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Joachim von Braun

UN Food Systems Summit 2021 –What Role Science and Innovation in the Summit and in Countries' Plans and Why?

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Abstract

The UN Food Systems Summit 2021 was different from all six previous food summits held in the past eight decades. New features of this Summit included the fact that it was anchored in the Sustainable Development Goals, focused on food systems, was based on multi-stakeholder engagement, had a focus on country level strategies (so called National Pathways), and the Summit was held in New York rather than Rome, where the UN food agencies are based. Moreover, for the first time the UN called upon science to provide guidance for a food summit. In this article outcomes and political economy processes of the Summit are briefly reviewed, and then a focus is on the role of science for shaping outcomes is quantitatively assessed by reviewing the 118 country reports of National Pathways. In 62% of the countries' strategies science, research, technology and innovation are more or less significantly mentioned. Quality of governance effectiveness is identified as a strong driver of more attention to science in countries' strategies. The relative weight of agriculture in the national economy shows some positive correlation with attention to science too, whereas level of undernutrition does not correlate with attention to science in the strategies. Implications of these findings are drawn for the science – policy interface in food systems, and for the follow-up process to the Summit that has been put in place by the UN until 2030.

Keywords: economic development, food system, agriculture, governance, United Nations, science, innovation, technology

JEL Codes: Q18, F55, Q010

1. Introduction

In 2021, the UN Secretary-General convened a Food Systems Summit as part of the Decade of Action to achieve the Sustainable Development Goals (SDGs) by 2030, aiming to "… launch bold new actions to deliver progress on all 17 SDGs, each of which relies to some degree on healthier, more sustainable and equitable food systems." Moreover, it was stated that "… the Summit will bring together key players from the worlds of science, business, policy, healthcare and academia, as well as farmers, indigenous people, youth organizations, consumer groups, environmental activists, and other key stakeholders. Before, during and after the Summit, these actors will come together to bring about tangible, positive changes to the world's food systems."[1] This paper aims to provide insights into outcomes of the 2021 UN Food Systems Summit (UNFSS) and the political economy forces that shaped the Summit's processes, reviewing its design and elements of its work areas. A particular focus of this paper is placed on the role of science[2], trying to identify the factors that led to the Summit's functioning and outcomes. Implications of the Summit for food system research and policy implications for Summit follow-up are derived, as the Food Systems Summit process did not end with the Summit in September 2021 but rather continues until 2030.

2. Food system concept and framing assessments of food summits

In order to review the UN Food Systems Summit, it is necessary to understand the very concept of food systems.

- A *sustainable food system* is one that contributes to food security and nutrition for all in such a way that the economic, social, cultural, and environmental bases to generate food security and nutrition for future generations are safeguarded (von Braun, Afsana, Fresco, Hassan & Torero, 2021).
- The concept of *food systems transformation* has been linked to the aspirations of the 2030 Agenda and refers to the objective of pursuing a fundamental change of food systems; for instance, to aim for climate neutrality and achieving the SDGs.

Conceptualizing food systems entails defining *system boundaries* and *system building blocks* and linkages among them, while simultaneously being connected to *neighbouring systems*. Figure 1 visualizes a generic food system.

In view of the UNFSS being a Food *Systems* Summit, a first question should be whether the Summit actually devoted appropriate attention to the food systems concept, or only used

[1] Source: the official UN website on the UN Food Systems Summit https://www.un.org/en/food-systems-summit/about Accessed August 22, 2022.

[2] When "science" is mentioned here and in the following text, always natural sciences and social sciences are referred to

systems as an undefined concept. Taking the food systems design in Figure 1 into consideration, related sub-questions are, are the systems' building blocks appropriately considered for exploring the Summit agendas, i.e. consumption, nutrition, health; agriculture and food industries, markets, infrastructure and services, and income and employment? And are the linkages with adjacent systems conceptualized, namely health systems, economic and governance systems, ecology and climate systems, science and innovation systems, which are critical for the synergies and trade-offs of policies in the framework of the SDGs.

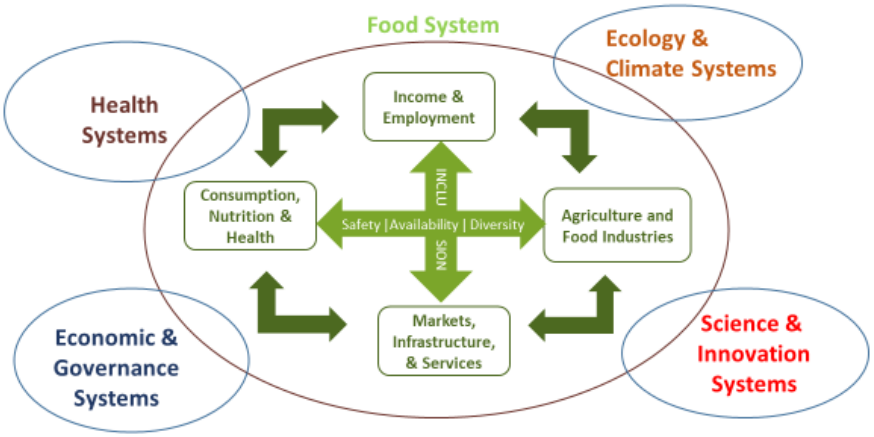

Figure 1: Food system in the context of other related systems (a positive systems concept)
Source: von Braun et al. (2021).

While acknowledging the limitations of a differentiation between *normative and positive economics* (Peil & van Staveren, 2009) – especially in relation to a complex public policy project such as the UNFSS – the assessment approach here is broadly structured along the lines of this theoretical distinction, in which positive economics focuses on the description and explanation of economic phenomena, whereas normative economics offers statements in which positions are taken, such as which SDG should be achieved by when. The UNFSS's concept embarked from a normative perspective, clearly re-emphasizing the SDGs and SDG2 in particular. We first assess how and to what extent the UNFSS changed matters in pursuance of its goals. Subsequently, we adopt a positive economics and political economy perspective to explore how, what forces and which interests shaped the UNFSS. The role of science and knowledge interfacing with other actors is then also addressed.

3. A preliminary normative assessment of UNFSS

The Food Summits since 1943

World food summits have an 80-year history by now, starting with the Conference on Food and Agriculture held in 1943 under the impression of regime-made hunger, in particular by Nazi Germany in Europe. Six summits followed thereafter until 2021, each of which was triggered by a set of major concerns and consequently adopted a focus on certain issues. Food crises and famines were dominant triggers for the summits in the 1960s and 1970s. Most of the conferences – especially the earlier ones – had some consequences in terms of organizational and institutional changes, such as the foundation of UN organizations or their reform. As listed in Table 1, many such changes either directly or indirectly resulted from food summits. Moreover, the location of summits was also relevant: while the first two summits were based in the US, all that followed – except the New York-based UNFSS 2021 – were held in Rome. As we shall discuss below, the choice of holding the UNFSS 2021 in New York was a cause for intra-UN dissonances with Rome-based agencies (RBAs – FAO, IFAD, WFP, CFA).

Table 1: UN Food Summits since 1943

Summits…	Year	Location	Triggers	Focus	Policy changes stimulated by conference	Source
United Nations Conference on Food and Agriculture	1943	Hot Springs Va. USA	World War II and related regime made hunger	Hunger	FAO founded	https://collections.nlm.nih.gov/ext/dw/25110080R/PDF/25110080R.pdf
World Food Congress	1963	Washing-ton DC	famine in Asia (South Asia, China)	Hunger, Food product-ion	World Food Programme founded, Freedom from Hunger Campaign; CGIAR	https://www.fao.org/3/x5571E/x5571e0c.htm
1974 World Food Conference	1974	Rome	famine Bangladesh and elsewhere; Africa; price crisis; oil crisis	Hunger, trade	World Food Council established; IFAD; IFPRI founded	https://www.fao.org/3/F5340E/F5340E03.htm
World Summit on Food Security	1996	Rome	Lack of progress	Broadly on food security	Aim to cut hunger in half by 2015	https://www.fao.org/3/w3613e/w3613e00.htm
World Food Summit (5 years later)	2002	Rome	Lack of action	Re-affirming 1996	Right to food guidelines (2004)	https://www.fao.org/3/Y7106E/Y7106E09.htm#TopOfPage
World Summit on Food Security	2009	Rome	Food price- and financial crisis	eradicate hunger	CFS reform	https://www.fao.org/fileadmin/templates/wsfs/Su

						mmit/Docs/Final_Declaration/WSFS09_Declaration.pdf
2021 UN Food Systems Summit	2021	New York	SDG2; Covid19; climate change	Food Systems	Country level initiatives (to be seen)	https://www.un.org/en/food-systems-summit

Source: compiled by the author

It should be stressed that the food summits listed in table 1 were not the only international initiatives to change the world food and nutrition situation or aspects of agriculture and land use systems. Indeed, it is important to mention the Rio Conference on Sustainable Development (1992), as it established climate, biodiversity, and desertification policy agendas and conventions but hardly considered agriculture and food. Nutrition conferences by the FAO and WHO in the 1990s and thereafter aimed to facilitate action focused on nutrition. It is also relevant to mention the Millennium Development Goals[3] (UN 2000) with their 21 targets, including "Halve between 1990 and 2015 the proportion of people who suffer from hunger". This goal was actually almost achieved, as the proportion of undernourished people in the developing world was reduced from 23.3% in 1990 to 12.9% in 2014/16 according to the FAO (2014).[4] Of course, we must refer to the 2030 Agenda with the SDGs and SDG2 among the seventeen goals (UN 2015)[5]. Lack of progress on SDG2 – the food, nutrition, agriculture-related goal – prompted the UNFSS 2021.

Unique design features of UNFSS 2021

The UNFSS 2021 was quite different from all previous food summits in the sense that it:

1. not only focused on hunger but also healthy and nutritious diets, and more broadly food systems with attention to environmental issues, anchored in the SDGs and SDG2 in particular: "End hunger, achieve food security and improved nutrition and promote sustainable agriculture."[6]
2. not only engaged governments but included a broad global stakeholder process with the ambition of a "Peoples' Summit". The virtual formats of events during the pandemic made them very accessible to a global audience.
3. was prepared in a complex two-year process, with a Pre-Summit in Rome, and hundreds of open dialogues, as well as more than 160 national dialogues and consultation events.

[3] https://www.un.org/millenniumgoals/
[4] FAO, IFAD and WFP. 2014. The State of Food Insecurity in the World 2014. Strengthening the enabling environment for food security and nutrition. Rome, FAO.
[5] https://sdgs.un.org/goals
[6] https://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E

4. received inputs and advice from an independent science advisory body, the "Scientific Group for the UNFSS", invited by UN leadership.
5. was governed by UN Secretary-General through an Advisory Committee, chaired by the UN Deputy Secretary-General,
6. established a follow-up process to the Summit with a time horizon until 2030 for actions and monitoring with follow-up reporting and possibly conferencing.

Promising outcomes and unfinished business of the UNFSS

While the UNFSS can only be adequately assessed much later, a preliminary balance sheet of "promising outcomes" and "unfinished business" is offered in Table 2. The main promising outcomes are broad political and societal engagement in food issues fostered by the Summit process. The emphasis of the Summit was placed on the national-level implementation of actions to achieve the food-related SDG's objectives. For this purpose, countries were encouraged to establish National Pathways toward their food systems' transformation. Promising outcomes are being checked against related potential weaknesses of the Summit (right column of Table 2).

Table 2: A preliminary balance sheet of the UNFSS 2021

Promising outcomes	**Unfinished business**
Strong political and societal engagement. The Summit was much more inclusive and mobilized nations and stakeholders with multiple dialogue formats. Never before has the world discussed and considered food system issues with attention to nutrition, health, ecology, and much more.	**Failed to develop a finance agenda** for the investments needed to achieve the end of hunger and other key targets that are important. The financial proposals, including those from the ScGroup, did not find sufficient resonance and other approaches are needed.
An action agenda. The UN Secretary-General's statement of action, with its systems focus and the five action areas to help inform the transitions needed to realize the vision of the 2030 agenda, are noteworthy.	**Hardly considered tradeoffs and synergies.** The action agenda appears balanced but lacks clarity on tradeoffs and synergies among goals and targets, which is a basic problem of the SDGs too.
National-level implementation was appropriately emphasized.	**Deficient in strengthening capacities for implementation** of actions at the national level, especially in emerging economies that is essential. This is an area for stakeholders to get together and catalyze the necessary actions, and scientific bodies can assist.
Significant global initiatives and coalitions on tackling hunger, healthy diets, anemia in women, agroecology, soil health, oceans, and more were considered.	**Lacked facilitating strong global level actions** in key areas such as *climate, Covid-19, and trade* to accompany national level actions and implementation that is

	necessary, as is addressing emerging food price inflation.
Broad scientific engagement. Never before has science had the opportunity to contribute in so many ways to the agenda of a food summit. Open debate and action-orientation mobilized many Academies of Science, research organizations, academics and practitioners.	**Lacked innovations for an improved science-policy interface** at the global level that is well networked with regional and national interfaces and remains critical.

Source: compiled by author

The 2021 Summit followed a much more complex approach than previous food summits, aiming to address systems failures that contribute to a range of issues, and thus implicitly multiple goals: the hunger, malnutrition, and obesity problems (Hendriks et al., 2021), the environmental problems of green-house gas emissions and biodiversity losses (Hodson et al., 2021), the poor livelihoods in farming communities, especially of women and youth (Neufeld, et.al 2021), and the fundamental issues of food system-related violations of rights, broadly defined as the human right to food. While all of these goals are relevant, there was little consideration of coherence and trade-offs among them. Furthermore, the financing of food systems' transformations remained an open issue (Díaz-Bonilla, 2021). Moreover, UNFSS did not open up to a critical review of SDG2 in an overall SDG context but drew on it for setting the normative framework of the Summit.

Consequently, the normative concept based on objectives stated in the SDGs is embraced by the so-called Action Points summarized by the UN Secretary-General at the Summit[7] (UNFSS 2021): (1) nourish all people; (2) boost nature-based solutions; (3) advance equitable livelihoods, decent work and empowered communities; (4) build resilience to vulnerabilities, shocks and stresses; and (5) accelerating the means of implementation. The brief action statement by the Secretary-General makes ample references to the key role of science for these actions and their implementation. The Summit stipulated that "national level implementation" is to be at the core of the way forward. This could be interpreted as indicative of limited ambition to trigger global actions. Nonetheless, such global actions should be a desirable outcome of a food summit, as has become clear in the world food crisis of 2022.

4. Political economy shaping the UNFSS 2021 and the role of science

UN summits provide opportunities for expanded political markets for diverse actors in governments, civil society organizations, and corporate sectors to (re-)position themselves as

[7] https://www.un.org/en/food-systems-summit/news/making-food-systems-work-people-planet-and-prosperity

actors in governance systems. Related features of the UNFSS 2021 shall be briefly addressed here, attempting to identify the political economy forces that shaped the UNFSS 2021 and are likely to continue to shape the follow-up to the Summit towards 2030.

The organizational and governance structure of the UNFSS holds some relevance for the political economy processes around UNFSS 2021 (Figure 2). At the top was an Advisory Council, chaired by the Deputy Secretary-General, including representatives of nations by hemispheres, heads of certain UN agencies, the Chair of the Scientific Group, the manager of Summit Dialogues, and a corporate representative. A special envoy with the rank of UN Assistant Secretary-General and her secretariat had strategic and management functions. The structural setup included the "Scientific Group", "Action Tracks",[8] a set of "Champions Networks",[9] hundreds of "Dialogues" at national levels and independent ones,[10] and a "UN Task force".[11] These temporary Summit entities formed the structure of the UNFSS stakeholder engagements.

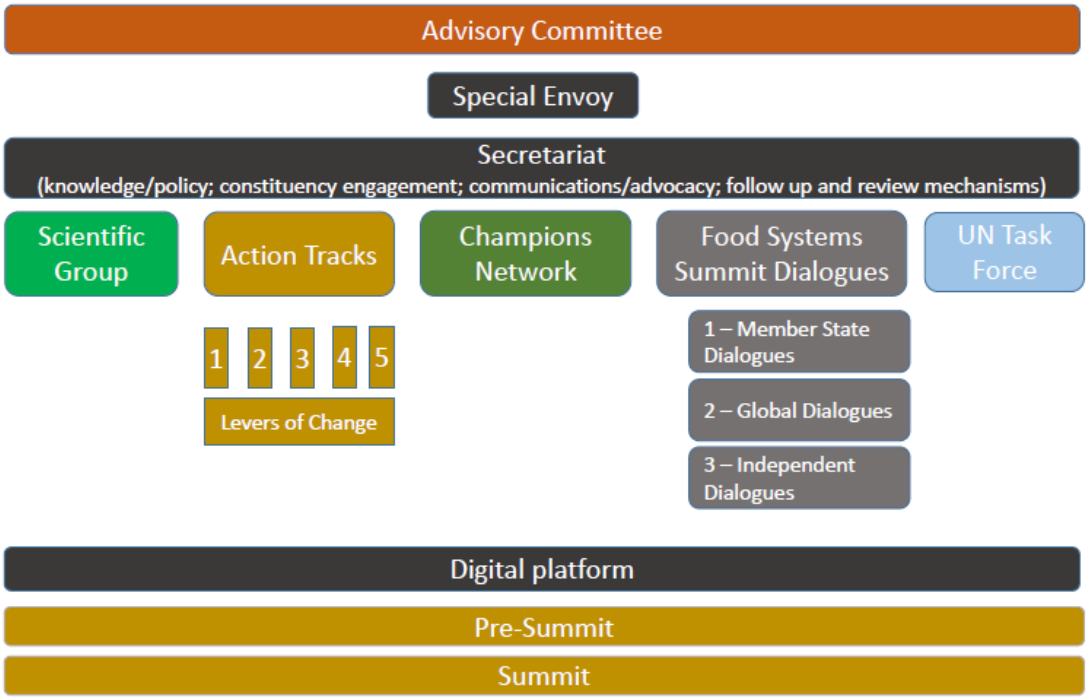

Figure 2: Areas of work for the UNFSS 2021

Source: UN, UNFSS Advisory Committee (2021)

Political economy is understood here as the analyses of the interrelationships among individuals or groups, governments, and public policy to explain the political behavior of actors and systems. Rent seeking and redistributive policies matter in a Summit context. We can

[8] https://www.un.org/en/food-systems-summit/action-tracks
[9] https://www.un.org/en/food-systems-summit/champions-network
[10] https://www.un.org/en/food-systems-summit/dialogues
[11] https://www.un.org/en/food-systems-summit/leadership

draw on theory of the links between political economics, governance structures and the distribution of political power in economic policy-making (Rausser et al., 2021). In reviewing the political economy of the UNFSS, it will be attempted to adopt a content-related look at the political economy, and an agency and interest group-related perspective (Cohn & Hira, 2020; Swinnen, 2018; Mukand & Rodrik, 2020). Politics and economics shape opinions and may have resource and political power implications, whereby a few examples are highlighted below:

- Interests, institutions, and international organizations establish rules that are intended to constrain the use of power, as member states consider the benefits of constraint versus the costs of loss of autonomy. In view of the UN being the assembly of nation states, political economy forces and national governments' interests played important roles in shaping the ultimate UNFSS agenda and outcomes. The emphasis on *"national level implementation"*, rather than a focus on global public goods, was then a logical and uncontroversial key item of consensus among Summit outcomes.
- UN agencies are partly in competitive relationships, which not only relates to the three RBAs among each other, but also each of them versus some other UN agencies. Consequently, the decision by UN leadership to host the Summit not in Rome but rather within the UN General Assembly in New York was a factor of dissonances among UN agencies.[12]
- Tensions arise due to material interests, ideas and beliefs. Particularly conflicting themes around the UNFSS were agroecology, international trade, biotechnology and genomics, land use and biodiversity, the role of meat consumption for health, the livestock sector, and the roles of the sciences.[13]
- There were concerns by some NGOs that corporate engagement and related power would undermine key goals for food systems change, such as equitable sustainability and broad-based participation in food system governance (Clapp, 2021), and consequently also in the UNFSS. In fact, corporate engagement played a rather minor and constructive role for the UNFSS.

The aforementioned interest patterns – national and UN agencies' interests – are not new in shaping the political economy of (food) summits (see Figure 3).

[12] A New York Summit in General Assembly context facilitated it to lift it to higher government levels with the inclusion of more heads of states in the Summit, whereas a Rome-based conference might have been merely a ministerial conference with key roles played by ambassadors and civil servants who are often delegated by Governments to serve on Boards and Councils of the RBAs.

[13] See the diverse perspectives in the papers by the Scientific Group and its partners https://sc-fss2021.org/materials/scientific-group-reports-and-briefs/

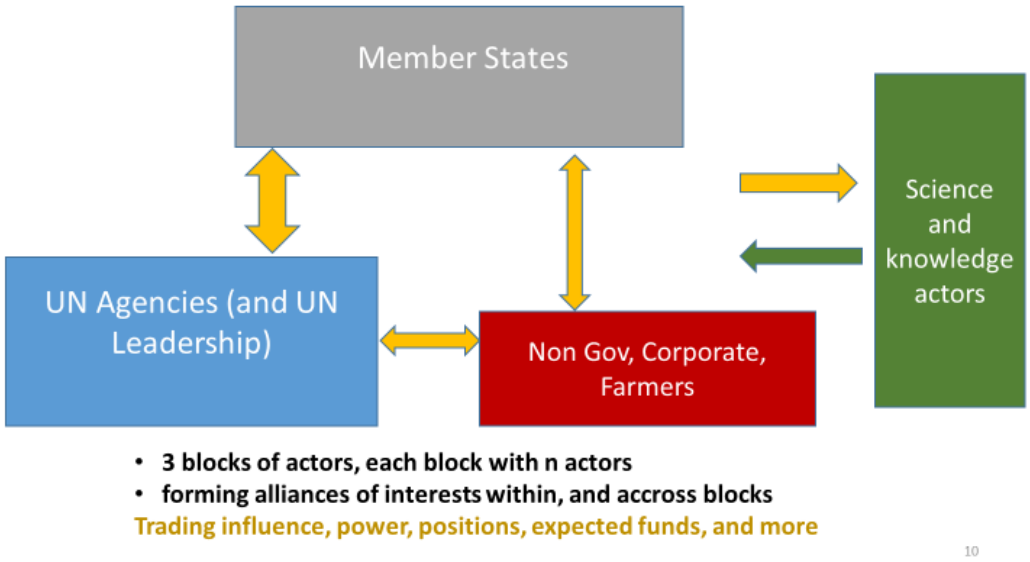

Figure 3: Political economy of the UNFSS 2021: A complex political market

Source: Designed by author

In addition, the political economy of the UNFSS 2021 was shaped by strategic dissonances among nations and in particular super-powers that have no direct relationship to food policy such as security and peace issues. A related lack of willingness to consider collective global actions adversely affects the functioning of the global food system. From a Summit that emphasized national-level actions and de-emphasized global-level actions, hardly significant impacts could be expected for the preparedness of responses to a food crisis that accelerated after the Russian attack on the Ukraine with the wide-reaching effects for food, fertilizer, and energy markets.

Looking into the processes and outcomes of the UNFSS through a political economy lens, two aspects shall be highlighted: the large time and transactions costs of processes, and the positioning of agencies for follow-up processes. Upon first glance, one may be concerned about the large time costs of actors who engage in these debates and lobbying, partly driven by veiled conflicts of interest and the protection of existing organizations.[14] Nonetheless, these processes may bring into the open deficiencies of organizations and actors, and therefore may trigger reform processes at a later stage. However, such risks for any organization participating in the UNFSS processes were minimized by the postulation that this Summit – quite differently from earlier ones – operated from the beginning under a dogma of "no new institutions". This guaranteed a reasonably harmonious Summit. The follow-up

[14] Policy and innovation processes in broadly defined systems agendas may – for instance – run the risk of neglecting equity issues. Critically reviewing four recent and influential publications from the EAT-Lancet Commission, the IPCC, the World Resources Institute and the Food and Land Use Coalition, Davis et. al (2022) identify a lack of explicit inclusion of the livelihoods of poor rural people in related modeling approaches. The UNFSS actually payed significant attention to the poorest and hungry in the Summit process.

process to the UNFSS is now embedded in the RBAs, with some engagement from UN New York. This seems logical as the competencies for the food systems issues are mainly with the RBAs. If the food issues – which are increasingly influenced by political security and climate policy issues – can be connected by UN leadership in sound ways, this hybrid governance of the UNFSS follow-up may actually be quite appropriate.

5. The role of science and science discourse in the UNFSS

In April 2020, UN leadership established the Scientific Group for the UNFSS (ScGroup), with the mandate of being responsible "… for ensuring that the Summit brings to bear the foremost scientific evidence from around the world and helps expand the base of shared knowledge about experiences, approaches, and tools for driving sustainable food systems that will inform the future. The work of the Scientific Group ensures the robustness and independence of the science underpinning dialogue of food systems policy and investment decisions. It also informs the content of the Summit, its recommended outcomes, and the asks and commitments that emerge from the Summit." It was new for a UN Food Summit to establish an independent Scientific Group with such a significant mandate.[15] As depicted in Figure 2, science had a formal position among the areas of work for the UNFSS. It shall be explored here to what extent this might have made a difference for the Summit processes and outcomes. Science was not only an apex but also included in the leading Advisory Committee structures that decided on the Summit agenda.[16] The ScGroup and its members engaged in many dialogues with governments and other stakeholders. A science conference over one week called "Science Days" engaged about 3,000 participants with several global partners (https://sc-fss2021.org/events/sciencedays/), and was continued as a Forum by FAO in 2022. Importantly, the Scientific Group developed a set of seven science-driven priorities of innovations in support of the UNFFS goals: innovations to end hunger and increase the availability and affordability of healthy diets and nutritious foods; innovations to de-risk food systems and strengthen resilience; innovations to overcome inefficient and unfair land, credit, labor, and natural resource use arrangements, and facilitate inclusion; bio-science and digital innovations for improving people's health, enhancing systems' productivity, and restoring

[15] The ScGroup constituted a team of 28 food systems scientists – social scientists, economists and scientists working within the natural and biological sciences, ecology, and food technology – from all over the world, identified in consultation with research organizations. https://sc-fss2021.org/about-us/membership/ They served in their personal capacities from June 2020 until December 2021". The Group and its partners produced a set of about 50 papers (accessible at https://sc-fss2021.org/ and an edited volume by von Braun, Afsana, Fresco, Hassan (2023) Science and Innovations for Food Systems Transformation. Springer Publ.). The Scientific Group had a sunset clause of December 2021 and closed its work by then. The role of science in the follow-up to the UNFSS is less clear than in serving the Summit. A "Science ecosystem of support" is part of the support structures for the UNFSS "Follow-up Coordination Hub", based at FAO.

[16] https://www.un.org/en/food-systems-summit/leadership

ecological well-being; innovations to maintain and – where needed – regenerate productive soils, water and landscapes, and protect the diversity of the agricultural genetic base and biodiversity; innovations for sustainable fisheries, aquaculture, and the protection of coastal areas and oceans, and engineering and digital innovations for the efficiency and inclusiveness of food systems and the empowerment of youths and rural communities (von Braun et.al, 2021).

Assessment of role of science at UN Leadership level: A first indication of the role of science in the outputs of the Summit can be offered by the content of the Secretary-General's "Chair Summary and Statement of Action on the UN Food Systems Summit,"[17] as the text strongly emphasizes the role of science in the transformation of food systems. For instance, it states, "Progress will require local and global communities of practice and stakeholders coming together with national governments... In particular, support to enhance implementation through financing, data, science and innovation, governance and trade" and "Global initiatives to reinforce the ambition of science-based solutions will be key to deliver on the 2030 Agenda."

Assessment of role of science at country levels: A more comprehensive assessment of the role of science for UNFSS outcomes requires a look into nations' strategies that emerged as a result of the Summit, because the Summit aimed to enhance national-level actions. Assessing the role of science in this respect is illuminated by identifying UN member countries' attention to science, research, technology, and innovation (SRTI) as revealed by their national strategy papers – the National Pathways reports - developed by nations in the UNFSS process. Attention to SRTI in each National Pathways report is identified here by a related word count approach. A total of 118 National Pathways reports are available, which were developed by the countries' authorities to outline strategies for transforming food systems towards sustainability and achieving the SDGs, in particular SDG2.[18] All available reports were screened for the frequencies of the words "science," "research," "technology," and "innovation". Reports that were not published in English were machine translated before screening them for the SRTI words.

A first impression of the level of attention to SRTI is offered by figure 4, which maps countries by quartiles of the SRTI frequencies. Of the 118 countries, 73 (62%) mention SRTI more than twice in their National Pathways reports. Looking at the global map of SRTI attention in the

[17] https://www.un.org/en/food-systems-summit/news/making-food-systems-work-people-planet-and-prosperity

[18] Dashboard that FAO Data Lab developed to analyze the pathways documents produced by countries for the Food Systems Summit: https://datalab.review.fao.org/datalab/dashboard/food-systems-summit/ .

National Pathways does not seem to indicate a particular pattern[19] but rather varied attention to SRTI globally and within different hemispheres.

Drivers of patterns of SRTI shall be further explored around four hypotheses, and related initial impressions can be gauged from table 3:

1. SRTI seems to strongly correlate with quality of governance, as depicted by the Governance Effectiveness indicators from the World Bank[20] (col. 2, table 3).
2. Higher per-capita income in terms of GDP seems to correlate with attention to SRTI. This may be the case because richer countries have stronger science and innovations systems to draw on for addressing food systems transformation. The data in table 3 seem to indicate that countries in the bottom 50 % of the SRTI have lower incomes.
3. Countries with relatively larger food systems within their national economy – as indicated by agriculture's share of GDP – may also call for more SRTI to transform food systems. Upon first glance, there is at best a minor indication of such a pattern (column 4 of table 3).
4. When countries have a greater problem of undernourishment (as measured by FAO's State of Food and Nutrition Security in the World, SOFI),[21] they may pay more attention to SRTI as part of solutions. However, there seems to be an inverse relationship between attention to SRTI and undernourishment (Col. 5, table 3), although this may simply be a national income effect as low-income countries have both higher undernourishment and small science capacity.

[19] The quartiles are formed to capture a broad structure of attention to SRTI. Moreover, the regression analyses also control for the volume of reports by a dummy variable, as larger page numbers of reports tend to have more frequent mentioning of SRTI.

[20] https://databank.worldbank.org/databases/governance-effectiveness

[21] https://www.fao.org/publications/sofi/2022/en/

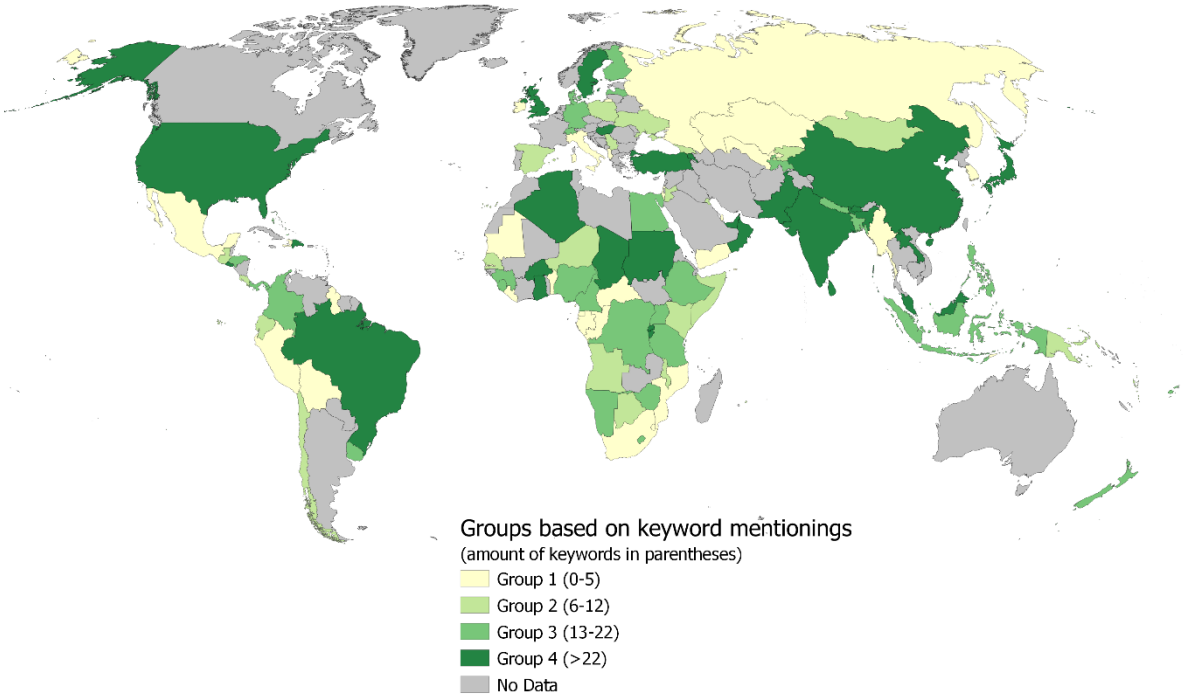

Figure 4: Countries' attention to science, research, innovation and technology in UN FSS National Pathways reports.

Source: Author's analyses based on keyword mapping from available National Pathways reports.

Table 3: Patterns of per capita GDP, Share of Agriculture GDP, Undernourishment, and Governance Effectiveness by quartiles of attention to SRTI

Groups (quartiles of SRTI)	Governance Effectiveness	GDP/Capita US$ (PPP)	GDP of Agr. Sector in %	SoFi (% of under-nourishment)
1	-0,449	10,994	13.4	14,2
2	-0,197	6,594	14.0	16,9
3	-0,0387	13,752	13.7	15,3
4	0,117	12,032	12,0	7,9

Source: compiled by author from National Pathways Reports of UNFSS 2021.

A regression analysis is employed, with selected models that include/exclude variables to review correlations and significances. We must assume, however, that the variables connected to the four aforementioned hypotheses are correlated with each other in multiple ways. Testing for multicollinearity in the regression models employed below indeed signals a multicollinearity issue, especially when the variable GDP per capita is included.[22] The summarized results of the regression exercise are presented in table 4 and details are provided in Table 1 in the annex A.

Table 4: Regression analyses of attention to Science, research, technology and innovation for food systems transformations.

Independent variables	*Models and respective coefficients*				
	I	II	III	IV	V
GDP/capita log	-.426**	-.399***	-	-	-
PoU log	-.103	-.096	.031	.060	-
Agr GDP % log	-.027	-	.222**	-	.224**
Gov. Effectiveness	.722***	.717***	.497***	.328***	.476***
Dummy (= 1 for many pages)	1.048***	1.053***	1.116***	1.102***	1.13***
R sq	.17	.17	.14	.11	.14

Significance levels: ***: 99%. **: 95%

Note: Dependent Variable: SRTI Quartiles (1, … 4, where 4 indicates highest frequency of mentioning SRTI in the reports of National Pathways to achieve the SDG 2)

Source: compiled by author, based on the reports on National Pathways and data sources as mentioned in the text. (details of the regression analyses are in Annex A)

Revisiting the above four hypotheses suggests a strong and robust effect of governance effectiveness on attention to SRTI in National Pathways. The parameters of governance effectiveness in models II, IV and V – that exclude GDP for reasons of multicollinearity – are highly significant and the impact is strong. There seems to be an overarching positive effect of GDP per capita on attention to SRTI (note that GDP and government effectiveness are correlated). However, models 1 and II are suspected to have a significant multicollinearity problem and therefore are not further interpreted. The consistent finding that the prevalence

[22] The Variance Influence Factor (VIF) for model I is 3.98 on average (with a VIF for GDP/capita of 8.87). Thus, models I and II with GDP per capita are problematic. Model III (and IV and V) shows a VIF of 1.79 on average, and none of the individual variables show a VIF above 2.5.

of undernourishment does not seem to trigger attention to more science-based solutions is somewhat surprising (the respective parameter being consistently insignificant). A policy implication of this finding is that the sharing of science and innovations with countries with high undernourishment should be accelerated, combined with science capacity strengthening. On the other hand, countries that have a relatively high share of the agricultural sector in their economy seem to emphasize science relatively more strongly in their National Pathways.

Besides screening the National Pathways reports for SRTI attention, further details about the nature and specificity of National Pathways were explored by checking whether countries actually specified *plans for implementation*. For this purpose, the National Pathways reports were screened in terms of whether they included working steps or an action plan (42 cases), if responsible institutions were mentioned that are tasked with implementation (16 cases), and a timeline was specified towards 2030 (9 cases), and they included a concrete funding concept (3 cases). This assessment indicates that National Pathways reports are strategic documents that still require augmentation by implementation plans in most cases. While the development of National Pathways reports by 118 countries is an important first step towards developing strategies, the UNFSS advocated “national level implementation”, which is yet to be achieved in most countries by adding plans for implementation to the strategic National Pathways reports.

6. Conclusions and implications for food systems policy and research

Among the promising outcomes of UNFSS are the large political, societal and science engagements, as well as initiatives for national-level strategies. However, steps toward implementation of strategies are yet to be taken in most countries and building capacities for implementation of actions in emerging economies require further attention in the future.

The Summit employed an extended framework for stakeholder engagement in addition to the traditional agents of food summits, i.e. member states and UN agencies. Due to its focus on national-level actions, the UNFSS processes may have prepared the world better for food crises in 2022 and beyond at national levels but not yet at the global level. In the 2022 food crisis, a mixed picture emerges with ad-hoc responses in the form of emergency committee formations of the UN, and some leadership initiatives by G7 and G20 with alliances forming to prevent and mitigate against worst outcomes.

The international science communities need to continue to engage at national and international levels, addressing international public goods issues such as food trade, food

safety, climate resilience, peace and security, trans-boundary water, equity and inclusion, science and knowledge transfers.[23]

Such science engagement could be facilitated if the UN and its member states were to open up to a process for exploring a convention on food systems comparable to those established for global climate and biodiversity policies. In that context, and building on the experience gained from the structured food systems science and policy interaction during the 2-year UNFSS process, food systems transformations could benefit from a perpetual global framework for science – policy interaction related to food systems moving ahead toward 2030 and beyond.

References

Clapp, J. (2021). The problem with growing corporate concentration and power in the global food system. *Nature Food*, *2*(6), 404-408. https://www.nature.com/articles/s43016-021-00297-7.

Cohn, T.H., A. Hira (2020). Global Political Economy - Theory and Practice. Routledge. New York. DOI https://doi.org/10.4324/9781003056881

Díaz-Bonilla, E. (2021). Financing SGD2 and Ending Hunger. *Food Systems Summit Brief prepared by Research Partners of the Scientific Group for the Food Systems Summit 2021.* https://dx.doi.org/10.48565/scfss2021-ba75.

Davis, B., Lipper, L. & Winters, P. (2022). Do not transform food systems on the backs of the rural poor. *Food Sec.* **14,** 729–740. https://doi.org/10.1007/s12571-021-01214-3.

Fears, R. & Canales, C. (*2021*). The Role of Science, Technology and Innovation for Transforming Food Systems Globally: *Food Systems Summit Brief Prepared by Research Partners of the Scientific Group for the UN Food Systems Summit 2021.* https://doi.org/10.48565/scfss2021-q703.

Hendriks, S, Soussana, J.-F., Cole, M., Kambugu, A. & Zilberman, D. (2021). Ensuring Access to Safe and Nutritious Food for All Through Transformation of Food Systems Paper on Action Track 1. doi.org/10.48565/scfss2021-wg92.

Hendriks, S., de Groot Ruiz, A., Acosta, M.H., Baumers, H., Galgani, P., Mason-D'Croz, P., Godde, C., Waha, K., ..., & Watkins, M (2021). The True Cost and True Price of Food, Scientific Group Report for the Food Systems Summit. https://sc-fss2021.org/wp-content/uploads/2021/06/UNFSS_true_cost_of_food.pdf.

[23] Inter-Academy Partnership. (2018). Opportunities for future research and innovation on food and nutrition security and agriculture: The Inter-Academy Partnership's global perspective. https://www.interacademies.org/sites/default/files/publication/iap_fnsa_global_web_complete_28nov.pdf

Herrero, M., Hugas, M., Lele, U., Wira, A., & Torero, M. (2021). Shift to Healthy and Sustainable Consumption Patterns. Scientific Group Report for the Food Systems Summit: A Paper on Action Track 2. *The Scientific Group for the UN Food System Summit 2021* https://dx.doi.org/10.48565/scfss2021-9240.

Hertel, T W., Elouafi, I., Frank, E., & Morakot, T. (2021). Building Resilience to Vulnerabilities, Shocks and Stresses: A paper on Action Track 5. *The Scientific Group for the UN Food System Summit 2021.* https://dx.doi.org/10.48565/scfss2021-cz84.

Hodson, E., Urs, N., Kaoru, K., Lal, R., Sadoff, C (2021). Boost Nature Positive Production: A paper on Action Track 3. *The Scientific Group for the UN Food System Summit 2021.* https://dx.doi.org/10.48565/scfss2021-q794.

IPCC. (2019). Summary for Policymakers. In: Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems [P.R. Shukla et l., (eds.)]. https://www.ipcc.ch/site/assets/uploads/sites/4/2020/02/SPM_Updated-Jan20.pdf.

Lal, R. (2017). Improving soil health and human protein nutrition by pulses-based cropping systems. Advances in Agronomy, 145, 167-204. https://doi.org/10.1016/bs.agron.2017.05.003.

Leape, J., Micheli, F., Tigchelaar, M., Allison, E. H., Basurto, X., Bennett, A., Bush, S. R., Cao, L., ..., & Wabnitz, C. C.C. (2021). The Vital Roles of Blue Foods in the Global Food System, - Protect and develop the potential of blue foods to help end malnutrition, *Food Systems Summit Brief Prepared by Partners of the Scientific Group* https://dx.doi.org/10.48565/scfss2021-bg71.

Mirzabaev, A., Wu, J., Evans, J., García-Oliva, F., Hussein, I.A.G., Iqbal, M.H., Kimutai, J., Knowles, T., …, & Weltz, M. (2019). Desertification. In: Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems[P.R. Shukla, et al. (eds.)]. https://www.ipcc.ch/site/assets/uploads/sites/4/2019/11/06_Chapter-3.pdf.

Mukand, S W, & Rodrik, D. (2020). The Political Economy of Liberal Democracy. The Economic Journal, Volume 130, Issue 627, April 2020, Pages 765–792, https://doi.org/10.1093/ej/ueaa004

Neufeld, L M., Jikun. H., Ousmane, B., Patrick C., & Forsse, L. S. (2021). Advance Equitable Livelihoods: A paper on Action Track 4. The Scientific Group for the UN Food System Summit 2021. https://dx.doi.org/10.48565/scfss2021-tw37.

Niggli, U., Sonnevelt, M., & Kummer, S. (2021). Pathways to advance agroecology for a successful transformation to sustainable food systems. *Food Systems Summit Brief*

prepared by Research Partners of the Scientific Group doi.org/10.48565/scfss2021-wf70.

Peil, J. & van Staveren, I. (2009). Handbook of economics and ethics. Cheltenham, UK: Edward Elgar. 2009. *ISBN 978-1-84542-936-2. OCLC 300403624.*

Rausser, G., Swinnen, J., & Zusman, P. (2012). Political Power and Economic Policy: Theory, Analysis, and Empirical Applications. Cambridge University Press. UK.

Swinnen, J. (2018). The Political Economy of Agricultural and Food Policies. New York: Palgrave Macmillan.

Valin, H., Hertel, T., Bodirsky, B. L., Hasegawa, T., & Stehfest, E. (2021). Achieving Zero Hunger by 2030 A Review of Quantitative Assessments of Synergies and Tradeoffs amongst the UN Sustainable Development Goals: A paper from the Scientific Group of the UN Food Systems Summit 2021. https://doi.org/10.48565/scgr2021-2337.

van Vliet, S., Kronberg, S. L., & Provenza, F. D. (2020). Plant-Based Meats, Human Health, and Climate Change. *Frontiers in Sustainable Food Systems, 4*, 128. https://doi.org/10.3389/fsufs.2020.00128.

von Braun, J., Afsana, K., Fresco, L. O., Hassan, M., & Torero, M. (2021). Food system concepts and definitions for science and political action. *Nature Food*, *2*(10), 748-750. https://doi.org/10.1038/d41586-021-02331-x.

von Braun, J., Afsana, K., Fresco, L. & Hassan, M. (2021). Food systems: seven priorities to end hunger and protect the planet, Nature. Sept 2021. https://www.nature.com/articles/d41586-021-02331-x.

von Braun, J. Afsana, K. Fresco, L., Hassan, M. (Ed.) (2023) Science and Innovations for Food Systems Transformation. Open access book. Springer Publ. https://doi.org/10.1007/978-3-031-15703-5 https://link.springer.com/content/pdf/10.1007/978-3-031-15703-5.pdf?pdf=button

Annex A

Table 1: Regression analyses: results of Models I – V

SUMMARY OUTPUT
Model I:

Regression Statistics	
Multiple R	0,415028
R Square	0,172249
Adjusted R Square	0,134962
Standard Error	1,061841
Observations	117

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	5	26,04339	5,208678	4,619644	0,000723
Residual	111	125,1532	1,127506		
Total	116	151,1966			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	6,353742	2,214984	2,868527	0,004937	1,964603	10,74288	1,964603	10,74288
GDP log	-0,42626	0,212733	-2,00375	0,047533	-0,84781	-0,00472	-0,84781	-0,00472
PoU log	-0,10341	0,15365	-0,67301	0,502341	-0,40788	0,20106	-0,40788	0,20106
Agr GDP log	-0,02788	0,165302	-0,16867	0,866361	-0,35544	0,299675	-0,35544	0,299675
GE.EST	0,721623	0,203956	3,538122	0,00059	0,317469	1,125776	0,317469	1,125776
Dummy many pages	1,048023	0,41823	2,505852	0,013666	0,219272	1,876773	0,219272	1,876773

SUMMARY OUTPUT Model II

Regression Statistics	
Multiple R	0,414773
R Square	0,172036
Adjusted R Square	0,142466
Standard Error	1,057225
Observations	117

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	26,01131	6,502828	5,81791	0,000272
Residual	112	125,1853	1,117726		
Total	116	151,1966			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	6,054894	1,323509	4,574879	1,24E-05	3,43253	8,677258	3,43253	8,677258

PoU log	-0,09642	0,147315	-0,65451	0,514126	-0,3883	0,195466	-0,3883	0,195466
GE.EST	0,716574	0,200872	3,567326	0,000532	0,318573	1,114576	0,318573	1,114576
GDP log	-0,3992	0,139093	-2,87004	0,004908	-0,6748	-0,12361	-0,6748	-0,12361
Dummy many pages	1,053114	0,415326	2,535631	0,012603	0,230198	1,87603	0,230198	1,87603

SUMMARY OUTPUT
Model III

Regression Statistics	
Multiple R	0,377237
R Square	0,142308
Adjusted R Square	0,111676
Standard Error	1,076038
Observations	117

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	21,51645	5,379112	4,645742	0,001657
Residual	112	129,6801	1,157858		
Total	116	151,1966			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	1,965757	0,336925	5,834412	5,33E-08	1,298184	2,633331	1,298184	2,633331
PoU log	0,031361	0,139994	0,224014	0,823154	-0,24602	0,308742	-0,24602	0,308742
Agr GDP log	0,221913	0,110004	2,017316	0,046054	0,003954	0,439871	0,003954	0,439871
GE.EST	0,49741	0,172801	2,878517	0,004787	0,155027	0,839793	0,155027	0,839793
Dummy many pages	1,116281	0,422414	2,642624	0,009404	0,279322	1,953239	0,279322	1,953239

SUMMARY OUTPUT Model IV

Regression Statistics	
Multiple R	0,333381
R Square	0,111143
Adjusted R Square	0,087545
Standard Error	1,090555
Observations	117

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	16,80447	5,601489	4,709862	0,003898
Residual	113	134,3921	1,189311		
Total	116	151,1966			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	2,340074	0,285021	8,210168	4,01E-13	1,775395	2,904753	1,775395	2,904753

PoU log	0,060275	0,141138	0,427063	0,670146	-0,21934	0,339894	-0,21934	0,339894
GE.EST	0,32788	0,153027	2,142636	0,034288	0,024707	0,631054	0,024707	0,631054
Dummy many pages	1,102292	0,428055	2,575117	0,011312	0,254238	1,950346	0,254238	1,950346

SUMMARY OUTPUT
Model V

Regression Statistics	
Multiple R	0,376727
R Square	0,141923
Adjusted R Square	0,119143
Standard Error	1,071506
Observations	117

ANOVA

	Df	*SS*	*MS*	*F*	*Significance F*
Regression	3	21,45834	7,152781	6,229961	0,000593
Residual	113	129,7382	1,148126		
Total	116	151,1966			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	2,019726	0,234545	8,611261	4,89E-14	1,555051	2,484402	1,555051	2,484402
Agr GDP log	0,224436	0,108965	2,059703	0,041724	0,008556	0,440315	0,008556	0,440315
GE.EST	0,476235	0,144046	3,306123	0,001268	0,190853	0,761617	0,190853	0,761617
Dummy many pages	1,126925	0,417965	2,69622	0,008086	0,298861	1,954989	0,298861	1,954989