. This is shown in Table 9.

It appears there is a clear dichotomy among countries. At one end of the spectrum, we see the FIRST countries in sub-Saharan Africa (plus Afghanistan) (in red), which continue to face moderate to severe hunger and child undernutrition and have shown weak capacity (and/or effort) in providing significant support to agricultural production and rural infrastructure development and failed to substantially reduce gender inequalities (policy cluster [ω]). At the other end of the spectrum, we have middle-income countries that undertook more active policies befitting policy cluster [α] (in green). Three of these countries do face rising adult overweight (Colombia, Guatemala, Kyrgyzstan), while others (Myanmar, Pakistan) still have significant levels of hunger and child undernutrition to address.

For the sake of illustration, we will consider that countries are successful if they have managed to go up <u>two</u> steps (definition of "success" in the preceding analysis) in our FSN scale in the last 20 years, even if it means that they also increase their exposure to overweight.

Forty-four countries have achieved this goal, of which three belong to the list of FIRST countries (Fiji, Suriname and Colombia). It should be noted that some of these successful countries are countries that have rebounded from severe deterioration in food insecurity and child undernutrition as a result of economic collapse or episodes of conflict.

Table 8 – Policy effort and FSN performance: a simple regression approach

Domain		Explanatory Variables	"Progress in reducing hunger" 2005	2015	Changes	"Success in ending hunger" 2005	2015	Changes
Decentralization	REVDC	Revenue centralization	-0.19 NS N=12	0.83* N=23	NA	-0.19 NS N=12	0.4 NS N=23	NA
	TAXDC	Tax revenue centralization	-0.31 NS N=12	0.15 NS N=23	NA	-0.31 NS N=12	-0.33 NS N=23	NA
Farm policies (a)	AGEXP	Percentage of agriculture expenditure	0.04** N=64	NA	NA	0.03** N=64	NA	NA
	AGORN	Agricultural Orientation Index	0.5** N=45	0.22 NS N=50	NA	0.57** N=45	0.37* N=50	NA
	AGREX	Government agricultural expenditures	0.27*** N=12	0.00 NS N=26	NA	0.16** N=12	NS N=26	NA
	NRAAG	Nominal rate of assistance	0.69 NS N=36	NA	NA	1.10* N=36	NA	NA
	POPAG	Per capita agriculture expenditure	0.01*** N=65	NA	NA	0.01*** N=65	NA	NA
Farm policies (b)	MFNAG	Agricultural tariffs (simple average, MFN)	0.00 NS N=81	NS N=81	0.00 NS N=56	0.01 NS N=81	0.00 NS N=81	0.0 NS N=56
	NRPAG	Nominal rate of protection	0.00 NS N=31	0.00 NS N=29	NA	0.01** N=31	0 NS N=29	NA
Gender policies	TEGPI	School enrolment, tertiary (gross), gender parity index (GPI)	2.03*** N=71	2.07*** N=68	-2.73*** N=45	1.82*** N=71	1.94*** N=68	-2.21*** N=45
Human capital	EDGDP	Percentage of education expenditure	1.23*** N=71	1.23*** N=69	-1.83*** N=45	1.13*** N=71	1.22*** N=69	-1.74*** N=45
	HLGDP	Percentage of health expenditure	0.56*** N=67	0.77*** N=66	0.00 NS N=43	0.58*** N=67	0.78*** N=66	0.08 NS N=43
	SPGDP	Percentage of social protection expenditure	0.05* N=52	NA	NA	0.02 NS N=52	NA	NA

Note: Next to the estimated coefficient, we indicate the degree of statistical significance: NS = statistically non-significant, * = significant at 10%, ** = significant at 5%, *** = significant at 1%. NA = not enough observations for estimation. Each cell also indicates the number of countries (N) included in the estimation.

Table 9 – FIRST countries in by policy type and FSN outcome type in 2015

FNS cluster	[α] Good infrastructure, average farm support, low tariffs	[γ] Good infrastructure, average farm support, high tariffs	[ω] Weak infrastructure, limited farm support, average tariffs (♀)
[1] High hunger			Ethiopia; Liberia; United Republic of Tanzania
[2] Moderate hunger but high child undernutrition			
[3] Moderate hunger and child undernutrition	Myanmar	Pakistan	Afghanistan; Burkina Faso; Côte d'Ivoire; Kenya; Niger; Uganda
[4] Moderate adult overweight and child undernutrition	Guatemala		
[5] Moderate adult overweight and low child undernutrition	Kyrgyzstan		
[6] High adult overweight	Colombia	Fiji	

Source: Authors' computation. Results are shown only for FIRST countries with sufficient data and that could be included in the cluster analysis.

5.3 Policy changes associated with changes in FSN outcomes

In the second part of The previous assessment identified "progress" using the typology framework: identifying the drivers impacting the probability of countries evolving across the FSN clusters identified. These clusters are multidimensional by nature and do not allow tracking of countries' performances on specific dimensions or if they remain within a cluster. The cluster approach aims to organize data points around the centroid of each group, and does not aim to measure the distance, or progress, *vis-à-vis* of a given threshold, defined normatively or positively.

In this sub-section, we assess the relation between our 21 policy variables, including those that were dropped from the list of policy indicators used eventually to derive the various policy types. We correlate each with the four FSN indicators, respectively, the prevalence of undernourishment, child stunting, child wasting and adult overweight.

Several specifications for the variables were tested to avoid drawing erroneous conclusions from the way the indicators are specified. For reasons explained in Appendix 7.4, we only present here the results for a specification in which we have transformed all variables logarithmically and then identify the correlations between the changes (log differences). Hence, we try to understand how changes in the food security and nutrition indicators are associated with changes in the policy variables. This type of specification, we believe, is most likely to avoid spurious correlations, e.g., because of co-integration of the data series used here after undertaking a partial log transformation. Table 9 shows the findings in a specification that does not control for so-called fixed effects, such as initial levels of undernourishment or overweight and the structural conditions that form part of the typology approach. Appendix 7.4 shows the findings for the fixed effects; we only refer to how those influence the estimates without fixed effects as reported in Table 10.

Summarizing the findings, the following are the salient ones:

- Only few individual policy variables by themselves seem to impact directly on reductions in the prevalence of undernourishment (PoU) or those for child wasting and stunting. Those include increases in (per capita) agriculture expenditures (on PoU, child stunting and wasting), in agricultural R&D (PoU), in access to safe drinking water and sanitation (PoU), in access to electricity (child wasting), and in social protection (child wasting). All of these are expected impacts.[12] The lack of statistical significance for all other policy variables does not mean they are not relevant; they likely are, but most likely have either an indirect influence on the undernutrition indicators or their significance depends on synergy (coherence) with other policies and structural conditions.

- An additional finding is that fiscal decentralization seems to help reduce the prevalence of undernourishment, though it seems to increase the probability of child wasting.[13] The finding should be interpreted with caution as the effectiveness of more or less decentralized revenue collection and allocation of resources likely is context specific. One possible explanation for the contradictory impact on undernourishment and child wasting could be that reducing undernourishment can be helped by programmes addressing local needs, while nationally coordinated programmes could be more effective in tackling acute child undernutrition. This is speculative and requires further assessment.

- Possibly the most interesting finding in Table 10 is that most of the variables that one would expect to contribute to reducing hunger and child undernutrition, at the same time appear to be drivers of the prevalence of overweight. Overweight and obesity seem to increase with higher agricultural spending, nominal rate of support, basic rural infrastructure (electricity, sanitation), but – remarkably – also with greater school enrolment and gender parity in education. The prevalence of overweight seems to decline with increases in social protection and health spending (or, possibly, health expenditures decline with lower overweight). Lower overweight is also associated with lower agricultural tariffs. As discussed earlier, none of the selected policy variables can be seen as efforts to – directly or indirectly – address problems of overweight and obesity. Rather, they typically are designed for dealing with food insecurity and undernutrition and promoting economic development more in general. It is likely therefore that the findings could be interpreted in the following way: they contribute to higher incomes, which in turn spur shifts in diets towards high intake of animal-sourced and processed foods, associated with increases in overweight. If true, the finding that policies seen to help reduce hunger

[12] The findings are broadly consistent with those of Smith and Haddad (2015), though they are not strictly comparable, not only because those authors only consider child stunting, but also because they estimate a multivariate model including multiple explanatory variables. For reasons explained earlier, we do not pursue that type of assessment as our purpose is different and as specifications such as in Smith and Haddad can be haphazard because of the degree of interdependence between what – from an econometric point of view – should be "independent" variables.

[13] Please note that in the data set, the degree of (tax) revenue decentralization is captured by the share of central government (tax) revenue in total (tax) revenue. Hence, a positive sign in the regression means more fiscal centralization would be associated with higher undernourishment, and vice versa.

and child stunting and wasting are contributing to higher overweight and obesity is as interesting as it is worrisome. It suggests countries will need to find a different mix of policies that can deal with the increasingly pressing trade-offs between efforts at reducing undernutrition and overweight.

These findings represent averages for the entire sample of countries. Estimations controlling for fixed effects (see Appendix 7.4) suggest that the degree of influence of each of the policy variables differs both by structural characteristic and FSN status, when using each of the corresponding clusters as a fixed effect.[14] Put differently, the effectiveness and relevance of policy interventions depend on existing structural conditions and the starting levels of food insecurity and nutrition.

More specifically, it clearly suggests that the policy options to address challenges of food insecurity and malnutrition need to be assessed at the country level. As was the purpose of the analysis at the outset, the cross-country comparison can help provide guidance for what to look for in such context-specific assessments. That guidance can be obtained by looking at the trajectories and policy efforts undertaken in other contexts, where governments and other actors were more or less successful in ending hunger and all forms of malnutrition.

[14] It would suggest that the relationships should be estimated specifically for each cluster or using control variables for each. Doing so, however, would lead to loss of degrees of freedom because of reduced sample size in each cluster, such that findings unlikely are robust.

Table 10 – Univariate correlates between changes in policy variables and changes in FSN outcomes

	Prevalence of Undernourishment					Prevalence of Stunting					Prevalence of Wasting					Prevalence of Overweight				
Explanatory Variables	**Estimates**	**Sign**	**Adj. R2**	**# obs**	**# Countries**	**Estimates**	**Sign**	**Adj. R2**	**# obs**	**# Countries**	**Estimates**	**Sign**	**Adj. R2**	**# obs**	**# Countries**	**Estimates**	**Sign**	**Adj. R2**	**# obs**	**# Countries**
(Intercept)	-0.0715	***	0.1	127	45	-0.1519	***	0	121	44	-0.0476	**	0.1	121	44	0.064	***	-0	132	46
REVDC Revenue decentralization	**0.6796**	***	0.1	127	45	0.5059	NS	0	121	44	**-1.0007**	***	0.1	121	44	7.00E-04	NS	-0	132	46
(Intercept)	-0.0559	***	0	170	55	-0.1183	***	0	164	54	-0.031	**	0	164	54	0.0596	***	0	181	55
TAXDC Tax revenue decentralization	0.1552	NS	0	170	55	0.2288	NS	0	164	54	**-0.5613**	**	0	164	54	3.44E-02	NS	0	181	55
(Intercept)	-0.0779	***	0	351	104	-0.1209	***	0	271	99	-0.0658	***	0	269	99	0.0911	***	0	368	105
AGEXP Percentage of agriculture expenditure	-0.0018	NS	0	351	104	-0.0636	NS	0	271	99	-0.0531	NS	0	269	99	-2.50E-03	NS	0	368	105
(Intercept)	-0.1135	***	0	234	97	-0.161	***	0	211	91	-0.0754	***	0	210	90	0.083	***	0	239	97
AGORN Agricultural Orientation Index	-0.0021	NS	0	234	97	0.0202	NS	0	211	91	-0.048	NS	0	210	90	**1.69E-02**	***	0	239	97
(Intercept)	-0.1523	***	-0	62	35	-0.2112	***	-0	52	30	-0.057	NS	0	52	30	0.0926	***	0	62	35
AGREX Government Agricultural Expenditure	0.0153	NS	-0	62	35	-0.0172	NS	-0	52	30	**-0.0952**	*	0	52	30	8.20E-03	NS	0	62	35
(Intercept)	-0.0372	***	-0	105	47	-0.0632	**	-0	97	45	-0.0215	NS	0	97	45	0.0779	***	0	112	48
NRAAG Nominal rate of assistance	-0.0065	NS	-0	105	47	-0.0089	NS	-0	97	45	-0.0276	NS	0	97	45	**9.70E-03**	**	0	112	48
(Intercept)	-0.0756	***	0	379	112	-0.1173	***	0	296	107	-0.0653	***	0	294	107	0.0881	***	0	399	113
POPAG Per capita agriculture expenditure	**-0.0345**	*	0	379	112	**-0.0787**	*	0	296	107	-0.0652	NS	0	294	107	**8.20E-03**	*	0	399	113
(Intercept)	-0.119	***	0	504	132	-0.1551	***	0	437	128	-0.0798	***	0	435	127	0.0863	***	0	534	133
MFNAG Agricultural Tariffs (Simple average, I	-0.0023	NS	0	504	132	0.0307	NS	0	437	128	0.0178	NS	0	435	127	**-1.74E-02**	***	0	534	133
(Intercept)	-0.1559	***	-0	60	35	-0.2225	***	0	57	33	-0.0481	NS	0	57	33	0.0814	***	-0	60	35
NRPAG Nominal rate of protection	0.0042	NS	-0	60	35	-0.0521	NS	0	57	33	-0.0481	NS	0	57	33	2.30E-03	NS	-0	60	35
(Intercept)	-0.1024	***	0	474	126	-0.1512	***	0	390	118	-0.0711	***	0	388	117	0.0778	***	0.1	493	126
PRGPI School enrollment, primary and secon	-0.3386	NS	0	474	126	-0.0631	NS	0	390	118	-0.4652	NS	0	388	117	**3.39E-01**	***	0.1	493	126
(Intercept)	-0.1028	***	0	482	127	-0.1467	***	0	395	118	-0.0701	***	0	393	117	0.0785	***	0.1	503	127
SEGPI School enrollment, secondary (gross), g	-0.1831	NS	0	482	127	-0.1422	NS	0	395	118	-0.3201	NS	0	393	117	**2.01E-01**	***	0.1	503	127
(Intercept)	-0.104	***	0	424	124	-0.1502	***	0	362	120	-0.0621	***	0	359	120	0.0799	***	0.1	451	124
TEGPI School enrollment, tertiary (gross), gen	-0.0864	NS	0	424	124	0.0647	NS	0	362	120	-0.1351	NS	0	359	120	**6.59E-02**	***	0.1	451	124
(Intercept)	-0.0665	***	0	337	101	-0.1273	***	0	269	96	-0.0653	***	0	268	96	0.0849	***	0	359	102
EDGDP Percentage of education expenditure	-0.0243	NS	0	337	101	0.0043	NS	0	269	96	-0.0292	NS	0	268	96	-1.20E-03	NS	0	359	102
(Intercept)	-0.0668	***	0	332	100	-0.131	***	0	267	96	-0.0662	***	0	266	96	0.0859	***	0	354	101
HLGDP Percentage of health expenditure	-0.0051	NS	0	332	100	0.023	NS	0	267	96	-0.0086	NS	0	266	96	**-8.50E-03**	**	0	354	101
(Intercept)	-0.0671	***	0	328	100	-0.1285	***	0	264	95	-0.0637	***	0	263	95	0.0853	***	0	350	101
SPGDP Percentage of social protection expen	0.003	NS	0	328	100	-0.0037	NS	0	264	95	**-0.0558**	**	0	263	95	**-5.10E-03**	*	0	350	101
(Intercept)	-0.1413	***	0	214	62	-0.1952	***	0	158	60	-0.101	***	-0	155	60	0.1076	***	0	214	62
RDFRM Agricultural R&D expenditures per 10	-0.0801	NS	0	214	62	-0.0856	NS	0	158	60	-0.0183	NS	-0	155	60	-6.10E-03	NS	0	214	62
(Intercept)	-0.1451	***	0	211	61	-0.1991	***	-0	155	59	-0.1008	***	0	152	59	0.1075	***	0	211	61
RDSHR Agricultural R&D expenditures as shai	-0.0457	NS	0	211	61	-0.0047	NS	-0	155	59	-0.0602	NS	0	152	59	-1.07E-02	NS	0	211	61
(Intercept)	-0.1432	***	0	213	61	-0.203	***	0	157	59	-0.1055	***	-0	154	59	0.108	***	0	213	61
SPNDP Agriculture R&D spending, total	**-0.0938**	*	0	213	61	-0.0649	NS	0	157	59	-0.0379	NS	-0	154	59	1.30E-03	NS	0	213	61
(Intercept)	-0.1801	***	-0	56	19	-0.2895	***	-0	46	18	-0.1244	*	-0	46	18	0.1045	***	-0	56	19
DWRUR People using safely managed drinkin	-0.0248	NS	-0	56	19	0.0707	NS	-0	46	18	-0.0084	NS	-0	46	18	6.60E-03	NS	-0	56	19
(Intercept)	-0.1032	***	0	600	135	-0.1737	***	0	484	131	-0.0641	***	0	481	131	0.0819	***	0.1	637	135
ELRUR Access to electricity, rural	-0.0177	NS	0	600	135	0.0491	NS	0	484	131	**-0.1293**	***	0	481	131	**2.22E-02**	***	0.1	637	135
(Intercept)	-0.0552	**	0.1	77	27	-0.1483	***	0	76	27	-0.0599	**	0	76	27	0.0512	***	0.4	80	27
SNRUR People using safely managed sanitatic	**-0.3598**	***	0.1	77	27	-0.3546	NS	0	76	27	-0.2335	NS	0	76	27	**2.18E-01**	***	0.4	80	27

Source: Authors' estimations.

See Appendix 7.4 for technical notes. Regressions are OLS estimates (no fixed effects) using log differences for both dependent and explanatory variables. The appendix shows findings when taking account fixed effects.

Notes: The "sign" column indicates the threshold of significance for estimates: N.S.: Non-significant, *: significant at 10%, **: significant at 5%, ***: significant at 1%

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7 Appendices

7.1 Detailed information on FSN variables

Table A.1 – Extended list of variables FSN

Catg.	Domain	Variable	Description	Unit	Source
FNS	Malnutrition (a)	DIETR	Minimum diet diversity in rural area (%)	Proportion of children 6-23 months who receive food from four or more food groups	Global Nutrition Report
FNS	Malnutrition (a)	DIETU	Minimum diet diversity in urban area (%)	Proportion of children 6-23 months who receive foods from four or more food groups	Global Nutrition Report
FNS	Malnutrition (a)	STUNT	Prevalence of stunting, height for age	% of children under 5	WDI, WHO
FNS	Malnutrition (b)	OWGHT	Prevalence of overweight, weight for height	% of adult population	WDI, WHO
FNS	Malnutrition (b)	WASTE	Prevalence of wasting, weight for height	% of children under 5	WDI, WHO
FNS	Undernutrition	ADESA	Access to food: average dietary energy supply adequacy	Percent	FAO
FNS	Undernutrition	PUNDP	Prevalence of undernourishment	% of population	FAO

Table A.2 – Selection variables criteria FSN

Variable	Description	Motives to be excluded from final clustering
DIETR	Minimum diet diversity in rural area (%)	Low coverage. Especially for FIRST countries
DIETU	Minimum diet diversity in urban area (%)	Low coverage. Especially for FIRST countries
STUNT	Prevalence of stunting, height for age	NA. Variable kept.
OWGHT	Prevalence of overweight, weight for height	NA. Variable kept.
WASTE	Prevalence of wasting, weight for height	NA. Variable kept.
ADESA	Access to food: Average dietary energy supply adequacy	Partial coverage. Good correlation with PUNDP.
PUNDP	Prevalence of undernourishment	NA. Variable kept.

Table A.3 – Descriptive statistics

Variable	Median	Mean	Minimum	Maximum	Filling Rate	Standard Deviation
			Full Sample			
DIETR	22.4	29.4	3.5	80	0.1	18.7
DIETU	35.9	39.5	10.1	87.2	0.1	17.7
STUNT	12.1	19.4	1.6	69.5	0.8	18.4
OWGHT	42.1	38.4	6.6	71.1	0.9	17.4
WASTE	2.7	5.3	0.5	26	0.8	4.8
ADESA	117.1	117.4	74.5	158	0.6	15.9
PUNDP	10.1	15.4	2	75.8	0.9	14.9
			FIRST Countries Sample			
DIETR	22.4	29.4	3.5	80	0.1	18.7
DIETU	35.9	39.5	10.1	87.2	0.1	17.7
STUNT	12.1	19.4	1.6	69.5	0.8	18.4
OWGHT	42.1	38.4	6.6	71.1	0.9	17.4
WASTE	2.7	5.3	0.5	26	0.8	4.8
ADESA	117.1	117.4	74.5	158	0.6	15.9
PUNDP	10.1	15.4	2	75.8	0.9	14.9

Table A.4 – Descriptive statistics for six FSN clusters (median, minimum and maximum value across time periods)

Code	Description	[1] High hunger and high child undernutrition	[2] High child undernutrition and moderate hunger	[3] Moderate hunger and child undernutrition	[4] Moderate adult overweight and child undernutrition	[5] Moderate adult overweight and low child undernutrition	[6] High adult overweight
OWGHT	Prevalence of overweight, weight for height , % of adult population	18.30 [6.6-49.7]	14.74 [7.6-41.12	19.96 [8.3-40.6]	42.8 [28.9-59.5]	32.12 [18.4-46.1]	55.46 [43.0-71.3]
PUNDP	Prevalence of undernourishment , % of population	41.68 [27.9-75.5]	27.18 [9.5-58.2]	20.17 [5.0-34.1]	14.39 [2-4.8]	5.44 [2-30.1]	2.0 [2-17.7]
STUNT	Prevalence of stunting, height for age, % of children under 5	40.69 [16.1-66.9]	45 [17.2-69.5]	35.24 [12.8-68.2]	23.49 [2-55.1]	4.87 [2-19.6]	2.0 [1.6-18.2]
WASTE	Prevalence of wasting, weight for height, % of children under 5	7.43 [2.3-15.1]	15.02 [11.0-23.9]	8.37 [3.2-15.7]	3.3 [0.6-10.8]	2.43 [1.8-9.8]	2 [0.5-7.6]

Source: Authors' computation

Notes: Minimum and maximum values are indicated between brackets.

Figure A.1 – Heat map of filling rate (% of years available) for FIRST countries and FSN variables (extended)

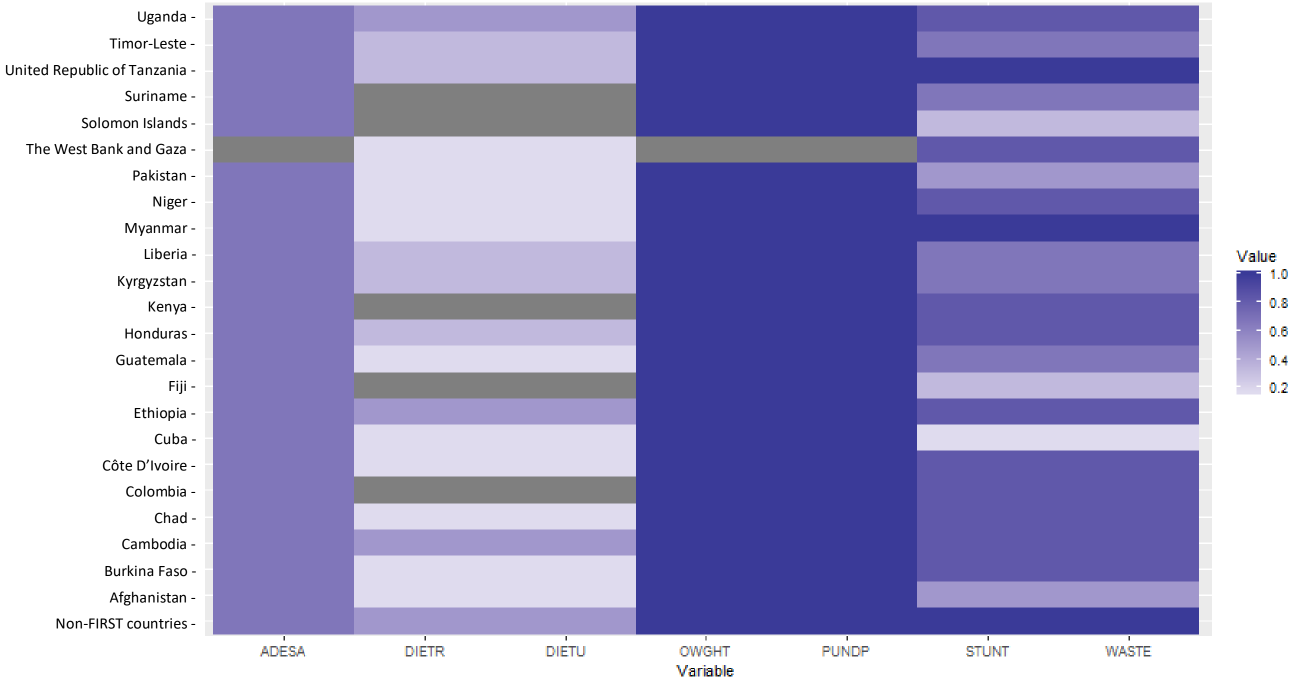
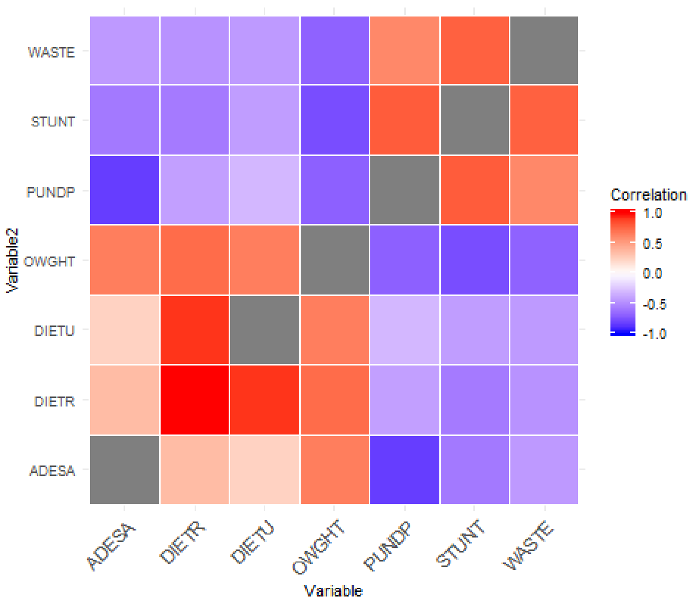


Figure A.2 – Correlation between FSN variables (extended)



7.2 Detailed information on structural variables

Table A.5 – Extended list of structural variables

Category	Domain	Variable	Description	Unit	Source
Structural	Agricultural assets	LNCAP	Agricultural land per capita	Hectare per capita	FAO
Structural	Agricultural assets	SUITAB	Potential land productivity	USD per ha	IFPRI based on GAEZ dataset, FAO
Structural	Agricultural productivity	AGVDW	Agriculture value added per worker	Constant 2010 $ per worker	IFPRI
Structural	Agricultural productivity	FERTI	N Fertilizer Use	Tonnes per ha	FAOSTAT
Structural	Agricultural productivity	PESTI	Pesticides Use	Tonnes per ha	FAOSTAT
Structural	Agricultural productivity	TFPAG	Total Factor Productivity in agriculture (changes)	%, growth rate	IFPRI
Structural	Agricultural productivity	YIELD	Cereals Yield	Kg per ha	FAO
Structural	Economic structure	AGEMP	Employment in agriculture	% of total employment	WDI, ILO
Structural	Economic structure	AGGDP	Agriculture, forestry, and fishing, value added	% of GDP	WDI
Structural	Economic structure	FDSHG	Food imports	% of GDP	WDI
Structural	Economic structure	GDPPC	Per Capita GDP PPP	US$ PPP	WDI
Structural	Economic structure	GINDX	Gini Index	Gini Index	PovCalNet
Structural	Economic structure	NARSD	Dependency to natural resources (In GDP: Raw commodities exports)	% of GDP	IFPRI based on WDI, COMTRADE
Structural	Economic structure	RUPOP	Rural population	% of rural population	WDI
Structural	Geography	LANDL	Landlocked country	Dummy	CEPII
Structural	Institutions	CCORP	Control of corruption	Index	WGI
Structural	Institutions	EFIND	Economic freedom index	Index	Heritage Foundation
Structural	Institutions	FSIND	Fragile State Index	Index	
Structural	Institutions	GOVEF	Government effectiveness	Index	WGI
Structural	Institutions	PSIND	Political stability index	Index	Heritage Foundation
Structural	Population dynamics	MIGSH	Net migration	% of population	WDI
Structural	Population dynamics	PDENS	Population density		WDI
Structural	Population dynamics	PGRWT	Population growth (birth rate)	Per 1000 people	WDI
Structural	Population dynamics	POPHF	Population ages 15–64	% of population	WDI

Table A.6 – Selection of structural variables criteria

Variable	Description	Motives
LNCAP	Agricultural land per capita	NA. Variable kept in the analysis
SUITAB	Potential land productivity	NA. Variable kept in the analysis
AGVDW	Agriculture value added per worker	NA. Variable kept in the analysis
FERTI	N Fertilizer Use	Weak data (coverage and quality) before mid 2000 Discontinuity in FAOSTAT series
PESTI	Pesticides Use	Partial coverage for FIRST countries and no changes in the clustering for other countries
TFPAG	Total Factor Productivity in agriculture (changes)	Instability in the data series across update of the series
YIELD	Cereals Yield	NA. Variable kept in the analysis
AGEMP	Employment in agriculture	High correlation with AGGDP
AGGDP	Agriculture, forestry, and fishing, value added	NA. Variable kept in the analysis
FDSHG	Food imports	No significant impacts on structural clustering
GDPPC	Per Capita GDP PPP	Capture economic development but does not identify key structural drivers (mainly a macro outcome variable)
GINDX	Gini Index	Limited coverage.
NARSD	Dependency to natural resources (Raw commodities exports in GDP)	NA. Variable kept in the analysis
RUPOP	Rural population	High correlation with AGGDP
LANDL	Landlocked country	NA. Variable kept in the analysis
CCORP	Control of corruption	NA. Variable kept in the analysis
EFIND	Economic freedom index	High correlation with GOVEF
FSIND	Fragile State Index	Limited coverage over time. Notion introduced in 2005
GOVEF	Government effectiveness	High correlation with CCORP
PSIND	Political stability index	NA. Variable kept in the analysis
MIGSH	Net migration	Limited coverage over time
PDENS	Population density	No significant changes in the country clustering
PGRWT	Population growth (birth rate)	NA. Variable kept in the analysis
POPHF	Population ages 15-64	High correlation with PGRWT

Table A.7 Descriptive statistics structural variable

Variable	Median	Mean	Minimum	Maximum	Filling Rate	Standard Deviation
Full Sample						
LNCAP	0.6	1.8	0	56.5	0.9	4.9
SUITAB	990.6	1047.1	1.7	2519.3	1	638.1
AGVDW	7013.5	17312.1	325.2	518586.1	0.9	34919.3
FERTI	0	0	0	1.4	0.5	0.1
PESTI	0	0	0	0	0.8	0
TFPAG	1.1	1.1	-8.9	10.7	0.7	1.8
YIELD	2426	2922.7	167.7	21363.3	0.9	2187.9
AGEMP	27.9	33.3	0.1	92.4	1	26.8
AGGDP	10	14.7	0	77.2	0.9	13.5
FDSHG	2.6	3.4	0.1	20.7	0.8	2.7
GDPPC	6381.3	12518.4	248.3	127840.5	0.9	15931.5
GINDX	39.1	40	24.6	65.8	0.6	9
NARSD	2.3	8	0	94.4	0.9	13
RUPOP	44.5	45.1	0	94.3	1	23.3
LANDL	0	0.2	0	1	1	0.4
CCORP	43.2	46.2	0	100	0.8	29.2
EFIND	58.6	58.6	1.6	89.8	0.8	11.9
FSIND	76.8	71.3	17	114.3	0.5	23.8
GOVEF	46.6	47.6	0	100	0.8	28.8
PSIND	41.9	44.2	0	100	0.8	27.2
MIGSH	-0.3	0.2	-20.4	70.7	0.8	5.6
PDENS	66	297.8	1.4	19764.1	1	1584.2
PGRWT	22.5	24.8	7.6	55.4	1	12.2
POPHF	62.4	61.2	45.8	85.4	1	7.3
FIRST Countries Sample						
LNCAP	0.6	1.1	0.1	7.9	0.9	1.3
SUITAB	1173.2	1230.5	156.8	2256.9	1	657.9
AGVDW	3594.9	7797.1	669.2	140452.2	0.9	17845.7
FERTI	0	0	0	0.1	0.5	0
PESTI	0	0	0	0	0.7	0
TFPAG	0.6	0.7	-5.9	5.3	1	1.8
YIELD	1794	2002.7	297	4471.1	0.9	996.3
AGEMP	50.6	51.8	2.7	90.5	1	24
AGGDP	25.2	26.5	3.7	77.2	0.9	14.6

Variable	Median	Mean	Minimum	Maximum	Filling Rate	Standard Deviation
FDSHG	2.8	3.8	0.3	12.5	0.7	2.8
GDPPC	2097.6	3186.4	429.9	15557.5	0.9	2946.5
GINDX	40.2	41.3	27.7	57.8	0.6	8.6
NARSD	1.2	4.5	0	44.5	0.8	8.2
RUPOP	70.8	63.5	20.2	88.6	1	20
LANDL	0	0.3	0	1	1	0.5
CCORP	24.3	28.5	0.9	73.7	0.8	19.7
EFIND	56	53.5	27.6	70.5	0.7	8.5
FSIND	90.3	90.5	68.4	110.9	0.5	10.4
GOVEF	27.8	27.1	0	53.7	0.8	14.3
PSIND	19.8	26	0.9	82.4	0.8	19.4
MIGSH	-0.6	-0.8	-17.9	19.1	0.8	3.8
PDENS	51.8	80.1	2.7	735	1	109.6
PGRWT	37.2	35.1	11	55.4	1	10.7
POPHF	53.5	55.5	47.2	70.1	1	6.2

Figure A.3 – Heat map of filling rate (% of years available) for structural variables (extended)

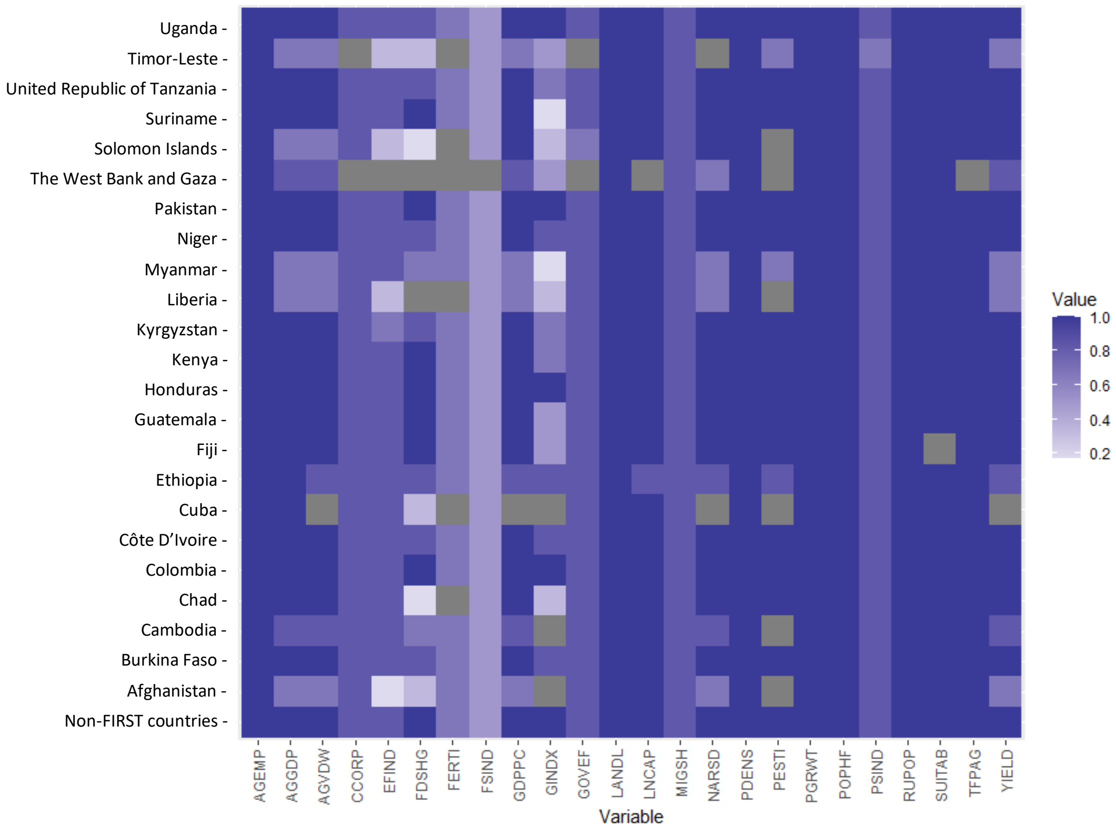
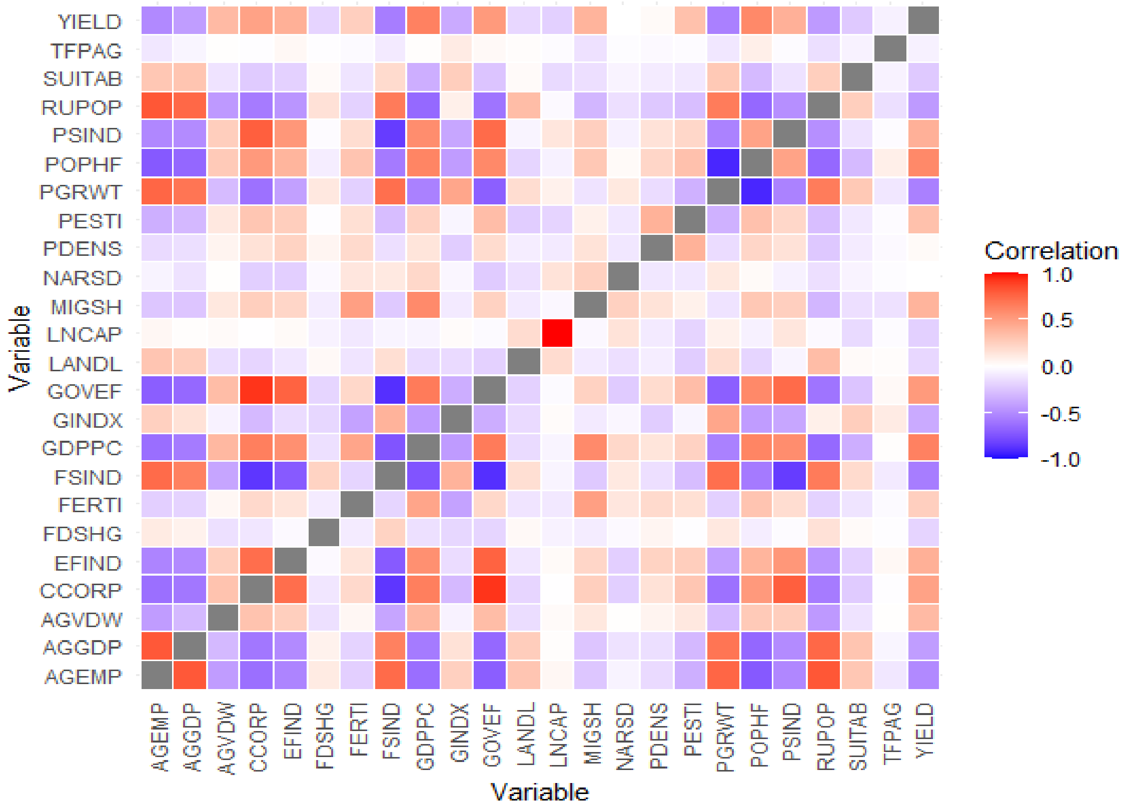


Figure A.4 – Correlation between structural variables (extended)



7.3 Detailed information on policy variables

Table A.8 – Extended list of policy variables

Category	Domain	Variable	Description	Unit	Source
Policies	Centralization	REVDC	Revenue centralization	Ratio of own revenues to general government revenues, central government	IMF
Policies	Centralization	TAXDC	Tax revenue centralization	Ratio of taxes to general government taxes, central government	IMF
Policies	Farm policies (a)	AGEXP	Percentage of public expenditure in agricultural value added	% in agriculture GDP	IFPRI, SPEED
Policies	Farm policies (a)	AGORN	Agricultural Orientation Index	Index	FAO
Policies	Farm policies (a)	AGREX	Government agricultural expenditures	% in agriculture GDP	FAO
Policies	Farm policies (a)	NRAAG	Nominal rate of assistance	Percentage by which domestic prices in	World Bank

Category	Domain	Variable	Description	Unit	Source
				agricultural sector differ from border prices due to government intervention	
Policies	Farm policies (a)	POPAG	Per capita agriculture expenditure	PPP $ per capita	IFPRI
Policies	Farm policies (b)	MFNAG	Agricultural Tariffs (Simple average, MFN)	Percent	TRAINS, UNCTAD
Policies	Farm policies (b)	NRPAG	Nominal rate of protection	Percentage by which domestic prices in agricultural sector differ from border prices due to domestic policy	IFPRI
Policies	Gender policies	PRGPI	School enrolment, primary and secondary (gross), gender parity index (GPI)	Female gross enrolment ratio in primary education by male gross enrolment ratio in primary education	WDI
Policies	Gender policies	SEGPI	School enrolment, secondary (gross), gender parity index (GPI)	Female gross enrolment ratio in secondary education by male gross enrolment ratio in secondary education	WDI
Policies	Gender policies	TEGPI	School enrolment, tertiary (gross), gender parity index (GPI)	Female gross enrolment ratio in tertiary education by male gross enrolment ratio in tertiary education	WDI
Policies	Human capital	EDGDP	Percentage of education expenditure	% of GDP	IFPRI, SPEED
Policies	Human capital	HLGDP	Percentage of health expenditure	% of GDP	IFPRI, SPEED
Policies	Human capital	SPGDP	Percentage of social protection expenditure	% of GDP	IFPRI
Policies	R&D in Ag	RDFRM	Agricultural R&D expenditures per 100,000 farmers	$ per 100,000 farmers	IFPRI
Policies	R&D in Ag	RDSHR	Agricultural R&D expenditures as share of agriculture value added	% of agricultural value added	IFPRI
Policies	R&D in Ag	SPNDP	Agriculture R&D spending, total	PPP $ per million population	IFPRI
Policies	Rural development	DWRUR	People using safely managed drinking water services, rural	% of rural population	WDI
Policies	Rural development	ELRUR	Access to electricity, rural	% of rural population	WDI
Policies	Rural development	SNRUR	People using safely managed sanitation services, rural	% of rural population	WDI

Table A.9 – Selection of policy variables criteria

Variable	Description	Motives to be excluded from final clustering
REVDC	Revenue centralization	Very limited coverage
TAXDC	Tax revenue centralization	Very limited coverage
AGEXP	Percentage of public expenditure in agricultural value added	NA. Variable kept in the final analysis
AGORN	Agricultural Orientation Index	High Correlation with AGEXP
AGREX	Government agricultural expenditures	High Correlation with AGEXP. Low coverage
NRAAG	Nominal rate of assistance	Low coverage
POPAG	Per capita agriculture expenditure	High Correlation with POPAG
MFNAG	Agricultural tariffs (Simple average, MFN)	NA. Variable kept in the final analysis
NRPAG	Nominal rate of protection	Low coverage
PRGPI	School enrolment, primary and secondary (gross), gender parity index (GPI)	Low variance across countries
SEGPI	School enrolment, secondary (gross), gender parity index (GPI)	Low variance across countries
TEGPI	School enrolment, tertiary (gross), gender parity index (GPI)	NA. Variable kept in the final analysis
EDGDP	Percentage of education expenditure	Low coverage. Average correlation with ELRUR
HLGDP	Percentage of health expenditure	Low coverage. Average correlation with ELRUR
SPGDP	Percentage of social protection expenditure	Low coverage. Average correlation with ELRUR
RDFRM	Agricultural R&D expenditures per 100,000 farmers	Low coverage. High correlation with RDSHR
RDSHR	Agricultural R&D expenditures as share of agriculture value added	Low coverage. Medium correlation with AGREX
SPNDP	Agriculture R&D spending, total	Low coverage. High correlation with RDSHR
DWRUR	People using safely managed drinking water services, rural	High correlation with ELRUR
ELRUR	Access to electricity, rural	NA. Variable kept in the final analysis
SNRUR	People using safely managed sanitation services, rural	High correlation with ELRUR

Table A.10 – Descriptive statistics policy variables

Variable	Median	Mean	Minimum	Maximum	Filling Rate	Standard Deviation
Full Sample						
REVDC	0.7	0.6	0.1	1	0.2	0.2
TAXDC	0.9	0.8	0	1	0.3	0.2
AGEXP	7.3	11.4	0	78	0.5	11.7
AGORN	0.4	0.7	0	20	0.4	1.5
AGREX	2.5	7	0	74.3	0.1	13
NRAAG	0	0.2	-0.6	2.7	0.3	0.4

Variable	Median	Mean	Minimum	Maximum	Filling Rate	Standard Deviation
POPAG	45.3	90.1	0.1	1133.4	0.6	140.6
MFNAG	14.8	17.4	0	84.1	0.8	12.2
NRPAG	6	11.5	-61	135.3	0.1	31.9
PRGPI	1	0.9	0	1.3	0.8	0.1
SEGPI	1	0.9	0	1.5	0.8	0.2
TEGPI	1.1	1	0.1	6.9	0.7	0.6
EDGDP	3.3	3.7	0	13.2	0.5	2.2
HLGDP	1.7	2.5	0	10.2	0.5	2.2
SPGDP	2.3	5.4	0	33.3	0.5	6.5
RDFRM	1.5	6.6	0.1	100.9	0.3	12.8
RDSHR	0.6	0.9	0	10.6	0.3	1.1
SPNDP	2.9	4.9	0.2	29.5	0.3	5.1
DWRUR	31.1	37.5	0	99.4	0.1	27.5
ELRUR	91.1	66.3	0	100	0.9	39.2
SNRUR	67.8	57.4	1.2	98.1	0.1	33.4
	FIRST Countries Sample					
REVDC	1	0.9	0.7	1	0.1	0.1
TAXDC	3.1	4.3	0.4	18.9	0.5	3.6
AGEXP	0.1	0.2	0	0.6	0.3	0.1
AGORN	0.7	0.9	0	2.2	0.2	0.7
AGREX	0	-0.1	-0.4	0.2	0.3	0.1
NRAAG	16.2	19.5	1.1	97.4	0.5	17.1
POPAG	14.8	16.3	0	48.6	0.7	8.5
MFNAG	9.4	3.3	-45.2	34.5	0.2	19.1
NRPAG	1	0.9	0	1.1	0.8	0.2
PRGPI	0.9	0.9	0	1.4	0.8	0.3
SEGPI	0.7	0.8	0.1	1.7	0.7	0.5
TEGPI	2.8	3.1	0.2	10.3	0.4	1.9
EDGDP	1.2	1.5	0.1	4.9	0.4	1.1
HLGDP	0.9	1.2	0	4.4	0.4	1.2
SPGDP	0.8	1.5	0.2	7.3	0.5	1.7
RDFRM	0.4	0.5	0.1	1.9	0.5	0.4
RDSHR	1.9	2.9	0.6	11.3	0.5	2.3
SPNDP	18.5	20.2	0	49.4	0.2	14.8
DWRUR	31.4	40.9	0	100	0.9	37.1
ELRUR	3	3.1	1.2	5.3	0.1	1.3
SNRUR	1	0.9	0.7	1	0.1	0.1

Figure A.5 - Heat map of filling rate (% of years available) for FIRST countries and policy variables (extended)

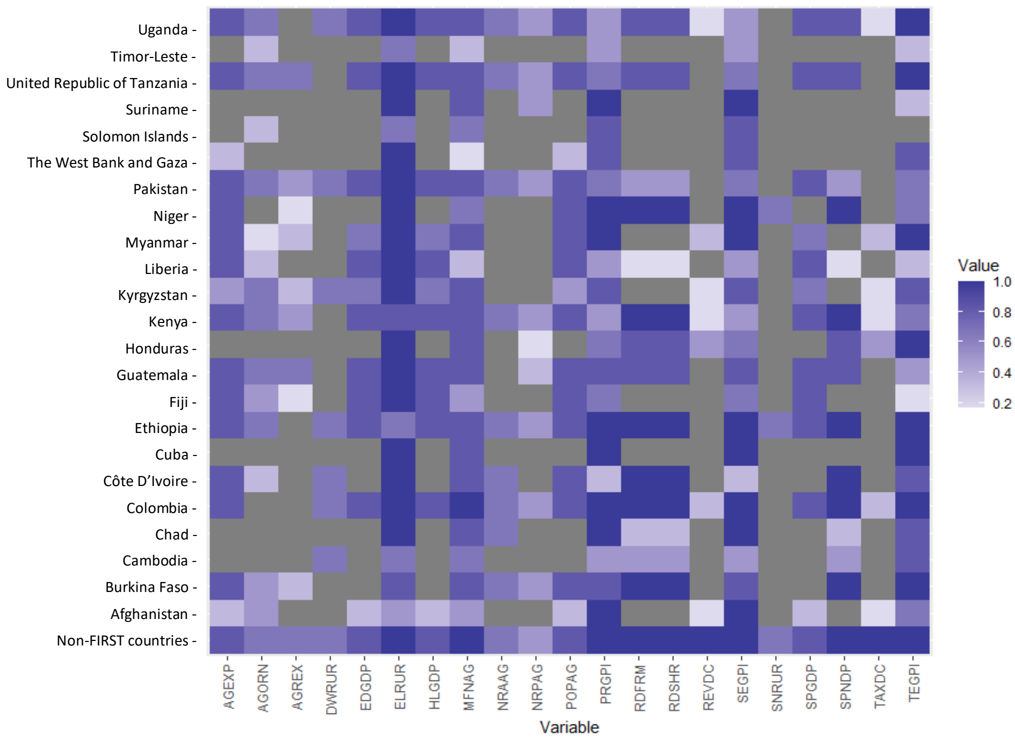
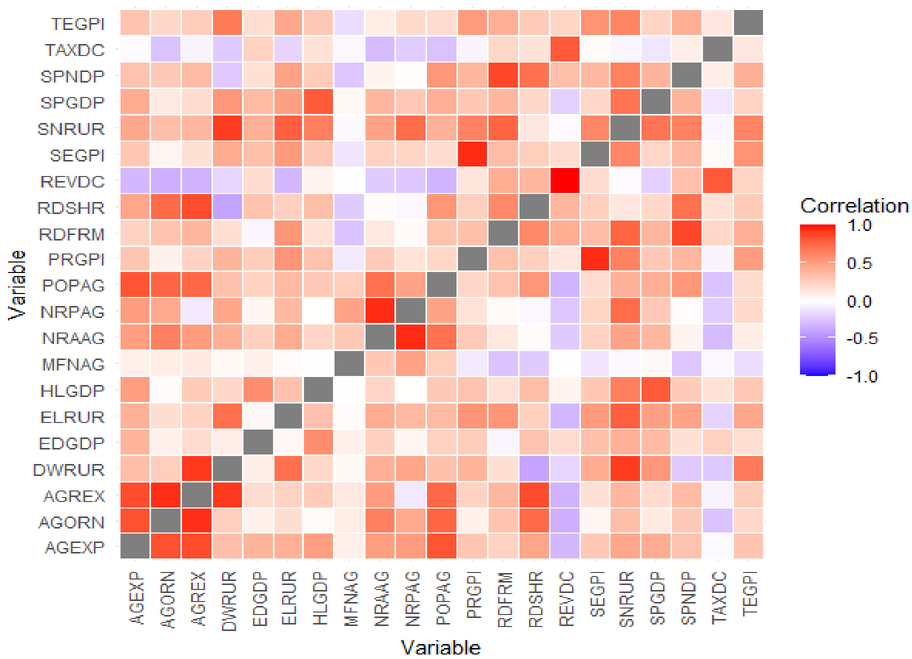


Figure A.6 - Correlation between policy variables (extended)



7.4 Correlation analysis of FSN outcomes and policy variables

In Section 5, the first part of the multidimensional analysis of the association between FSN outcomes and policy efforts is consistent with the typology framework: identifying the drivers impacting the probability of countries moving across the FSN clusters.

These clusters are multidimensional by nature and do not allow tracking countries' performances on specific dimensions or may miss out on progress if countries reduced hunger and child nutrition but remained in the same cluster. The cluster approach aims to organize data points around the centroid of each group and does not aim to measure the distance (progress) vis-à-vis of a given threshold, defined normatively or positively.

In the second part of Section 5, we investigate the univariate relationship between, on the one hand, each of the 21 policy variables (including those not kept in the policy clustering) and, on the other hand, the four core FSN indicators: prevalence of overweight (OWGHT), prevalence of undernourishment (PUNDP), stunting (STUNT) and wasting (WASTE).

7.4.1 Methodological approach

Due to the limited scope of the exercise and to avoid sample restrictions driven by non-overlapping data coverage, we proceed to univariate regressions. This would imply 84 regression estimations (21x4), in principle. In practice, however, we estimated more than that, applying different specification and data transformation procedures to test for possible specification problems.

Univariate regressions on data specified in level may easily lead to spurious correlations, that is, estimates may be found to suggest a statistically significant correlation, when there is no reason to believe that such variables stand in any causal relationship. One problem could be that of omitted variables, that is to say, the size, sign and significance of the regression coefficient of the univariate model could change if other relevant explanatory variables would have been included. In our case, the impact of policies most probably will be highly dependent on the structural context and the initial FSN situation, such that omission of such factors could bias the estimator for any single policy variable tested in our set of regression models.

To address such problems, we specify the univariate regressions using fixed effects for structural drivers and initial FSN conditions. We do this separately for FSN clusters and structural clusters. This approach also allows us to add interaction terms between the clusters and the explanatory variables to see if either the type of FSN situation, or the structural context, impacts the role of the policy variables, i.e., changing the size, sign and/or significance of the regression coefficient obtained without considering the fixed effects.

Also, the specification of the data may influence the robustness of the regression estimates. For instance, specifying data in original level terms may also generate spurious correlations, as the two series may be co-integrated. Using a first-order difference estimations strategy may address this problem. In this case, we regress the changes in the value of the explanatory variable against changes in the dependent variable between two time periods.

Another way of solving such estimation problems is transformation of the data, e.g., through log transformation. This can be done for both the dependent and explanatory variables or just the dependent variable. In the latter case of partial log transformation, the regression coefficient can be interpreted as semi-elastic; that is, it shows the impact of a unit change in an explanatory variable (e.g., degree of coverage of rural electrification) on the percentage change in the dependent variable (e.g., the prevalence of undernourishment). A full log transformation would allow interpreting the regression coefficient as elastic (one percentage change in rural electrification leads to XX percentage change in the prevalence of undernourishment). Using the log transformation helps to minimize potential stationarity issues in our time series.

Combining these different types of specification, we ended up estimating 1513 "models". Each model is tagged by a four-component code: AAA_BBB_CCC_DDD with:

- AAA the model structure with
  - noFE indicating no fixed effects,
  - FEFNS indicating fixed effects are the FSN clusters, and
  - FEstr the fixed effects based on structural clusters
- BBB the way that we process the variable with
  - Base: variables used in level, no transformation
  - Dbase: first-order time difference (changes in level between two periods)
  - Log: variables transformed in logs
  - DLog: first-order time difference (changes in level between two periods) in log. So actual relative changes.
  - Hlog: half log transformation. Only explanatory variables are transformed
  - Dhog: first order difference in the level of the explained variables and in the log of the explanatory variables.
- CCC indicates the explained variable,
- DDD indicate the explanatory variable.

For instance, the model coded *FEstr_base_OWGHT_REVDC* is a model explaining the prevalence of overweight on the index for revenue decentralization, including structural cluster fixed effects and using data specified in level.

The table below summarizes the various model specifications.

Table A.11 – Estimated models

	No fixed effects: noFE	Fixed effects on FSN clusters: FEFNS	Fixed effects on structural clusters: FEstr
Untransformed data: Base	$y_{r,t} = a \cdot x_{r,t} + b + \epsilon_{r,t}$	$y_{r,t} = a \cdot x_{r,t} + b + \sum_{i=1}^{6} \delta_i \cdot FEFNS_i + \sum_{i=1}^{6} \alpha_i \cdot FEFNS_i \cdot x_{r,t} + \epsilon_{r,t}$	$y_{r,t} = a \cdot x_{r,t} + b + \sum_{i=1}^{6} \gamma_i \cdot FESTR_i + \sum_{i=1}^{6} \beta_i \cdot FESTR_i \cdot x_{r,t} + \epsilon_{r,t}$
Period-to-period changes on untransformed data: Dbase	$(y_{r,t} - y_{r,t-1}) = a \cdot (x_{r,t} - x_{r,t-1}) + b + \epsilon_{r,t}$	$(y_{r,t} - y_{r,t-1}) = a \cdot (x_{r,t} - x_{r,t-1}) + b + \sum_{i=1}^{6} \delta_i \cdot FEFNS_i + \sum_{i=1}^{6} \alpha_i \cdot FEFNS_i \cdot (x_{r,t} - x_{r,t-1}) + \epsilon_{r,t}$	$(y_{r,t} - y_{r,t-1}) = a \cdot (x_{r,t} - x_{r,t-1}) + b + \sum_{i=1}^{6} \gamma_i \cdot FESTR_i + \sum_{i=1}^{6} \beta_i \cdot FESTR_i \cdot (x_{r,t} - x_{r,t-1}) + \epsilon_{r,t}$
Log transformation: Log	$\log(y_{r,t}) = a \cdot \log(x_{r,t}) + b + \epsilon_{r,t}$	$\log(y_{r,t}) = a \cdot \log(x_{r,t}) + b + \sum_{i=1}^{6} \delta_i \cdot FEFNS_i + \sum_{i=1}^{6} \alpha_i \cdot FEFNS_i \cdot \log(x_{r,t}) + \epsilon_{r,t}$	$\log(y_{r,t}) = a \cdot \log(x_{r,t}) + b + \sum_{i=1}^{6} \gamma_i \cdot FESTR_i + \sum_{i=1}^{6} \beta_i \cdot FESTR_i \cdot \log(x_{r,t}) + \epsilon_{r,t}$
Period-to-period changes on log data: Dlog	$log(y_{r,t}) - \log(y_{r,t-1}) = a \cdot (log(x_{r,t}) - \log(x_{r,t-1})) + b + \epsilon_{r,t}$	$log(y_{r,t}) - \log(y_{r,t-1}) = a \cdot (log(x_{r,t}) - \log(x_{r,t-1})) + b + \sum_{i=1}^{6} \delta_i \cdot FEFNS_i + \sum_{i=1}^{6} \alpha_i \cdot FEFNS_i \cdot (log(x_{r,t}) - \log(x_{r,t-1})) + \epsilon_{r,t}$	$log(y_{r,t}) - \log(y_{r,t-1}) = a \cdot (log(x_{r,t}) - \log(x_{r,t-1})) + b + \sum_{i=1}^{6} \gamma_i \cdot FESTR_i + \sum_{i=1}^{6} \beta_i \cdot FESTR_i \cdot (log(x_{r,t}) - \log(x_{r,t-1})) + \epsilon_{r,t}$

	No fixed effects: noFE	Fixed effects on FSN clusters: FEFNS	Fixed effects on structural clusters: FEstr
semi-log transformation: hlog	$y_{r,t} = a \cdot log(x_{r,t}) + b + \epsilon_{r,t}$	$y_{r,t} = a \cdot log(x_{r,t}) + b + \sum_{i=1}^{6} \delta_i \cdot FEFNS_i + \sum_{i=1}^{6} \alpha_i \cdot FEFNS_i \cdot log(x_{r,t}) + \epsilon_{r,t}$	$y_{r,t} = a \cdot log(x_{r,t}) + b + \sum_{i=1}^{6} \gamma_i \cdot FESTR_i + \sum_{i=1}^{6} \beta_i \cdot FESTR_i \cdot log(x_{r,t}) + \epsilon_{r,t}$
Period-to-period changes on semi-log data: Dhlog	$(y_{r,t} - y_{r,t-1}) = a \cdot (log(x_{r,t}) - \log(x_{r,t-1})) + b + \epsilon_{r,t}$	$(y_{r,t} - y_{r,t-1}) = a \cdot (log(x_{r,t}) - \log(x_{r,t-1})) + b + \sum_{i=1}^{6} \delta_i \cdot FEFNS_i + \sum_{i=1}^{6} \alpha_i \cdot FEFNS_i \cdot (log(x_{r,t}) - \log(x_{r,t-1})) + \epsilon_{r,t}$	$(y_{r,t} - y_{r,t-1}) = a \cdot (log(x_{r,t}) - \log(x_{r,t-1})) + b + \sum_{i=1}^{6} \gamma_i \cdot FESTR_i + \sum_{i=1}^{6} \beta_i \cdot FESTR_i \cdot (log(x_{r,t}) - \log(x_{r,t-1})) + \epsilon_{r,t}$

Note: Indices *r* and *t* are for the country and period respectively. The time step is five years. *y* indicates the explained variable from our FSN set, *x* is the explanatory variable from our policy set, and ϵ is a normally distributed term.

We use ordinary least squares (OLS) estimations in all cases. Because the dependent variables are defined as rates (prevalence), they are bounded, ranging from 0 to 1, using the OLS method could have some drawbacks. However, using a logit model with fixed effects will be more problematic.

7.4.2 Results

All results are available in an electronic appendix available at:
https://www.dropbox.com/s/mnox0umvfxe4ibs/ResultsEconometrics.xlsx?dl=0

The excel file includes three worksheets:

1. ***EstimatesDetails*** providing for each model, the estimations for each coefficient (indicated in column E), and their significance level (NS means not significant, * means 10% threshold, ** 5% threshold and*** 1% threshold). Adjusted R2 is provided as well as the omitted fixed effects, the number of observations and the number of countries for each model.
2. *SignificanceAndSign* presents a summary of the sign of each explanatory variable, for each explained variable in each model. 0 indicates non-significant estimates at a 10% threshold or below.
3. *SignificanceTable* presents a summary of the significance of each explanatory variable, for each explained variable in each model.

As expected, the findings are highly sensitive to the specification of the regression model (i.e., with or without fixed effects) and transformation of the data. As indicated in Section 5, we identify the specifications in log differences as more robust because these may be least sensitive to co-integration of the data series. This way we avoid a key cause of biased estimators.

Yet, as reported further in the narrative of Section 5, also in this specification results are sensitive to whether fixed effects are considered or not. That is, when including fixed effects, we find that the degree of influence of each of the policy variables differs both by structural characteristic and FSN status. Put differently, the effectiveness and relevance of policy interventions depend on existing structural conditions and the starting levels of food insecurity and nutrition. It would suggest that the relationships should be estimated specific to each cluster or using control variables for each. Doing so, however, would lead to loss of degrees of freedom because of reduced sample size in each cluster, such that findings are unlikely to be robust. Hence, we did not pursue this procedure.

7.5 Sensitivity analysis of clusters

In this appendix, we explore the influence on the typology when changing the number of clusters in the FSN dimension. We vary the number of clusters from four to ten groups. The new country groupings are shown in Table A.11. Evidently, this changes the composition of clusters and also the degree to which countries shift from one cluster to the next over time.

Nonetheless, after comparing the alternative groupings, depending on the number of clusters, we conclude that this does not alter the overall narrative of the trends as discussed in the main body of the text. Even with ten clusters, for instance, the identified "outliers", Japan and the Republic of Korea, would not become part of a separate cluster when taken over the full period of analysis. With ten clusters, a number of countries with a heavy double burden of malnutrition would stand out more clearly in a separate cluster (this applies to the Central American countries in the sample, for instance).

Table A.11 – Sensitivity analysis on the number of FSN clusters

Period	Clusters	FIRST / NO	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
x1990	4	Non-FIRST countries:	...	...	IDN; IND	CHN	JPN; KOR; MEX; ZAF	AUS; FRA; GBR; NLD; USA	...	...	...	...
x1990	4	FIRST countries:	...	...	AFG; BFA; CIV; KHM; NER; PAK; TCD; TLS	ETH; KEN; LBR; MMR; TZA; UGA	COL; FJI; GTM; HND; KGZ; SLB; SUR	...	...	...	...	...
x1995	4	Non-FIRST countries:	...	...	IDN; IND	...	CHN; JPN; KOR; MEX; ZAF	AUS; FRA; GBR; NLD; USA	...	...	...	...
x1995	4	FIRST countries:	...	...	AFG; BFA; KHM; NER; PAK; TCD; TLS	ETH; KEN; LBR; MMR; TZA; UGA	CIV; COL; FJI; GTM; HND; KGZ; SLB; SUR	...	...	...	...	...
x2000	4	Non-FIRST countries:	...	...	IND	IDN	CHN; JPN; KOR; ZAF	AUS; FRA; GBR; MEX; NLD; USA	...	...	...	...
x2000	4	FIRST countries:	...	...	AFG; BFA; KHM; NER; PAK; TCD; TLS	ETH; KEN; LBR; MMR; TZA; UGA	CIV; COL; GTM; HND; KGZ; SLB; SUR	CUB; FJI	...	...	...	...
x2005	4	Non-FIRST countries:	...	...	IDN; IND	...	CHN; JPN; KOR; ZAF	AUS; FRA; GBR; MEX; NLD; USA	...	...	...	...
x2005	4	FIRST countries:	...	...	BFA; CIV; KHM; NER; PAK; TCD; TLS	AFG; ETH; KEN; LBR; MMR; TZA; UGA	GTM; HND; KGZ; SLB	COL; FJI; SUR	...	...	...	...
x2010	4	Non-FIRST countries:	...	...	IDN; IND	...	CHN; JPN; KOR	AUS; FRA; GBR; MEX;	...	...	...	...

Period	Clusters	FIRST / NO	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
								NLD; USA; ZAF				
x2010	4	FIRST countries:	…	…	BFA; CIV; KHM; NER; PAK; TCD; TLS	AFG; ETH; KEN; LBR; MMR; TZA; UGA	GTM; HND; KGZ; SLB	COL; FJI; SUR	…	…	…	…
x2015	4	Non-FIRST countries:	…	…	IND	…	CHN; IDN; JPN; KOR	AUS; FRA; GBR; MEX; NLD; USA; ZAF	…	…	…	…
x2015	4	FIRST countries:	…	…	KHM; NER; PAK; TCD; TLS	AFG; BFA; ETH; LBR; TZA; UGA	CIV; GTM; HND; KEN; MMR; SLB	COL; FJI; KGZ; SUR	…	…	…	…
x1990	5	Non-FIRST countries:	…	…	CHN	AUS; FRA; GBR; NLD; USA	JPN; KOR; MEX; ZAF	IDN; IND	…	…	…	…
x1990	5	FIRST countries:	…	ETH; KEN; MMR	CIV; GTM; HND; LBR; SLB; TZA; UGA	…	COL; FJI; KGZ; SUR	AFG; BFA; KHM; NER; PAK; TCD; TLS	…	…	…	…
x1995	5	Non-FIRST countries:	…	…	CHN	AUS; FRA; GBR; NLD; USA	JPN; KOR; MEX; ZAF	IDN; IND	…	…	…	…
x1995	5	FIRST countries:	…	ETH; KEN; LBR; MMR; TZA	CIV; GTM; UGA	…	COL; FJI; HND; KGZ; SLB; SUR	AFG; BFA; KHM; NER; PAK; TCD; TLS	…	…	…	…
x2000	5	Non-FIRST countries:	…	…	IDN	AUS; FRA; GBR; MEX; NLD; USA	CHN; JPN; KOR; ZAF	IND	…	…	…	…
x2000	5	FIRST countries:	…	ETH; KEN; LBR; MMR; TZA	CIV; GTM; UGA	CUB; FJI	COL; HND; KGZ; SLB; SUR	AFG; BFA; KHM; NER; PAK; TCD; TLS	…	…	…	…

Period	Clusters	FIRST / NO	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
x2005	5	Non-FIRST countries:	...	...	...	AUS; FRA; GBR; MEX; NLD; USA	CHN; JPN; KOR; ZAF	IDN; IND	...	...	...	...
x2005	5	FIRST countries:	...	AFG; ETH; KEN; LBR; MMR; TZA	CIV; KHM; UGA	COL; FJI; SUR	GTM; HND; KGZ; SLB	BFA; NER; PAK; TCD; TLS	...	...	...	...
x2010	5	Non-FIRST countries:	...	...	IDN	AUS; FRA; GBR; MEX; NLD; USA; ZAF	CHN; JPN; KOR	IND	...	...	...	...
x2010	5	FIRST countries:	...	ETH; LBR; TZA	AFG; CIV; KEN; KHM; MMR; UGA	COL; FJI; SUR	GTM; HND; KGZ; SLB	BFA; NER; PAK; TCD; TLS	...	...	...	...
x2015	5	Non-FIRST countries:	...	...	...	AUS; FRA; GBR; MEX; NLD; USA; ZAF	CHN; IDN; JPN; KOR	IND	...	...	...	...
x2015	5	FIRST countries:	...	ETH; LBR; TZA	AFG; BFA; CIV; KEN; KHM; MMR; NER; PAK; UGA	COL; FJI; SUR	GTM; HND; KGZ; SLB	TCD; TLS	...	...	...	...
x1990	6	Non-FIRST countries:	...	IDN; IND	CHN	MEX; ZAF	JPN; KOR	AUS; FRA; GBR; NLD; USA	...	...	...	...
x1990	6	FIRST countries:	ETH; KEN; MMR	AFG; BFA; KHM; NER; PAK; TCD; TLS	CIV; GTM; LBR; TZA; UGA	COL; HND; KGZ; SLB; SUR	FJI	...	...	...	...	...
x1995	6	Non-FIRST countries:	...	IDN; IND	CHN	MEX; ZAF	JPN; KOR	AUS; FRA; GBR; NLD; USA	...	...	...	...
x1995	6	FIRST countries:	ETH; KEN; LBR; MMR; TZA	AFG; BFA; KHM;	CIV; UGA	COL; GTM; HND; KGZ; SLB; SUR	FJI	...	...	...	...	...

Period	Clusters	FIRST / NO	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
				NER; PAK; TCD; TLS								
x2000	6	Non-FIRST countries:	...	IND	IDN	ZAF	CHN; JPN; KOR	AUS; FRA; GBR; MEX; NLD; USA	...	...	...	...
x2000	6	FIRST countries:	ETH; KEN; LBR; MMR; TZA	AFG; BFA; KHM; NER; PAK; TCD; TLS	CIV; UGA	COL; GTM; HND; KGZ; SLB; SUR	...	CUB; FJI	...	...	...	...
x2005	6	Non-FIRST countries:	...	IDN; IND	...	ZAF	CHN; JPN; KOR	AUS; FRA; GBR; MEX; NLD; USA	...	...	...	...
x2005	6	FIRST countries:	AFG; ETH; LBR; MMR; TZA	BFA; NER; PAK; TCD; TLS	CIV; KEN; KHM; UGA	GTM; HND; KGZ; SLB	...	COL; FJI; SUR	...	...	...	...
x2010	6	Non-FIRST countries:	...	IND	IDN	...	CHN; JPN; KOR	AUS; FRA; GBR; MEX; NLD; USA; ZAF	...	...	...	...
x2010	6	FIRST countries:	ETH; LBR; TZA	BFA; NER; PAK; TCD; TLS	AFG; CIV; KEN; KHM; MMR; UGA	GTM; HND; KGZ; SLB	...	COL; FJI; SUR	...	...	...	...
x2015	6	Non-FIRST countries:	...	IND	...	...	CHN; IDN; JPN; KOR	AUS; FRA; GBR; MEX; NLD; USA; ZAF	...	...	...	...
x2015	6	FIRST countries:	ETH; LBR; TZA	TCD; TLS	AFG; BFA; CIV; KEN; KHM; MMR; NER; PAK; UGA	GTM; HND; SLB	KGZ	COL; FJI; SUR	...	...	...	...

Period	Clusters	FIRST / NO	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
x1990	7	Non-FIRST countries:	IDN; IND	AUS; FRA; GBR; NLD; USA	JPN; KOR	MEX; ZAF	CHN	...	...	...	...	...
x1990	7	FIRST countries:	AFG; BFA; KHM; NER; PAK	...	...	COL; FJI; SUR	CIV; GTM; LBR; TZA; UGA	HND; KGZ; SLB	ETH; KEN; MMR; TCD; TLS	...	...	...
x1995	7	Non-FIRST countries:	IDN; IND	AUS; FRA; GBR; NLD; USA	JPN; KOR	MEX; ZAF	CHN	...	...	...	...	...
x1995	7	FIRST countries:	AFG; BFA; KHM; NER; PAK; TLS	...	...	COL; FJI; SUR	CIV; UGA	GTM; HND; KGZ; SLB	ETH; KEN; LBR; MMR; TCD; TZA	...	...	...
x2000	7	Non-FIRST countries:	IND	AUS; FRA; GBR; MEX; NLD; USA	CHN; JPN; KOR	ZAF	IDN	...	...	...	...	...
x2000	7	FIRST countries:	BFA; KHM; NER; PAK; TCD	CUB	...	COL; FJI; SLB; SUR	CIV; UGA	GTM; HND; KGZ	AFG; ETH; KEN; LBR; MMR; TLS; TZA	...	...	...
x2005	7	Non-FIRST countries:	IDN; IND	AUS; FRA; GBR; MEX; NLD; USA	CHN; JPN; KOR	ZAF	...	...	...	...	...	...
x2005	7	FIRST countries:	BFA; NER; PAK; TCD; TLS	COL; FJI; SUR	...	KGZ; SLB	CIV; KEN; KHM; UGA	GTM; HND	AFG; ETH; LBR; MMR; TZA	...	...	...
x2010	7	Non-FIRST countries:	IDN; IND	AUS; FRA; GBR; MEX; NLD; USA	CHN; JPN; KOR	ZAF	...	...	...	...	...	...
x2010	7	FIRST countries:	BFA; NER; PAK; TCD; TLS	COL; FJI; SUR	...	HND; KGZ; SLB	AFG; CIV; KEN; KHM; MMR; UGA	GTM; LBR	ETH; TZA	...	...	...
x2015	7	Non-FIRST countries:	IND	AUS; FRA; GBR; MEX;	CHN; IDN; JPN; KOR	...	...	...	...	...	...	...

Period	Clusters	FIRST / NO	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
				NLD; USA; ZAF								
x2015	7	FIRST countries:	TCD; TLS	COL; FJI; SUR	...	HND; KGZ; SLB	AFG; BFA; CIV; KEN; KHM; MMR; NER; PAK; UGA	GTM; LBR; TZA	ETH	...	...	...
x1990	8	Non-FIRST countries:	IDN; IND	...	JPN; KOR	MEX; ZAF	CHN	...	AUS; FRA; GBR; NLD; USA	...	...	...
x1990	8	FIRST countries:	AFG; BFA; KHM; NER; PAK	KEN	...	FJI; SUR	CIV; GTM; LBR; TZA; UGA	COL; HND; KGZ; SLB	...	ETH; MMR; TCD; TLS	...	...
x1995	8	Non-FIRST countries:	IDN; IND	...	JPN; KOR	MEX; ZAF	CHN	...	AUS; FRA; GBR; NLD; USA	...	...	...
x1995	8	FIRST countries:	AFG; BFA; KHM; NER; PAK	KEN; LBR	...	FJI; SUR	CIV; GTM; TZA; UGA	COL; HND; KGZ; SLB	...	ETH; MMR; TCD; TLS	...	...
x2000	8	Non-FIRST countries:	IND	...	CHN; JPN; KOR	ZAF	IDN	...	AUS; FRA; GBR; MEX; NLD; USA	...	...	...
x2000	8	FIRST countries:	BFA; KHM; NER; PAK	KEN; LBR; TZA	...	FJI; SUR	CIV; UGA	COL; GTM; HND; KGZ; SLB	CUB	AFG; ETH; MMR; TCD; TLS	...	...
x2005	8	Non-FIRST countries:	IDN; IND	...	CHN; JPN; KOR	ZAF	...	...	AUS; FRA; GBR; MEX; NLD; USA	...	...	...
x2005	8	FIRST countries:	BFA; NER; PAK; TCD; TLS	LBR; MMR; TZA	...	...	CIV; KEN; KHM; UGA	GTM; HND; KGZ; SLB	COL; FJI; SUR	AFG; ETH	...	...

Period	Clusters	FIRST / NO	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
x2010	8	Non-FIRST countries:	IDN; IND	...	CHN; JPN; KOR	...	...	...	AUS; FRA; GBR; MEX; NLD; USA; ZAF	...	...	...
x2010	8	FIRST countries:	BFA; NER; PAK; TCD; TLS	LBR; TZA	...	SLB	AFG; CIV; KEN; KHM; MMR; UGA	GTM; HND; KGZ	COL; FJI; SUR	ETH	...	...
x2015	8	Non-FIRST countries:	IND	...	CHN; IDN; JPN; KOR	...	...	...	AUS; FRA; GBR; MEX; NLD; USA; ZAF	...	...	...
x2015	8	FIRST countries:	NER; TCD	LBR; TZA	...	CIV; SLB	AFG; BFA; ETH; KEN; KHM; MMR; PAK; TLS; UGA	GTM; HND	COL; FJI; KGZ; SUR	...	...	...
x1990	9	Non-FIRST countries:	...	...	JPN; KOR	CHN	...	MEX; ZAF	AUS; FRA; GBR; NLD; USA	...	IDN; IND	...
x1990	9	FIRST countries:	COL	HND; KGZ; SLB	...	GTM; KEN; LBR; TZA; UGA	CIV	FJI; SUR	...	ETH; MMR; TCD; TLS	AFG; BFA; KHM; NER; PAK	...
x1995	9	Non-FIRST countries:	...	...	JPN; KOR	CHN	...	MEX; ZAF	AUS; FRA; GBR; NLD; USA	...	IDN; IND	...
x1995	9	FIRST countries:	COL	HND; KGZ; SLB	...	GTM; KEN; LBR; TZA; UGA	CIV	FJI; SUR	...	ETH; MMR; TCD	AFG; BFA; KHM; NER; PAK; TLS	...
x2000	9	Non-FIRST countries:	...	...	CHN; JPN; KOR	IDN	...	ZAF	AUS; FRA; GBR; MEX; NLD; USA	...	IND	...
x2000	9	FIRST countries:	COL; CUB; FJI; SUR	GTM; HND; KGZ	...	KEN; LBR; TZA; UGA	CIV	SLB	...	AFG; ETH; MMR; TCD; TLS	BFA; KHM; NER; PAK	...
x2005	9	Non-FIRST countries:	ZAF	...	CHN; JPN; KOR	...	IDN	...	AUS; FRA; GBR; MEX; NLD; USA	...	IND	...

Period	Clusters	FIRST / NO	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
x2005	9	FIRST countries:	COL; FJI; KGZ; SUR	GTM; HND	...	KEN; LBR; MMR; TZA; UGA	CIV; KHM	SLB	...	AFG; ETH	BFA; NER; PAK; TCD; TLS	...
x2010	9	Non-FIRST countries:	ZAF	...	CHN; JPN; KOR	...	IDN	...	AUS; FRA; GBR; MEX; NLD; USA	...	IND	...
x2010	9	FIRST countries:	HND; KGZ	GTM	...	AFG; KEN; LBR; MMR; TZA; UGA	BFA; CIV; KHM; TLS	SLB	COL; FJI; SUR	ETH	NER; PAK; TCD	...
x2015	9	Non-FIRST countries:	...	...	CHN; IDN; JPN; KOR	...	...	...	AUS; FRA; GBR; MEX; NLD; USA; ZAF	...	IND	...
x2015	9	FIRST countries:	HND; KGZ	GTM	...	AFG; ETH; KEN; LBR; TLS; TZA; UGA	BFA; KHM; MMR; NER; PAK	CIV; SLB	COL; FJI; SUR	...	TCD	...
x1990	10	Non-FIRST countries:	...	MEX; ZAF	JPN; KOR	CHN	...	...	...	AUS; FRA; GBR; NLD; USA	...	IDN; IND
x1990	10	FIRST countries:	...	FJI; SUR	...	GTM; HND; KGZ; SLB	CIV	KEN; LBR; TZA; UGA	COL	...	ETH; MMR; TCD; TLS	AFG; BFA; KHM; NER; PAK
x1995	10	Non-FIRST countries:	...	MEX; ZAF	JPN; KOR	CHN	IDN	...	...	AUS; FRA; GBR; NLD; USA	...	IND
x1995	10	FIRST countries:	...	FJI; SUR	...	CIV; GTM; HND; KGZ; SLB	...	KEN; LBR; TZA; UGA	COL	...	ETH; MMR; TCD	AFG; BFA; KHM; NER; PAK; TLS
x2000	10	Non-FIRST countries:	...	ZAF	JPN; KOR	CHN; IDN	...	...	...	AUS; FRA; GBR; MEX; NLD; USA	...	IND

Period	Clusters	FIRST / NO	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
x2000	10	FIRST countries:	HND	FJI; SUR	...	CIV; GTM; KGZ; SLB	...	KEN; LBR; TZA; UGA	COL; CUB	...	AFG; ETH; MMR; TLS	BFA; KHM; NER; PAK; TCD
x2005	10	Non-FIRST countries:	...	ZAF	CHN; JPN; KOR	...	IDN	...	...	AUS; FRA; GBR; MEX; NLD; USA	...	IND
x2005	10	FIRST countries:	HND	SLB	...	GTM; UGA	CIV; KHM	AFG; KEN; LBR; MMR; TZA	COL; FJI; KGZ; SUR	...	ETH	BFA; NER; PAK; TCD; TLS
x2010	10	Non-FIRST countries:	...	...	CHN; JPN; KOR	...	IDN	...	ZAF	AUS; FRA; GBR; MEX; NLD; USA	...	IND
x2010	10	FIRST countries:	GTM	SLB	...	KEN; MMR; UGA	BFA; CIV; KHM; PAK; TLS	AFG; ETH; LBR; TZA	HND; KGZ	COL; FJI; SUR	...	NER; TCD
x2015	10	Non-FIRST countries:	...	...	CHN; IDN; JPN; KOR	...	...	...	...	AUS; FRA; GBR; MEX; NLD; USA; ZAF	...	IND
x2015	10	FIRST countries:	GTM	SLB	...	BFA; CIV; KEN; LBR; MMR; TZA; UGA	KHM; NER; PAK	AFG; ETH; TLS	HND; KGZ	COL; FJI; SUR	...	TCD

7.6 2015 outliers in the FSN and structural space

In this appendix, we revisit the issue of outliers by comparing in 2015 the FSN status to the structural cluster in 2015.

Table A.12 shows that some countries display specific behaviour. Sections 4 and 5 focused on the performance (progresses) in FSN. In particular:

5. Countries that are structurally advanced all managed to eliminate hunger and undernutrition but have high level of overweight except **Japan, the Republic of Korea and Malaysia**;
6. For transforming economies with limited political stability and limited dependence on natural resources, most of them have finished their FSN transition, but **Haiti, Bangladesh and India** are underperforming with high level of hunger and/or undernutrition. **China, Indonesia Thailand** and **Sri Lanka** have still limited level of overweight;
7. For transforming economies with some political stability, most of them have achieved a high stage in FSN transformation with already high level of overweight in Arab countries and Central Asia. **Gabon** and **Namibia** are the two countries in this category having reduced undernutrition without reaching high level overweight. **Angola, Mauritania** and **Congo** are lagging in this group**;**
8. Rural economies, relatively land poor but with excellent productivity potential, with weak institutions and strong demographic pressures are in general in moderate FSN status except **Ghana**, which is quite advanced in its FSN nutrition, with still moderate level of overweight. On the other side, **Liberia, the United Republic of Tanzania** and **Madagascar** still lag in FSN compared to their structural status;
9. Rural and landlocked countries have all low performance in FSN, especially the **Central African Republic, Ethiopia, Rwanda, Zambia** and **Chad**. On the other side, **Botswana** and **Kyrgyzstan** have managed to reduce undernutrition significantly. **Paraguay** has reached the last stage of FSN transformation, already reaching high level of overweight (40 percent), being more advanced than its structural status implies.

Table A.12 – Country distribution in the FSN and structural space

Structure	[1] High hunger	[2] High child undernutrition and moderate hunger	[3] Moderate hunger and child undernutrition	[4] Moderate adult overweight and child undernutrition	[5] Moderate adult overweight and low child undernutrition	[6] High adult overweight
[A] Advanced economies					JPN; KOR; MYS	ARE; ARG; AUS; AUT; BEL; BGR; CAN; CHE; CHL; CRI; CYP; DEU; DNK; ESP; EST; FIN; FRA; GBR; HRV; HUN; IRL; ITA; KWT; LTU; LUX; LVA; NLD; NOR; NZL; OMN; POL; PRT; SUR; SVK; SVN; SWE; URY; USA
[B] Transforming economies, with productive land, with average institutions but some political instability	HTI	BGD; IND	MMR; PAK; PHL; VNM	GTM; GUY; HND; NIC	CHN; IDN; LKA; THA	ALB; ARM; BIH; BLR; BRA; COL; DOM; ECU; EGY; GEO; GRC; IRN; ISR; JAM; JOR; LBN; MAR; MEX; PAN; PER; RUS; SLV; TTO; TUN; TUR; VEN; ZAF
[C] Transforming economies, with weak institutions but political stability and strong dependency on natural resources (land and others)			AGO; COG; MRT	SLB	GAB; NAM	AZE; DZA; IRQ; KAZ; LBY; MNG; SAU; TKM
[D] Rural economies, relatively land poor but with excellent productivity potential, other natural resources are available, with weak institutions and strong demographic pressures	LBR; TZA	MDG	BEN; CIV; GIN; GMB; GNB; KEN; KHM; MOZ; NGA; SEN; SLE; TGO	CMR	GHA	
[E] Rural economies, mainly landlocked, relatively land rich but with limited productivity potential, with weak institutions and strong demographic pressures	CAF; ETH; RWA; ZMB	TCD	AFG; BFA; LAO; MLI; MWI; NER; NPL; TJK; UGA	BOL; LSO; UZB; ZWE	BWA; KGZ	PRY

Progress towards
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EUROPEAN UNION

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