Assessing the impact of shocks on food insecurity:

An empirical analysis of the Asia-Pacific

Master's Thesis

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Declaration

I, Kaushal Prakash, sole author of this master's thesis, confirm that the work of this thesis is my own work and all used sources have been referenced and cited in-text.

Sincerely,
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Abstract

This quantitative study is focused on researching the relationship between multifaceted shocks in food systems and resulting food insecurity measured through undernourishment prevalence in the Asia-Pacific region from 2002-2021. The contribution that this study makes to the literature is an in-depth analysis of shocks and resulting risk in food insecurity outcomes whereas traditional literature has placed greater emphasis on vulnerability & resilience studies. Utilising a panel data regression analysis fixed effects model, the results of this study show that unemployment and food price inflation shocks had the most statistically significant effects in increasing undernourishment prevalence throughout the region from 2002-2021, with food price inflation showing the stronger effect. Moreover, these results displayed that the access dimension of food insecurity is considered the most at-risk to increase the prevalence of food insecurity in the Asia Pacific region. Lastly, the study found that while shocks do have an impact, majority of the variation in undernourishment prevalence within Asia-Pacific from 2002-2021 is explained by long term systemic vulnerabilities and lack of resilient coping capacities. This study is characterised for its focus on specifically analysing shocks and resulting risk in food insecurity outcomes which adversely impacts food systems.

Keywords: Risk, Shocks, Food systems, Undernourishment prevalence, Food insecurity, Asia Pacific

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Zásady pro vypracování

This thesis will research food insecurity in Asia Pacific States. This thesis will be conducted under the supervision of Professor Maria Sassi who has extensive research experience in the topic of food insecurity. Furthermore, my thesis will be a quantitative based paper based on existing data and previous research literature in the field. While the exact independent and dependent variables have yet to be identified, my thesis will attempt to look at several data-backed indicators of adaptive capacity, resilience, vulnerability, and various shock exposure types among populations across Asia-Pacific countries. These indicators will then be analyzed regarding the overall effect of food insecurity within the Asia-Pacific countries studied.

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Resilience and household food security: a review of concepts, methodological approaches and empirical evidence. Food Security (2019), A methodological framework for rapidly assessing the impacts of climate risk on national-level food security through a vulnerability index. Global Environmental Change (2014), FAO-Building sustainable and resilient food systems in Asia and the Pacific-regional conference (2020), FAOSTAT datasets, and more.

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1. <u>Introduction</u>

We live in a time where shocks to food systems are becoming more frequent, volatile, and unpredictable. The occurrence of these shocks increases adverse outcomes for food security across countries and regions of the world. This study aims to understand the relationship between multifaceted shocks and food insecurity which is measured through undernourishment prevalence in the Asia-Pacific from 2002-2021. Moreover, this study is interested in understanding which specific volatile shocks have the strongest effect on increasing food insecurity. In addition, there is a focus on understanding which dimensions of food insecurity are considered the most at-risk to increase undernourishment prevalence when shocks occur. Lastly, this study in interested in discovering how much of food insecurity in the form of undernourishment prevalence is explained by the occurrence of shocks in comparison to long term systemic stresses such as vulnerabilities and lack or resilient capacity among individuals, households, and governments.

To address these critical research questions a discussion of the literature is provided in the sections below. The literature highlights which multifaceted shocks this study will be analysing in addition to mentioning how the existing literature is limited on its analysis of shocks to food systems. After providing an understanding of the Asia-Pacific as the key regional focus of this study, a panel data regression with fixed effects model is deployed to quantitatively assess the effects of various shocks on undernourishment prevalence in the region. In summary, the results found that economic shocks in the form of unemployment and food price inflation had the most statistically significant effects in increasing undernourishment prevalence throughout the region from 2002-2021, with food price inflation showing the stronger effect. Moreover, these results displayed that the access dimension of food insecurity is considered the most at-risk to increase the prevalence of food insecurity in comparison to other dimensions analysed in this study. The study also found that while shocks do have an impact, majority of the variation in undernourishment prevalence in explained by long terms systemic vulnerabilities and lack of resilient coping capacities. This study is concluded with a detailed discussion on the limitations present within the study, the contributions made to the literature, and policy implications in terms of calls for future research & analysis of shocks to food systems.

2. <u>Literature review</u>

This section will discuss the various literature related to how multifaceted shocks increase food insecurity within food systems. First, a theoretical understanding of how shocks are conceptualised as a catalyst to increasing risk within food systems will be provided. After an overview of key definitions incorporated into this study, the literature will validate the assumption that food insecurity is an outcome of shocks affecting the food system. Moreover, with specific reference and introduction to the Asia-Pacific, this section will also highlight the specific salient shocks that have impacted the region over the past two decades. As a result, based on the literature, justifications for analysing relevant shocks that lead to food insecurity in food systems will be provided. Moreover, this literature review section will further highlight how my study of risk in food systems aims to contribute to the overall literature by focusing on shocks and risk which are under-analysed in the literature compared to vulnerability and resilience studies. Lastly, my predictor or independent variables of study will be conceptually categorised into the dimensions of food insecurity.

<u>An overview of concepts and traditional literature</u>

<u>Food Systems</u>

This study specifically focuses on the relationship of shocks increasing risk to food insecurity outcomes within food systems. However, before we dive into an understanding of shocks, risks, and food insecurity, it is essential to have a comprehension of food systems which are all encompassing. As previously mentioned, food systems refer to the entirety of food as we know it which ranges from production, aggregation, processing, distribution, storage, transportation, and consumption. These key processes in this cycle are all influenced and actively affected by actors and interconnected activities which include labour, inputs, knowledge, access to natural resources, finance, organisations, infrastructures, policies, laws, regulations, and socio-cultural norms. All these constantly moving processes, actors, and interconnected activities affect agriculture, forestry, fisheries, climate, water, natural eco-systems in food, and surrounding

socio-economic environments (FAO 2018[1], UNFSS 2021[2]). As a result, the continuous interaction of all these multifaceted factors affects outcomes which include sustainable food systems, poverty reduction, and food security. This study is concerned with outcome of food insecurity due to the occurrence of shocks in food systems.

Food Insecurity

Now that an overview of food systems has been provided, food insecurity as a negative outcome of food systems will be discussed. In summary, food insecurity refers to being unable to acquire access to nutritious, safe, and sufficient food to meet growth, development, and dietary needs & preferences of households and individuals (FAO 2022)[3]. However, to truly rationalise food insecurity and recognise its broad range of impact, a conceptual framework of the various dimensions surrounding food security must be presented.

Food insecurity affects all four dimensions of risk in food security: Availability, Access, Utilisation, and Stability. (FAO 2022)

Food insecurity in the availability dimension refers to food not being physically available to meet the quantity and quality dietary needs of a population. The availability dimension involves the macro-economic cycles of food in which the unit of analysis includes production, processing, distribution, and storage.

Food insecurity in the access dimension refers to households and individuals being unable to obtain food either through purchase, subsistence production, or social welfare and safety nets such as food assistance programs. Even though the unit of analysis for the access dimension is individuals and households, food access is multi-layered since the acquisition of food is

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[1] - Food and Agriculture Organization of the United Nations (FAO), 2018, *Sustainable Food Systems: Concept and Framework,* https://www.fao.org/3/ca2079en/CA2079EN.pdf

[2] - United Nations Food Systems Summit 2021,, *Food Systems: Definition, Concept, and Application for the UN Food Systems Summit,* https://sc-fss2021.org/wp-content/uploads/2021/06/Food_Systems_Definition.pdf

[3] - Food and Agriculture Organization of the United Nations (FAO), 2022, *State of Food Security and Nutrition in the World*

dependent upon the affordability of food and numerous social barriers that are likely to prevent or limit access to food.

Similar to the access dimension, the unit of analysis for the food insecurity in the utilisation dimension is individuals and households. In regard to the utilisation dimension, when there is food insecurity, individuals and households are unable to use the food they have access to or acquired to meet their dietary needs and preferences. This includes poor access to safe drinking water, sanitation and health services which exacerbate food insecurity.

When food systems are unable to recover from a multitude of non-food related shocks which range from various economic crisis to natural disasters, to political conflict, violence, and more, then the stability dimension of food insecurity is considerably affected. Since the unit of analysis for the stability dimension consists of the food system in its entirety, risk incurred in the stability dimension results in further vulnerabilities across the other food security dimensions of availability, access, and utilisation.

However, recent academic literature and inter-agency organisations (Clapp et al 2022[4], HLPE 2012[5]) argue that there are two more dimensions to consider to truly assess the full-scale impact of food insecurity in food systems. These involve the inclusion of Agency and Sustainability.

Food insecurity in the agency dimension consists of individuals, communities, and other actors being unable to make informed decisions and actions which would positively influence their prosperity outcomes. For example, food insecurity in the agency dimension takes the form of poor education & knowledge regarding nutrition and dietary good practices. Instances include the lack of, or poor policies, investments, and regulations in food systems that increase negative outcomes. Essentially, agency is a unique dimension in which its unit of analysis can apply to individuals, communities, governments, and organisations. Agency is concerned with the responsiveness of these previously mentioned actors to meet needs and preferences catered to food systems.

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[4] Clapp, J., Moseley, W. G., Burlingame, B., & Termine, P. (2022). *The case for a six-dimensional food security framework. Food Policy, 106*, 102164.

[5] - High Level Panel of Experts (HLPE). 2012. *Food Security and Climate Change.:A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security. Rome*

Increasing food insecurity in the sustainability dimension applies to food systems being unable to meet their current needs without compromising on the needs of future generations. The non-efficient use of natural resources, lack of ecosystems preservation, proper sustainable waste reduction, and pollution mitigation measures is likely to exacerbate the risk of food insecurity in food systems. Essentially, sustainability as a food security dimension prioritises a sense of social equity which ensures that needs and preferences are met for future generations and vulnerable groups.

Now that all dimensions of food insecurity have been introduced and defined, this study will analyse the dimensions of access, availability, and stability to conceptually represent our independent shock variables in this study. The shocks analysed in this study will be mapped according to the dimensions of food insecurity risk to visually represent the various processes by which food systems are affected when it comes to shocks. Utilisation, agency, and the sustainability dimension have not been factored into this study since those dimensions represent measures of vulnerabilities and resilience, while availability, access, and stability are directly related to shocks in food systems.

Understanding shocks in the context of food systems and food insecurity

The State of Food and Agriculture Report (FAO 2021[6]) defines shocks as short-term deviations from longer term trends which have considerable negative effects on food systems, the wellbeing of people, livelihoods, assets, and safety. Furthermore, the ability to withstand future shocks is heavily compromised. Shocks are multi-varied in the sense that they can be meteorological/geophysical which includes climate variability and several natural disasters such as earthquakes, floods, cyclones, drought, landslides, and much more. Shocks are both naturally induced or manmade which considers market failures, inflation, currency devaluations, conflict, political instability, and more. Shocks are also a biological phenomenon which includes human epidemics in the form of respiratory infectious diseases or animal

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[6] Food and Agriculture Organization of the United Nations (FAO), 2021, *State of Food and Agriculture Report: Making agrifood systems more resilient to shocks and stresses"*

epidemics prominent in specific regions of the world (Sagara 2018[7]). While there are numerous instances of shocks, this study will analyse shocks to food systems in the Asia-Pacific region that are identified under the categories of man-made and natural geophysical/meteorological. Biological health related shocks will not be included in this study and is further elaborated on in the limitations section of this study.

Now that the definition of shocks to food systems and the various contexts in which they operate has been provided, understanding the identifying nature and time frame of shocks is key. Shocks can be interpreted as either covariate or idiosyncratic (Sagara 2018). Covariate shocks events feature substantial numbers of people in a given geographic area being affected at once. Idiosyncratic shocks on the other hand are shocks which affect specific individuals or households at a time within a community. This is the measure of scale referred to for shocks.

Complementary to that, the time dimension categorisation of shocks plays a large role in understanding the effect of shocks. Shocks can either be acute in which events rapidly or suddenly occur in a short period of time or shocks can be transformed into systematic stresses which are slow occurring and affects people at an extended protracted period of time such as poverty, population density, obesity, and more. Based on this methodological categorisation, the shocks analysed in this study will be shocks that are both covariate and acute in terms of measure of scale and time. In summary, my study will analyse only shocks in Asia-Pacific food systems and not long-term stresses.

Deviation from the traditional literature: A move away from Vulnerability and Resilience

A multitude of institutions, qualitative & quantitative food systems & food security studies research the discipline in the literature under pursuit of traditional outcomes such as vulnerability and resilience. Before elaborating more on these various studies, a basic overview of vulnerability and resilience is introduced to show the contrast and contribution that my study intends to add to the literature.

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[7] -   Sagara, B. (2018). *Resilience Measurement Practical Guidance Note Series 2: Measuring Shocks and Stresses. Produced by Mercy Corps as part of the Resilience Evaluation, Analysis and Learning (REAL) Associate Award.*

Vulnerability is formally defined as the probability that households/individuals have in becoming food insecure in the future (FAO.org[8]). Shocks and long-term stresses have the ability to induce vulnerabilities. For example, in the events of crop failure or volatile markets, vulnerability increases for individuals and households since their access and affordability has been affected.

Essentially, vulnerability is understood as an outcome. Vulnerability either increases, decreases, or stays stagnant depending on one or a set of events which include the incidence of rapid random shocks. This has led to a plethora of research papers concerning vulnerability since researchers have been primarily interested in measuring the probability of vulnerability and the effects it has on the human condition in relation to food insecurity because of adversities in household food acquisition, poverty, gender inequality, rural urban divides, production flaws, trade exposures, market volatilities, disease burdens, and more. Previous literature includes measuring food security vulnerability as a result of famine in sub-Saharan Africa (Baro et al 2006[9]), measuring food security vulnerability as a result of population growth and climate change (Godeber et al 2014[10]), vulnerability in relation to trade dependencies (Hellegers 2022[11]), vulnerability as an outcome of cash transfers (Bhalla et al 2018[12]), vulnerability in relation to regional urban rural inequalities (Yin et al 2009[13]), vulnerability as an outcome of pandemics (Moseley 2020[14]), and much more.

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[8] - Food and Agriculture Organization of the United Nations (FAO), *Component 2: Food Insecurity Vulnerability Analysis* https://www.fao.org/in-action/amicaf/countries/phl/vulnerability-analysis/en/

[9] - Baro, M., & Deubel, T. F. (2006). *Persistent hunger: Perspectives on vulnerability, famine, and food security in sub-Saharan Africa. Annu. Rev. Anthropol., 35, 521-538.*

[10] - Godber, O. F., & Wall, R. (2014). *Livestock and food security: vulnerability to population growth and climate change. Global change biology, 20(10), 3092-3102*

[11] - Hellegers, P. (2022). *Food security vulnerability due to trade dependencies on Russia and Ukraine. Food Security, 14(6), 1503-1510.*

[12] - Bhalla, G., Handa, S., Angeles, G., & Seidenfeld, D. (2018). *The effect of cash transfers and household vulnerability on food security in Zimbabwe. Food policy, 74, 82-99.*

[13] - Yin, P., Fang, X., & Yun, Y. (2009). *Regional differences of vulnerability of food security in China. Journal of Geographical Sciences, 19, 532-544.*

[14] - Moseley, William G., and Jane Battersby. (2020) *"The vulnerability and resilience of African food systems, food security, and nutrition in the context of the COVID-19 pandemic." African Studies Review 63, no. 3 : 449-461.*

Resilience is another key outcome that is treated similarly to vulnerability despite being defined as contrasting or differing terms. Resilience refers to a food system's adaptive capacity to provide sufficient, nutritious, and accessible food to all in the face of adverse and unforeseen disturbances at all levels ranging from individuals, households, communities, to governments (Tendall et al 2015[15]). Examples at the individual level include having alternate sources of income to maintain food security in the face of shocks and implementing early warning systems for communities and contingency planning at an institutional level.

While vulnerability measures the probability that households will become food insecure because of shocks, resilience measures the probability of households and other actors adapting to shocks. Resilience is focused on capabilities at varying units of analysis which range from the adaptive capacity of economic and public institutions, participation, human capital capabilities, agricultural productivity, climate adaptive capacity, resource management and more. Previous literature in food security includes relationships between urban infrastructure and resilience (Barthel et al 2013[16]), the role of sustainable assets in increasing food security resilience in coastal regions (Wright et al 2012[17]), comprehending equity and resilience in food systems (Cafer et al 2019[18]), traditional rural-based household level resilience to food insecurity inducing shocks (Boukary et al 2016[19]), labour based agricultural productivity resilience measures for farmers increasing food availability (Asfaw et al 2016[20]), and much more.

In summary, the analysis of this literature review subsection was conducted to display how the literature on food insecurity has placed greater emphasis on researching vulnerability and

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[15] - Tendall, D. M., Joerin, J., Kopainsky, B., Edwards, P., Shreck, A., Le, Q. B., ... & Six, J. (2015). *Food system resilience: Defining the concept. Global Food Security, 6, 17-23.*

[16] - Barthel, S., & Isendahl, C. (2013). *Urban gardens, agriculture, and water management: Sources of resilience for long-term food security in cities. Ecological economics, 86, 224-234.*

[17] - Wright, H., Kristjanson, P. M., & Bhatta, G. D. (2012). *Understanding adaptive capacity: Sustainable livelihoods and food security in coastal Bangladesh. CCAFS working paper.*

[18] - Cafer, A., Green, J., & Goreham, G. (2019). *A community resilience framework for community development practitioners building equity and adaptive capacity. Community Development, 50(2), 201-216.*

[19] - Gambo Boukary, A., Diaw, A., & Wünscher, T. (2016). *Factors affecting rural households' resilience to food insecurity in Niger. Sustainability, 8(3), 181.*

[20] - Asfaw, S., McCarthy, N., Lipper, L., Arslan, A., & Cattaneo, A. (2016). *What determines farmers' adaptive capacity? Empirical evidence from Malawi. Food Security, 8(3), 643-664.*

resilience as outcomes when shocks occur. However, there is far less academic and official organisational literature on the analysis of shocks in food systems and food insecurity. Highlighted in greater depth in the following section, the contribution that my thesis aims to make to the existing literature is to analyse the effects and nature of shocks in Asia-Pacific food systems measuring risk as an outcome rather than vulnerabilities or resilience.

Understanding risk in food systems

Risk in the context of food insecurity is defined as the expected degree of loss due to a specific natural phenomenon and as a function of both shocks and vulnerabilities (Dilley et al 2001[21]). In other words, risk is the probability of loss from an event which can be a result of a shock or a growing vulnerability in individuals, households, populations, communities, governments, and more.

For example, before the occurrence of a shock like an earthquake, the construction quality of physical infrastructure around you would be considered as a vulnerability, and vulnerability measured after an earthquake would be the proportion of the population in this earthquake affected area living without adequate housing. On the other hand, risk would be measured much differently. Using the same example, before the occurrence of an earthquake shock, the risk or 'measure of loss' (Dilley et al 2001) is the probability of infrastructure collapsing & potential lives lost, and after an earthquake shock has occurred, the risk measured is clearly the number of lives lost and infrastructure damage incurred.

In the context of other global shocks, the unit of analysis will surely change but the fundamental idea of probability of loss as result of a shock will stay the same. When economic shocks occur such as recessions or inflation, unit of analysis in monetary and the probability of loss or risk is measured in wages and percentage spikes in inflation rates. With trade dependency, the unit of analysis is countries/governments with risk measured in dependency ratios of specific food commodities. In essence, these vital examples are able to clearly delineate the relationship between shocks occurring and the resulting risk or loss incurred as an outcome.

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[21] - Dilley, M., & Boudreau, T. E. (2001). *Coming to terms with vulnerability: a critique of the food security definition. Food policy, 26(3), 229-247.*

What is the relevance of analysing shocks in the context of risk?

This study makes several contributions to the literature. By deviating away from vulnerability and resilience-based studies and prior research, this study aims to add to the limited literature on the relationship between shocks and resulting risks in the context of food insecurity. Furthermore, there is imperative decision-making relevance and policy implications for supporting studies that focus on the effects of risks. Capturing the severity of risks based on different shocks in different areas enables better resource allocation decisions to be made by policymakers. By focusing on the most severe threats to a community and encompassing food systems, the incidence of risk in the future decreases more which in turn decreases future vulnerabilities and builds resilience.

To justify this argument, (Boudreau 1998[22]) presented findings of an evaluation project in North Tanzania where food security outcomes among impoverished households across six different zones were analysed based on the effects of a hypothetical drought shock & crop failure. Essentially, the treatment of a single hypothetical shock on 6 communities displayed how the effect of the shock was not uniform across all six districts. With risk clearly more evident in certain regions based on data, geographic targeting of social assistance programs became a reality. In summary, understanding risk from shocks results in informed policy decisions. On that note, my study aims to analyse the effects of several multifaceted shocks and resulting risks on food systems of Asia-Pacific countries in the context of food insecurity using data from 20 years. One of the objectives of this study is to inform potential policy implementers and decision makers by capturing risk trends seen across the expansive Asia-Pacific region.

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[22] - Boudreau, T. (1998). *The food economy approach: a framework for understanding rural livelihoods (p. 32). London: Overseas Development Institute.*

Research regional context and dependent variable: Undernourishment in The Asia-Pacific

The Asia Pacific region is the largest region of the planet in terms of sheer landmass and population size. This bulk of our planet comprises of 60 percent of the world's population which is a substantial 4.3 billion people (UNFPA[23]) Geographically, the entire region stretches from the Eurasian and Central Asian bloc of countries, coming all the way to the densely populated and growing sub-region of South Asia, reaching the wide range of South-East Asian identifying countries and splitting northwards and south respectively into East Asia and Oceania & the South Pacific. With a region classified with these extensive credentials and scope, any development issue is going to have a considerable impact, and food insecurity is not any different.

Asia and the Pacific is crucially off track towards achieving Targets 2.1 and 2.2 of the Sustainable Development Goals (SDGs). Target 2.1 is highlighted as follows "By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round". Moreover, Target 2.2 is spotlighted as follows. "By 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons" (UNSTATS[24]).

The *Regional Overview of Food Security and Nutrition 2022* (FAO, UNICEF, WFP & WHO. 2023[25]) brings attention to the alarming statistics encompassing the region on food insecurity measured through undernourishment. Of the planet's 767.9 million people that are undernourished, 52% are from the Asia Pacific region. 83% of that 52 percent demographic of undernourished are specifically from the South Asia region. Moreover, despite the prevalence of undernourishment almost decreasing by half from 14.3% in 2000 to 7.3% in 2019, the rate

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[23] - United Nations Population Fund, Asia and the Pacific overview, *https://asiapacific.unfpa.org/en/populationtrends*

[24] - United Nations, Department of Economic and Social Affairs, *Statistics Division, UNSTATS, SDG Indicators metadata repository https://unstats.un.org/sdgs/metadata/?Text=&Goal=2&Target*

[25] - FAO, UNICEF, WFP & WHO. 2023. *Asia and the Pacific – Regional Overview of Food Security and Nutrition 2022. Urban food security and nutrition. Bangkok, FAO*

or velocity of decline was slowing down much before the Covid-19 pandemic due to climate change, conflict, and a variety of other factors and shocks. Of course, the pandemic increased the frequency of undernourished in the Asia Pacific from 370 million in 2020 to 396 million in 2021 with the prevalence of undernourishment rising by 9.1% at a regional unit of analysis (FAO, UNICEF, WFP & WHO. 2023). While it is obvious that a shock like a pandemic would increase food insecurity, the more alarming implication is that food systems in the region are still not adequately adaptive, resilient, or robust enough to withstand and recover from shocks despite considerable economic growth seen cross-country over the past two decades. Overall, these key statistics show how the outcome of food insecurity, indicated through the prevalence of undernourishment, is understood in the Asia-Pacific region.

With a region of the world consisting of the largest population and land mass, it becomes necessary to find a formal way to recognise sovereign countries' identifying as Asia-Pacific countries. Thus, for the purposes of this study, my thesis will be analysing countries that are members of the United Nations Economic and Social Commission of Asia and the Pacific (UNESCAP). The formal institution headquartered in Bangkok, Thailand acts as one of five regional commissions which represent UN member states for that particular region. The full list of regional commissions include Economic Commission for Africa (ECA), Economic Commission for Europe (ECE), Economic Commission for Latin America and the Caribbean (ECLAC), Economic and Social Commission for Western Asia (ESCWA) (NOTE: Representation for this organisation is comprised of Middle Eastern and North African States), and finally as mentioned before for this study, Economic and Social Commission of Asia and the Pacific (UNESCAP).

The purpose of these sub-organizations within the UN system is to promote regional cooperation and development (UN Research Group[26], UNESCAP[27]). More importantly for the purposes of this study, the organisation formally demarcates the lines of membership based on regions of the world. As a result, for this study, my regional analysis of Asia-Pacific is formally composed of 53 UNESCAP member states which will be highlighted further in the data and variables section. Not all member states were included in the analysis due to data collection

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[26] - United Nations Research,
https://research.un.org/en/docs/unsystem/regionalcommissions#:~:text=There%20are%20five%20regional%20commissions ,Latin%20America%20and%20the%20Caribbean

[27] United Nations Economic and Social Commission for Asia and the Pacific *https://www.unescap.org/about/member-states*

issues, but this is discussed further in the data and methods section. Overall, this study aims to utilise undernourishment prevalence in the Asia-Pacific as its dependent variable to quantitatively measure food insecurity as a result of shocks over the past two decades.

Independent variables: Shocks

Food Price Inflation

This study seeks to cover the impact of food price inflation shocks on the prevalence of undernourishment in Asia-Pacific countries using data over the past two decades. Food price inflation is the broad increase in the price of food commodity goods and services over time. While this will be highlighted in much more detail in my methods section, food inflation captures the percentage increase in a basket of food items consumed by households. Inflation generally and food inflation are one of many factors which reduces the value of a currency over time (ECB[28]).

The economic theory regarding the relationship between food price inflation and undernourishment & other adverse health outcomes is relatively straightforward. As the prices of food commodities increase, they become more expensive to purchase for households. When the price of food goes beyond the affordability of consuming the adequate number of calories and nutrition needed for a healthy diet and productive lifestyle, we observe negative outcomes such as food insecurity in form of undernourishment and other specific adverse health outcomes such as stunting, wasting, malnutrition, and more (Headey et al 2022[29]).

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[28] - European Central Bank, *What is inflation? https://www.ecb.europa.eu/ecb/educational/explainers/tell-me-more/html/what_is_inflation.en.html*

[29] Derek D. Headey and Marie T. Ruel, 2022, *Food inflation and child undernutrition in low and middle income countries.* International Food Policy Research Institute

Previous literature has demonstrated this clear relationship between food inflation spikes and rising undernourishment combined with other specific food insecurity indicators such as malnutrition, child wasting, stunting, underweight prevalence, and more. Vellakal et al 2015 conducts an instrumental variable model study in the Indian state of Andhra Pradesh to reveal that spikes in food prices were associated with increased risk probability of child malnutrition[30]. Arndt et al 2012 implements a propensity score matching study based on a household survey in Mozambique to conclude similar results[31]. Their results were similar to the general literature in the sense that the authors discovered that wasting and underweight prevalence is found to be lower when food inflation rate is low. Sassi et al 2016 conducts a regression analyses study considering the impact of domestic food prices on child malnutrition outcomes in Malawi and Niger[32]. Despite this paper focusing on famine struck communities in Malawi and Niger, the results from Sassi et al 2016 are generalisable to display that regardless of the nature of shock that results in a domestic food price spike, there will be undernourishment as a result when there is food price inflation. Dorward et al 2012 collates the existing theoretical and empirical evidence literature on the short term and medium risk impacts of food price inflation[33]. This extensive literature review further justifies the positive relationship between increases in food price inflation and corresponding increase in undernourishment.

As discussed, previous studies have conducted instrumental variable approaches, propensity score matching, and regression analyses in specific locations to understand the relationship between food price inflation and undernourishment. The contribution that my study aims to make to the existing literature is to analyse the same relationship using a cross-country panel-data regression-based research analysing the relationship between food price inflation shocks across countries and a two-decade time span in the Asia-Pacific region.

[30] - Vellakkal, S., Fledderjohann, J., Basu, S., Agrawal, S., Ebrahim, S., Campbell, O., ... & Stuckler, D. (2015). *Food price spikes are associated with increased malnutrition among children in Andhra Pradesh, India. The Journal of nutrition, 145(8), 1942-1949.*

[31] - Arndt, C., Hussain, M. A., Salvucci, V., & Østerdal, L. P. (2016). *Effects of food price shocks on child malnutrition: The Mozambican experience 2008/2009. Economics & Human Biology, 22, 1-13.*

[32] - Cornia, G. A., Deotti, L., & Sassi, M. (2016*). Sources of food price volatility and child malnutrition in Niger and Malawi. Food Policy, 60, 20-30.*

[33] - Dorward, A. (2012). *The short-and medium-term impacts of rises in staple food prices. Food security, 4, 633-645.*

Cereal import trade dependency

Economists have traditionally utilised aggregated trade dependence indexes to measure and compare importance, influence, and dependence that countries have over one another in regard to trade and trade policy. Trade dependence is usually measured in multiple ways which include factoring in share of imports/exports as a proportion of GDP, ratio of general trade to GDP, and the specific commodity export/import trade concentration for a country (Johnston 1992[34]). This study is going to focus on the latter and this specificity is related to cereal import trade dependency. Prior to that, a general overview of trade dependence and its implications will be provided.

Trade dependency occurs when countries rely largely on specific commodities in specific sectors to meet economic growth needs and developmental goals. The implication of this dependency is that a substantial portion of the country's gross domestic product (GDP) is tethered to imports, and any shocks in international trade will have direct repercussions on an economy. However, understanding the nature of trade is complex. One argument for trade dependency is that it can be beneficial for countries since it provides access to the greater international markets, diversifies the national economy in terms of trade networks, and increases competitiveness (Vijayasri 2013[35]). On the other hand, trade dependency increases the probability of risk to external trade related shocks which include shifts in global demand, international supply chain issues, protectionist trade barriers, price fluctuations on the international market, domestic production shortfalls, and more (Anderson et al 2012[36]). This study will focus on the latter, treating trade dependency as a negative effect since prior literature argues that trade dependency shocks increase risk. In the context of this study, cereal import dependency will be analysed since that is a specific trade shock that has a direct relationship with undernourishment.

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[34] - Paul, V Johnston 1992, *Three Measures of Trade Dependence: A Critique, AgEcon Search, Research in Agricultural & Applied Economics*

[35] - Vijayasri, G. V. (2013). *The importance of international trade in the world. International Journal of Marketing, Financial Services & Management Research, 2(9), 111-119.*

[36] - Anderson, K., & Nelgen, *S. (2012). Trade barrier volatility and agricultural price stabilization. World Development, 40(1), 36-48.*

Cereal imports trade dependency demonstrates how much of a country's food supply of cereals such as wheat, maize, barley, oats, rice, millets, rye, sorghum, and more is domestically produced and how much is imported (Hellegers 2022[37]). The reason cereals trade dependency was chosen over other specific trade dependencies is due to the importance cereals has in reducing undernourishment in human beings. Cereals are staple food crops in human food consumption because they provide more energy globally than any other crop type (Sarwar 2013[38]). To provide more key statistics on cereals, in developing countries, maize, rice, and wheat combines provide 48% of total calories and 42% of total protein. If you consider every other region of the world excluding South & Central America, then cereals provide more protein than meat, eggs, fish, and milk combined (Kropff et al 2019[39]).

Thus, it goes without saying that the presence of cereal crops within countries is an enormous factor in calculating food security in national systems. As the literature argues, food security is threatened with increased risk when countries are heavily dependent on importing cereals as scarcity and cost of cereals increases. Furthermore, when shocks in international food trading systems occur, then risk is exacerbated in local food systems. This study aims to capture the impact of risk on undernourishment when countries are import dependent on cereals because of either international or domestic trade/production shocks.

Political instability and the presence of political violence/terrorism

Political instability and the presence of political violence and terrorism are all clear impediments to growth in communities and countries. According to the literature, political instability is defined as the 'propensity of a government collapse' within a country and is directly correlated with lower levels of economic growth, investment, and income distribution

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[37] - Hellegers, P. (2022). *Food security vulnerability due to trade dependencies on Russia and Ukraine. Food Security, 14(6), 1503-1510.*

[38] - Sarwar, M. H., Sarwar, M. F., Sarwar, M., Qadri, N. A., & Moghal, S. (2013). *The importance of cereals (Poaceae: Gramineae) nutrition in human health: A review. Journal of cereals and oilseeds, 4(3), 32-35.*

[39] - Martin Kropff and Matthew Morell (2019) *The cereals imperative of future food systems, International Rice Research Institute,* https://www.irri.org/news-and-events/news/cereals-imperative-future-food-systems

(Alesina et al 1996[40], Peroitt et al 1996[41]). Moreover, political violence and terrorism is formally defined as 'politically motivated violence perpetrated in a clandestine manner against non-combatants. The act is committed in order to create a fearful state of mind in an audience different from the victims' (Ruby 2002[42]). Similarly, extensive previous literature has placed key emphasis on the causal relationship between terrorism and reduced economic growth outcomes (Gries et al 2013[43], Shahbaz 2013[44]). However, the relationship between political instability, political violence & terrorism and undernourishment is much more complex and nonlinear.

The basic rationale is that acts of political instability, political violence, and terrorism would lead to massive disruptions in food systems ranging from extreme displacement and forced migration to disruptions in the food production, processing, and distribution to increased poverty and endemic starvation as a result. Prior literature complements this baseline theory that political shocks would lead to food insecurity. Verwimp 2012 analyses the effect of political violence which is exemplified through civil war in Burundi for this study as an explanatory factor for child undernutrition[45]. Using anthropometric data from a longitudinal survey, the results of the study highlighted those children exposed to civil war had worse nutritional outcomes complemented with higher probability of mortality. Moreover, Kinyoki et al 2017 utilises a Bayesian spatial-temporal regression based on household surveys in Somalia to test the effects of conflicts, domestic terrorism, and internal displacement on child undernutrition[46]. The results displayed that conflict, domestic terrorism, and internal

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[40] -   Alesina, A., Özler, S., Roubini, N., & Swagel, P. (1996). *Political instability and economic growth. Journal of Economic growth, 1, 189-211.*

[41] -   Alesina, A., & Perotti, R. (1996). *Income distribution, political instability, and investment. European economic review, 40(6), 1203-1228.*

[42] -   Ruby, C. L. (2002). *The definition of terrorism. Analyses of social issues and public policy, 2(1), 9-14.*

[43] -   Meierrieks, D., & Gries, T. (2013). *Causality between terrorism and economic growth. Journal of Peace Research, 50(1), 91-104.*

[44] -   Shahbaz, M. (2013). *Linkages between inflation, economic growth and terrorism in Pakistan. Economic modelling, 32, 496-506.*

Voors, M. J., Nillesen, E. E. M., Verwimp, P., Bulte, E. H., Lensink, R., & Soest, D. P. V. (2012). Violent conflict and behavior: a field experiment in Burundi. American Economic Review, 102(2), 941-964.
[45]

[46]

displacement is associated with higher wasting and stunting among children thus increasing undernutrition.

Yet, there is literature raising the counterargument that political violence and instability related shocks do not necessarily increase undernourishment. Headey et al 2015 analyses undernutrition as a result of Nepal's numerous political instabilities and civil war shocks during their tumultuous period of 2001-2011[47]. Deploying an intermediate determinant child and maternal nutritional change mode based on Nepal's demographic health surveys, the results of the study indicate that child stunting not only decreased in Nepal but recorded one of the fastest declines in child stunting. The authors identified four key adaptive capacity measures that were implemented at a steady rate amid conflict and shocks. These four key measures included asset accumulation, health and nutrition interventions, maternal educational gains, and improvements in sanitation. This key piece of literature raises an imperative counterargument which is that the risk of conflict related shocks can be potentially offset if there are steady adaptive capacity measures being implemented as a safety net during political instability shocks.

As a result, my study aims to contribute to the contrasting existing literature by testing the effects of political instability, violence and terrorism shocks on the prevalence of undernourishment in Asia-Pacific countries to observe whether the effect is positive or negative.

Incidence of natural disasters

Natural disasters are calamitous shocks with atmospheric, geological, and hydrological origins and within this specific description includes an exhaustive list of natural disasters and climate shocks such as droughts, earthquakes, floods, hurricanes, landslides, extreme temperatures, and more that cause fatalities, property damage, and social environmental disruption (Xu et al 2016[48]). Yet, within this traditional definition of natural and climate disasters, the inclusion of

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[47] - Headey, D. D., & Hoddinott, J. (2015). *Understanding the rapid reduction of undernutrition in Nepal, 2001–2011. PloS one, 10(12), e0145738.*

[48] Xu, J., Wang, Z., Shen, F., Ouyang, C., & Tu, Y. (2016). *Natural disasters and social conflict: A systematic literature review. International journal of disaster risk reduction, 17, 38-48*

negative health outcomes apart from extreme fatalities and deaths are not properly captured. Phalkey et al 2016 places a substantial emphasis on the importance of including health impacts as a result of natural disasters as a key impact to consider and take adaptive capacity action on through strengthening of health institutions.[49]

Previous literature has conducted research on the relationship between natural and climate disasters directly affecting undernourishment through the use of unique statistical methods, additional variables, and unit measurements. Hasegawa et al 2016 created a cross-country computable general equilibrium model that factored in morbidity and mortality as a result of being underweight[50]. Then the authors took independent variables into account such as uncertainties in crop yields, labour shocks, health expenditures, and severe climate conditions into the model. Most importantly, to measure the effect of climate change and natural disasters on undernourishment, an economic valuation of health as an interpretation of analysis was utilised. Essentially, this study aimed at economically assessing the effect of disasters on undernourishment. The results found that the economic value of a healthy life lost from undernourishment as a result of natural disasters was much larger than the effect of additional health expenditures and jobs lost due to undernourishment from climate change.

Location specific research papers have also utilised various methods to assess the relationship between natural disaster shocks and food insecurity outcomes. Castro et al 2020 utilised non-probabilistic sampling based on the April 2016 Ecuador earthquakes to assess whether a household's nutrition and food security status can be affected after natural disaster shocks[51]. The results showed that all households suffered from mild food insecurity followed by severe food insecurity post-earthquake. Moreover, the nutritional consumption of food was low showing that post-disaster, nutritional intakes are affected which lead to increasing undernourishment in disaster affected populations. For literature more context specific to the Asia-Pacific region, Wendt et al 2018 quantifies the impact of a seasonal flooding in

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[49] -   Phalkey, R. K., & Louis, V. R. (2016). *Two hot to handle: How do we manage the simultaneous impacts of climate change and natural disasters on human health?. The European Physical Journal Special Topics, 225, 443-457.*

[50] -   Hasegawa, T., Fujimori, S., Takahashi, K., Yokohata, T., & Masui, T. (2016). *Economic implications of climate change impacts on human health through undernourishment. Climatic Change, 136, 189-202.*

[51] -   Herrera-Fontana, M. E., Chisaguano, A. M., Villagomez, V., Pozo, L., Villar, M., Castro, N., & Beltran, P. (2020). *Food insecurity and malnutrition in vulnerable households with children under 5 years on the Ecuadorian coast: a post-earthquake analysis. Rural and Remote Health, 20(1).*

Bangladesh on dietary diversity, coping mechanisms, and food insecurity present in women and children in the locality using the treatment of a randomised control trial[52]. The results showed that families with large deficits of rice reserves had their odds doubled for being food insecure and dietary diversity post flooding is lower among women and children.

Essentially, the review of the various literature results on natural disaster shocks affecting undernourishment prevalence clearly indicate that risk observed among individuals and households in terms of undernourishment and nutritional deficiency is highest immediately post-shock. Thus, to measure the effect of various natural disaster shocks on undernourishment, my study will be factoring in the share of affected people as a result of natural disasters and the details of this independent variable will be elaborated on further in the data and methods section.

Unemployment shocks

In simple terms unemployed individuals are working groups above the age of fifteen that are categorised as currently not at work, seeking work, or carrying out activities to seek further employment during a specific period (UNSTATS, ILO[53]).

Unemployment is considered as a shock because it both affects the functioning of productive economies and negatively impacts individuals coping ability through reduced income thus increasing risk. Since this study is looking into the effects of shocks on undernourishment on people, the analysis of unemployment as a shock will be conducted at an individual level. Moreover, since unemployment is a type of shock that affects individuals specifically upon impact, unemployment shocks have been identified as an idiosyncratic shock which is a shock that has the tendency to affect specific individuals or households at a time. Unemployment shocks is the only idiosyncratic shock analysed in this study while the rest of shocks evaluated in this study such as food price inflation, cereal import dependence, political instability, and

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[52] - Gabrysch, S., Waid, J. L., Wendt, A. S., Müller, A. A., Kader, A., & Gosh, U. (2018). *Nutritional effects of flooding due to unseasonably early monsoon rainfall in Bangladesh: A cross-sectional study in an ongoing cluster-randomised trial. The Lancet Planetary Health, 2, S3.*

[53] United Nations Statistics, UNSTATS Metadata, *Reference: International Labour Organization glossary for unemployment rate, https://unstats.un.org/sdgs/metadata/files/Metadata-08-05-02.pdf ,*

natural disasters are all considered covariate due to their tendency to affect droves of people in a given geographic area at the same time (Sagara 2018).

Klasen 2008 examines the relationship between measures of income poverty, undernourishment, child undernutrition, and child mortality in developing countries[54]. Utilising regression analysis, the results of the paper find that insufficient calorie consumption is highest in the Caribbean, child undernutrition is largest in South Asia, and child mortality is largest in Sub-Saharan Africa, but these different regional outcomes do not delineate the causal relationship between income shocks and food insecurity outcomes. To address the gap in the existing literature, my study will attempt to understand the causal relationship between income shocks such as unemployment rates and food insecurity outcomes such as undernourishment specifically in the Asia-Pacific region with the purpose of finding trends that are generalisable within the region to further deepen our understanding of shocks and increased risk.

Mapping Shocks and Undernourishment to Risk Dimensions of Food Insecurity

This sub-section of the literature review will now provide a synthesis of the theoretical frameworks surrounding food systems such as food insecurity dimensions discussed earlier and how these frameworks apply to our study which looks the relationship regarding multifaceted shocks affecting undernourishment prevalence. Now that all proposed independent variables in terms of shocks have been discussed in detail throughout the literature review section, they can now be mapped according to the risk dimensions of food insecurity.

Food price inflation shocks and unemployment shocks will be mapped to the 'Access' dimension in terms of risk to food insecurity. As mentioned earlier in the literature review section, access refers to households and individuals being unable to obtain food either through purchase, subsistence production, or social welfare programs. This dimension of risk to food insecurity is dependent upon food affordability for access to food. Since food price inflation and unemployment shocks affect individual and household affordability, they have been categorised into the access dimension. Thus, this study aims to analyse the effect of how shocks decreasing access to food affect undernourishment in Asia-Pacific food systems.

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[54] Klasen, S. (2008). Poverty, undernutrition, and child mortality: *Some inter-regional puzzles and their implications for research and policy. The Journal of Economic Inequality, 6, 89-115.*

Cereal import dependency shocks will be mapped to the 'Availability' dimension in terms of risk to food insecurity. As mentioned earlier in the literature review section, availability refers to food not being physically available to meet the quantity and quality needs of a population. This dimension of risk is dependent upon the efficiency of production, processing, distribution, and storage in food systems. Since cereal import dependency is an indicator of how efficient and independent national food systems are, they have been categorised into the availability dimension. Thus, this study aims to analyse the effects of shocks decreasing food availability affect the prevalence of undernourishment in the Asia-Pacific region.

Political instability/presence of violence/terrorism and natural/climate disaster related shocks will be mapped to the 'Stability' dimension in terms of risk to food insecurity. As mentioned earlier in the literature review, stability refers a wide range of non-food related volatilities that impact the provision and intake of food in communities. Since political conflicts and natural/climate disaster related shocks represent various non-food related volatilities, they have been categorised into the stability dimension. Thus, this study aims to analyse the effects of non-food related shocks increasing food instability through the prevalence of undernourishment in the Asia-Pacific region. In summary, by categorising various shocks to risk dimensions for food insecurity, we can capture the effects of which shocks under which dimensions are driving the most risk in terms of undernourishment prevalence.

Figure 1.1

Shocks	Risk categorization in food insecurity dimensions
- Food price inflation - Unemployment	Access
- Cereal Import Dependency	Availability
- Political instability/ presence of violence and terrorism - Natural/climate disasters	Stability

3. <u>Research questions & Hypothesis</u>

<u>Research questions</u>

- **Q1:** What is the relationship between multifaceted shocks and undernourishment prevalence in the Asia-Pacific region ranging from a time period of 2002-2021?

- **Q2:** Which specific shocks have the strongest effect, (or any effect at all) on impacting undernourishment prevalence in the Asia Pacific region ranging from a time period of 2002-2021?

- **Q3:** Which dimensions of food insecurity are considered the most at-risk to increase undernourishment prevalence in Asia Pacific region ranging from a time period of 2002-2021?

- **Q4:** How much of variation in undernourishment prevalence risk in the Asia-Pacific region from 2002-2021 is explained by the occurrence of multifaceted shocks in comparison to systematic long-term vulnerabilities and lack of resilient adaptive capacities in food systems?

Hypothesis

- **H1**: Based on the multitude of literature, the hypothetical assumption is that there is a positive relationship between the occurrence of various shocks and undernourishment prevalence in the Asia-Pacific region from 2002-2021. Thus, an increase in shocks to food systems results in an increase in food insecurity measured through undernourishment prevalence.

- **H2:** Based on the literature, the hypothetical assumption is that specific shocks such as food price inflation, cereal import dependency ratio, unemployment, political instability/violence/terrorism, and natural disaster shocks are all expected to have a positive effect in increasing undernourishment prevalence in Asia Pacific region from 2002-2021.

- **H3**: Based on the food security dimensions & independent variables considered for this study, the hypothetical assumption based on the literature is that access, availability, and stability categorised shocks are considered the most at-risk dimensions to increase food insecurity for the Asia-Pacific region from 2002-2021.

- **H4:** In reference to earlier literature that has placed more emphasis on researching long-term systematic vulnerabilities & resilient coping capacities in food systems rather than an elaborate analysis of shocks and risk, the hypothetical assumption is that there is variation in undernourishment prevalence caused from shocks to food systems BUT whether that variation is largely explained by shocks is unknown due to limited literature.

4. <u>Data, Methodology, and Initial Results</u>

<u>Data coverage</u>

Data for this study has been collected for the years ranging from 2002-2021 which is a collective data intake of 20 years for Asia Pacific countries. As mentioned, and justified earlier in the literature review section, this study will utilise Asia-Pacific countries that are formally recognised as members of the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP). The specific Asia-Pacific countries that will be collectively analysed for this cross-country analysis study in alphabetical order are:

- Afghanistan, Armenia, Australia, Azerbaijan, Bangladesh, China, Fiji, Georgia, Indonesia, India, Iran, Japan, Kazakhstan, Kyrgyzstan, Cambodia, South Korea, Lao PDR, Sri Lanka, Myanmar, Mongolia, Malaysia, Nepal, New Zealand, Pakistan, Philippines, Papua New Guinea, Russian Federation, Solomon Islands, Thailand, Tajikistan, Timor Leste, Turkey, Uzbekistan, Vietnam, Vanuatu, and Samoa **(36 Countries analysed in study)**

- **(NOTE: REMOVED FROM ANALYSIS)** Brunei, Bhutan, Federated States of Micronesia, Kiribati, Marshall Islands, Maldives, Nauru, North Korea, Palau, Singapore, Tonga, Turkmenistan, and Tuvalu (13 countries).

Note: A fair number of countries within the Asia-Pacific region could not be utilised for this study for a multitude of reasons. The driving issue for removal is missing data & non-coverage. These countries simply did not collect or have data available for the single dependent or outcome variable used in this study that we want to quantitatively assess which is undernourishment prevalence. That resulted in an instant removal. In the special case of Singapore, undernourishment rates are so low, the government stopped collecting this data (SINGSTAT)[55].

Moreover, these removed countries also had a high number of independent variables missing which include the shocks of this study such as food price inflation, cereal import dependency,

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[55] Department of Statistics Singapore, SINGSTAT, https://www.singstat.gov.sg/find-data/sdg/goal-2

political instability and violence/terrorism, unemployment rates, and people affected from natural and climate disasters. The second reason for removal from analysis was inconsistent time coverage where data was covered but was recorded at a random sporadic non-annual basis. The last reason for removal was specific countrie(s) having corrupted or falsified data which included extremely *highly* unlikely results such as no citizen being affected by natural disasters for over 20 years despite aid agencies & news reports reporting indicating casualties which questioned the validity of overall government data collection.

Variables in study and summary statistics

The following section will discuss which indicator sources have been used to quantify the dependent and independent variables and a description of the summary statistics.

Figure 4.1

Dependent Variable	Indicator details, Reference, and Source	Units and polarity
Undernourishment prevalence	The prevalence of undernourishment expresses the probability that a randomly selected individual from the population consumes an amount of calories that is insufficient to cover her/his energy requirement for an active and healthy life. The indicator is computed by comparing a probability distribution of habitual daily dietary energy consumption with a threshold level called the minimum dietary energy requirement. Both are based on the notion of an average individual in the reference population. Basically, this indicator captures the percentage probability for an individual to be undernourished in a given country. Source: FAOSTAT, Food and Agriculture Organization of the United Nations Link: https://www.fao.org/faostat/en/#data/FS	Unit of measurement: percentage (%) Polarity: Negative Unit of analysis: Proportion of population

Figure 4.2 **Descriptive Statistics for dependent/outcome variable**

Variable	Obs	Mean	Std. Dev.	Min	Max
Undernourishment prevalence	760	10.029	9.12	1.25	47.8

Undernourishment prevalence as a dependent variable in this study is measured with 760 observations from 36 countries from a time span of 20 years ranging from 2002-2021. The unit of measurement analysis for this variable is in percentage probability of undernourishment. Its polarity is negative is stated as negative which simply means that if the percent value increases, undernourishment increases in the Asia-Pacific region. Undernourishment prevalence has an average of approximately 10 percent, a standard deviation of 9 percent, minimum values of 1.25 percent, and a maximum value of 47.8 percent.

Figure 4.3

Independent Variables	Indicator details, Reference, and Source	Units and polarity
Food Price Inflation (Access)	The FAO Food Price Index (FFPI) is a measure of the monthly change in international prices of a basket of food commodities. It consists of the average of five commodity group price indices weighted by the average export shares of each of the groups over 2014-2016. Food price inflation measures the annual percentage change in the FFPI. Essentially, percentage increases in the price of food commodities are captured through this indicator. Source: FAOSTAT, Food and Agriculture Organization of the United Nations Link: https://www.fao.org/faostat/en/#data/CP/metadata	Unit of measurement: percentage (%) Polarity: Negative Unit of analysis: rate of change in pricing of food commodities
Cereal Import Dependency Ratio (Availability)	The cereals imports dependency ratio tells how much of the available domestic food supply of cereals has been imported and how much comes from the country's own production. It is computed as (cereals imports - cereals exports)/(cereals production + cereals imports - cereals exports). The greater the indicator, the higher the dependence. Source: FAOSTAT, Food and Agriculture Organization of the United Nations Link: https://www.fao.org/faostat/en/#data/FS/metadata	Unit of measurement: Index value Polarity: Negative Unit of analysis: level of dependency at a country level
Political Stability and the absence of violence & terrorism (Stability)	Political stability and absence of violence and terrorism is one dimension of the Worldwide Governance Indicators, which bring together perceptions data from over 30 different sources. These data sources are rescaled and combined to create the six aggregate indicators using a statistical methodology known as an Unobserved Components Model. Political Stability and Absence of Violence/Terrorism measures perceptions of the likelihood of political instability and/or politically-motivated violence, including terrorism. Source: World Bank Link: https://info.worldbank.org/governance/wgi/Home/Documents	Unit of measurement: Index value Polarity: Positive Unit of analysis: Likelihood of political instability, violence, and/or terrorism at a country level

Unemployment rate (Access)	The standard definition of unemployed persons is those individuals without work, seeking work in a recent past period, and currently available for work, including people who have lost their jobs or voluntarily left work. In addition, persons who did not look for work but have an arrangement for a future job are also counted as unemployed. Still, some unemployment is unavoidable—at any time, some workers are temporarily unemployed between jobs as employers look for the right workers and workers search for better jobs. The labor force or the economically active portion of the population serves as the base for this indicator, not the total population. The series is part of the "ILO modelled estimates database," including nationally reported observations and imputed data for countries with missing data, primarily to capture regional and global trends with consistent country coverage. Country-reported microdata is based mainly on nationally representative labor force surveys, with other sources (e.g., household surveys and population censuses) considering differences in the data source, the scope of coverage, methodology, and other country-specific factors. Source: World Bank, International Labour Organization (ILO) Link: https://data.worldbank.org/indicator/SL.UEM.TOTL.ZS	Unit of measurement: percentage (%) Polarity: Negative Unit of analysis: Proportion of unemployed labour force within a country
Share of people affected by natural disasters (log) (Stability)	The EMDAT database is compiled from various sources including UN, governmental and non-governmental agencies, insurance companies, research institutes and press. EMDAT records all disasters that meet at least one these three criteria: 10 or more deaths, 100 or more people affected/injured/homeless, or a declaration of a state of emergency or appeal for international assistance. Furthermore, the range of classification of disasters includes floods, droughts, earthquakes, extreme temperatures, cyclones/storms, landslides, and other natural disasters. The total affected is the sum of injured, affected and homeless. Injured is defined as people suffering from physical injuries, trauma, or an illness requiring immediate medical assistance as a direct result of a disaster. Affected people are those requiring immediate assistance during the emergency. People are considered homeless if their house is destroyed or heavily damaged and they need shelter after an event. A ten year moving average of the number of people affected is calculated for each country. Source: EM-Dat, the International Disaster Database Link:https://public.emdat.be/	Unit of measurement: Number (#) Polarity: Negative Unit of analysis: Amount of people affected by natural disasters has been log transformed for this study to capture % increase.

Figure 4.4 **Descriptive Statistics for independent/predictor variables**

Variable	Obs	Mean	Std. Dev.	Min	Max
Food price inflation	740	.07	.077	-.134	.583
Cereal import dependency	727	20.748	51.517	-267.8	100
Political instability/viol/terr	759	-.352	.965	-2.81	1.595
Affected by natural disasters_log	725	14.073	3.021	4.443	21.14
Unemployment rates	738	5.393	3.641	.14	20.71

Food price inflation as an independent variable in this study is measured with 740 observations from 36 countries from a time span of 20 years ranging from 2002-2021. The unit of measurement analysis for this variable is percentage rise in price of food commodities. Its polarity is negative which means that as this variable's percentage value increases, food price inflation increases. Food price inflation has an average of .07 percent, a standard deviation of .077 percent, minimum value of -0.134 percent (disinflation) and a maximum value of 0.583 percent (high inflation).

Cereal import dependency as an independent variable in this study is measured with 727 observations from 36 countries from a time span of 20 years ranging from 2002-2021. The unit of measurement analysis is a ratio value created by Food and Agriculture Organization of the United Nations (FAO). Its polarity is negative which means that as the ratio value increases, countries are more dependent on importing cereals and vice versa. Cereal import dependency has an average ratio value of 20.748, a standard deviation of 51.517, minimum value of -267.8 (Cereal import independent) and a maximum value of 100 (entirely cereal import dependent).

Political instability and the presence of violence and terrorism as an independent variable in this study is measured with 759 observations from 36 countries from a time span of 20 years ranging from 2002-2021. The unit of measurement analysis is an index value created by the World Bank & World Governance Indicators. The polarity of this variable is positive which means that as the index value increases, we interpret more political stability and lack of violence & terror. Political instability and the presence of violence and terrorism has an average

index value of -0.352, a standard deviation of 0.965, minimum value of -2.81 (Extremely politically unstable), and a maximum value of 1.595 (very politically stable).

Persons affected from natural disasters as an independent variable in this study is measured with 725 observations from 36 countries from a time span of 20 years ranging from 2002-2021. Since this variable, from its original data source EMDAT, the International Disaster Database, is measured using persons affected from disasters, this variable has thus been transformed into Log form to capture percentage increases in people affected from natural disasters in the Asia Pacific. Its polarity is negative which means that as percentage value increases, a higher percentage of people are affected from various disasters in the Asia-Pacific and vice versa.

Unemployment rates as an independent variable in this study is measured with 738 observations from 36 countries from a time span of 20 years ranging from 2002-2021. The unit of measurement analysis for this variable is percentage rise in unemployment among the labour force. Its polarity is negative which means that as percentage value increases, then unemployment is increasing in the Asia-Pacific region. The average is 5.39 percent, standard deviation is 3.64 percent, a minimum value of 0.14 percent (low unemployment), and a maximum value of 20.71 percent (high unemployment).

Empirical Strategy

To empirically analyse the effects of various shocks on undernourishment prevalence, this study will utilise a panel data regression with fixed effects model. Panel data refers to datasets where information of entities is observed across time. While entities can be anything ranging from states, companies, households, and individuals, for the purposes of this study the term entity refers to countries in the Asia-Pacific region. An issue largely related to using panel data is omitted variable bias which is the idea that important factors are excluded and not present in an analysis. The use of fixed effects in panel data attempts to address omitted variable bias caused from heterogeneity in data. Fixed effects controls for specific variables that we cannot measure, we cannot observe, or whose data is simply not available, but these variables are correlated with our predictor or independent variables (Stock and Watson 2007)[56].

There are two types of fixed effects. The first type of fixed effects is entity fixed effects which accounts for variables that don't change over time, but they differ across entities. In the context of this study, a potential example is country differences in cultural factors, political will, or attitudes towards decreasing various shocks in causing undernourishment. As mentioned, certain variables like the previously mentioned example would be difficult to measure thus we control for it with the use of fixed effects. The second type of fixed effects is time fixed effects which accounts for variables that change over time but not across entities, or Asia-Pacific countries in the context of this study. A potential example includes national resilient adaptive capacity measures and national policies taken towards decreasing food insecurity. Essentially, the use of fixed effects attempts to control for time and individuals' effects heterogeneity. The econometric equation of use to represent the panel data regression analysis with fixed effects model is highlighted below.

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[56] Stock and Watson, 2007, Introduction to econometrics, 2nd edition, Boston: Pearson Addison Weasley

$$Yit = \alpha i + \beta Xit + \delta t + ui + eit$$

$$i = 1\ldots n \ ; \ t = 1\ldots.T$$

- Yit is the outcome variable (for entity i at time t) which is undernourishment prevalence for this study.

- Alpha-i is the intercept for each entity or Asia-Pacific country for this study (n entity-specific intercepts).

- Xit is a vector of predictors or independent variables which represents the cluster of shocks analysed in this study (for entity i at time t).

- Delta-t is the coefficient for the time regressors (t).

- u-i accounts for the within-entity error term.

- e-it accounts for the overall error term.

- Lastly an interpretation of the Beta coefficient will be provided. For a given entity or Asia-Pacific country, when the independent variable(s), which is shocks, changes one unit over time, the dependent or outcome variable, which is undernourishment prevalence, will either increase or decrease by Beta units. Overall, Beta displays common effects across entities or Asia-Pacific countries by controlling for individual and time heterogeneity.

This empirical strategy section highlighted how shocks in food systems affect food insecurity in the form of undernourishment prevalence in Asia-Pacific countries ranging from a time period of 2002-2021 with the use of a panel data fixed effects regression model.

Initial Results Interpretation

Figure 4.5 **Regression results**

Undernourish ment prevalence	Coef.	Robust St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Food price inflation	19.119	7.145	2.68	.011	4.614	33.624	**
Cereal import dependency	.007	.02	0.34	.736	-.034	.048	
Political instability/viol/ter.	-2.439	1.605	-1.52	.138	-5.698	.82	
Unemployment rates	1.024	.58	1.77	.086	-.154	2.202	*
Affected by natural disasters_log	.171	.403	0.43	.673	-.646	.989	
Constant	-.063	6.675	-0.01	.992	-13.614	13.487	

Mean dependent var		10.574	SD dependent var			9.254
R-squared		0.173	Number of obs (Groups=36)			710
F-test		3.562	Prob > F			0.015

***p<.01, **p<.05, *p<.1

Overall, in a comparison of multifaceted shocks to food systems in the Asia-Pacific region over the past two decades, this study finds that food price inflation shocks and unemployment rate shocks are the most statistically significant predictor variables in increasing the risk of undernourishment prevalence. These details in addition to the analysis of further variables and statistical outputs will be discussed further below.

Food price inflation has the strongest statistical effect as a shock in affecting undernourishment prevalence in the Asia-Pacific region. The p-value for this variable is statistically significant at the 5% level ($p < .05$) with a p-value of .011. This means we can reject the null hypothesis which states that there is no relationship between our two variables and accept the alternate hypothesis which claims there is statistical significance between our two variables. As food

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price inflation increases by one percent, undernourishment prevalence in the Asia-Pacific region increases by approximately 19 percent.

Unemployment shocks have a statistically significant relationship in affecting undernourishment prevalence in the Asia-Pacific region. The p-value for this variable is statistically significant at the 10% level (p< .1) with a p-value of .086. This means we can reject the null hypothesis which states that there is no relationship between our two variables and accept the alternate hypothesis which claims there is statistical significance between our two variables. As unemployment rates increase by one percent, undernourishment prevalence in the Asia-Pacific region increased by approximately one percent as well.

Cereal import trade dependency shocks have no statistically significant effect in impacting undernourishment within the Asia-Pacific region. The p-value for this variable is highly statistically insignificant well beyond the 10% significance level (p>.1) with a p-value of .736. This means we fail to reject the null hypothesis which states that is no relationship between our independent and dependent variable. We interpret the results as follows, as one unit of cereal import dependency ratio increases, undernourishment increases by 0.007 percent. However, the result for this independent variable is statistically insignificant.

Political instability and violence & terror related shocks have no statistically significant effect in impacting undernourishment within the Asia-Pacific region. The p-value for this variable is statistically insignificant and is slightly above the 10% significance level (p>.1) with a p-value of .138. This means we fail to reject the null hypothesis which states that there is no relationship between our independent and dependent variable. Since this variable has a positive polarity, we interpret the results as one index value unit of political stability and absence from violence & terror increases, undernourishment decreases by 2.439 percent. However, the result for this independent variable is statistically insignificant.

Being affected by natural and climate disaster shocks also show to have no statistically significant effect in impacting undernourishment across the Asia-Pacific region. The p-value for this variable is highly statistically insignificant well beyond the 10% significance level (p>.1) with a p-value of .673. This means we fail to reject the null hypothesis which states that is no relationship between our independent and dependent variable. While we interpret the results as one percent share of affected peoples from natural disasters increases,

undernourishment increases by 0.171 percent. However, the result for this independent variable is statistically insignificant.

In summary, economic shocks in the form of food price inflation and unemployment are driving risk related to food insecurity through increased undernourishment prevalence. Moreover, this study finds that cereal import dependency, political instability, and natural disasters shocks do not have a statistically significant relationship in affecting undernourishment prevalence across Asia-Pacific countries. The R-squared score of 0.173 displays that shocks in general do not affect much of the variation in undernourishment prevalence compared to systematic long-term stresses, lack of coping capacities, and other unknown factors but this will be elaborated on further in the results discussion section.

Robustness Checks and Model Fit

The F-test is an indicator which displays the strength and relevance of your model in explaining your outcome variable. This test observes if all the coefficients present in the model are jointly different than zero. The F-test delineates whether the model utilised provides a better fit to the data than a model with no independent variables at all. The null hypothesis expresses that the model with no independent variables at all fits the data better than the model with independent variables. The alternative hypothesis states that the model with the independent variables fits the data better than our intercept only non-independent variable inclusive model.

Figure 4.6

F-test	3.562	Prob > F	0.015

In the case of this study, the F-test signifies whether our panel data fixed effects model with independent variables such as food price inflation, cereal import dependency, unemployment rates, political instability, and being affected from natural disasters explains the prevalence of undernourishment compared to a model looking at the prevalence of undernourishment with none of these independent variables at all. The model utilised in this study receives an p-value for the F-test (Prob > F) of 0.015 which is statistically significant at the 5% level ($p<.05$). When the p-value for the F-test is statistically significant below the 5% significance level ($p<.05$), then we can conclude that the sample data utilised in our panel data fixed effects regression for

this model fits the data better than a null model with no independent variables. In other words, the model for this study fits the data and thus the model is considered adequate and satisfactory.

Figure 4.7
Hausman (1978) specification test

	Coef.
Chi-square test value	15.844
P-value	.007

Furthermore, this study validates and justifies the use of a fixed effects model to explain the relationship between shocks and undernourishment in the Asia-Pacific model. A Hausman test was run to consider the use of fixed effects or random effects model. Since the definition and rationale of fixed effects & random effects has been discussed earlier in the empirical strategy section, this section of the robustness check will focus on why we use Hausman tests.

In simple terms, the Hausman test, tests whether the errors are correlated with our regressors. The null hypothesis is if they are not correlated, then we should use random effects. If the errors are correlated which is the alternate hypothesis, then we use fixed effects. Thus, if the p-value of the Hausman test is significant at the 5% significance level ($p < .05$), then we reject the null hypothesis and accept the alternate hypothesis by using fixed effects for the model. As indicated in the figure above, we receive a Hausman test p-value of .007 which is significant at the 5% significance level ($p < .05$), which indicates that our model was correct in utilising fixed effects to evaluate the relationship of shocks on undernourishment using panel data.

Moreover, this regression model controls for heteroskedasticity using the 'robust' command in STATA within the regression. Heteroskedasticity refers to when the variance of the error, or residual term, is not constant across observations in a regression model. Thus, through the use of 'robust' command in STATA, we control for heteroskedasticity in the model by obtaining heteroskedasticity-robust standard errors.

These various robustness checks and model fitness tests justifies the use of our panel data fixed effects regression analysis.

5. Results Discussion, Limitations, Policy Implications, Contributions, and Conclusion

Results Discussion

The first research question this study brings forward is whether there is a relationship between multifaceted shocks and undernourishment prevalence when analysing the Asia-Pacific region from 2002-2021. Our initial hypothesis was that there is a positive relationship between shocks and undernourishment prevalence implying an increase in shocks results in an increase in undernourishment prevalence. The results from this indicate that there is indeed a positive relationship observed among shocks analysed in this study and the prevalence of undernourishment. However, while the relationship is positive, only a few specific shocks had a statistically significant effect on undernourishment prevalence in the Asia-Pacific region which brings us to addressing the second research question of this study.

The second research question this study aims to address is which specific shocks, if any, have an impact on undernourishment prevalence in the Asia-Pacific region from the past two decades. Our initial hypothesis backed by the literature was that all independent shock variables would have a statistically significant impact on undernourishment prevalence. However, this hypothesis assumption was not observed in our results. The results clearly show that only food price inflation and unemployment shocks have had any statistically significant effects in increasing the prevalence of undernourishment across 36 countries from 2002-2021. Of the two significant shocks, food price inflation shocks were shown to have the stronger effect on increasing undernourishment prevalence across the region over the past two decades. Regardless, both food price inflation and unemployment belong to the same food insecurity risk dimension categorisation which is what the next research question discussion elaborates on.

Based on the results of this study, one of the key research questions was to determine which dimensions of food insecurity were considered the most-at risk to increase undernourishment prevalence in the Asia Pacific when analysing various shocks over the region over the past two decades. The initial hypothesis backed by various literature was that shocks that affect food

system access, availability, and stability would all increase the prevalence of undernourishment in the region. However, this hypothesis was only partially observed in the results. The results indicate that the most at-risk dimension to increase food insecurity through undernourishment prevalence is access. Our study shows that when access to food in terms of affordability and income/monetary inflow is affected through food price inflation and individual unemployment, then you are considered at *most* risk of being food insecure in comparison to other dimensions of risk such as availability, stability, and more.

Lastly, this study was interested in researching how much of the variation in food insecurity or undernourishment prevalence risk is explained by shocks in the Asia-Pacific region over the past two decades. The majority of the traditional literature on food insecurity has placed greater emphasis on the study of systemic long-term stresses such as vulnerabilities and lack of resilient adaptive capacities than an analysis of shocks. With limited literature to back up an educational literature-backed hypothesis, the hypothetical assumption was that this variation was simply unknown. Through the R-squared value of our panel data fixed effects regression, the results display that while the independent shock variables of this study account for some of the variation in undernourishment prevalence, that variation is quite low. The implication of this result complements the traditional literature which is to say that while shocks do indeed impact undernourishment prevalence, undernourishment prevalence is understood largely through long term systemic vulnerabilities and lack of coping capacities such as endemic poverty, population density stresses, non-communicable diseases burdens, diminished individual and state capacity, and other slow building long-term stresses. Regardless, the contribution that my study makes to the limited literature is analysing the risk of random volatile shocks in food systems through its variational position despite being low.

Limitations

Lack of greater variability in data to conduct sub-regions and development/income status analysis.

One of the problems with utilising panel data at the yearly & country level for entities is ensuring that data is available consistently throughout all time periods for each variable. Since this is yearly country level data provided mainly by national governments to international organizations, occasional inconsistencies in collection resulting in missing values for a specific year for one country will not match missing values recorded by other countries. This results in a decreased number of total observations. Thus, this reduces variability in the data and decreases statistical power. This also largely reduces the ability to conduct sub-regional or country income-based analyses. The initial plan was factor development/income status such as developed or developing, and include subregional analysis for South Asia, Eurasia & Central Asia, Southeast Asia, East Asia and the Pacific but limited observations made this plan unfeasible. If given the opportunity to conduct this study again on a larger scale with a hypothetical scenario of better country level data collection resources and availability, I would replicate this study utilising monthly data across two decades of shock patterns in the Asia-Pacific as this would enable an exponentially higher number of observations, greater variability, and increased statistical power to account for these various effects.

Removal of countries comprising of key regional blocs

Utilising country panel data in regression analyses enables researchers to discover trends from observations across entities or countries. The use of panel data strengthens the critical concept of external validity in regression analysis, which in simple terms shows us how generalizable are the results we receive. The purpose of this study was to find out the impact of various shocks across the Asia-Pacific region to understand which specific shocks are driving food insecurity risk through undernourishment prevalence across Asia-Pacific countries over the last two decades. It was possible to conduct this study using data from 36 Asia Pacific countries across 6 variables. However, one of the key issues of this study was limited, inconsistent, or zero data accounting from 13 Asia-Pacific countries that were omitted or excluded from the

analysis. With more than half of the missing countries representing the majority small island Pacific states of the Asia-Pacific region, a substantial portion of a prominent sub-regional bloc was missing from the analysis. As mentioned earlier in the previous limitation discussion, if given the opportunity to continue this research with more hypothetical resources and data from the various omitted countries, they would be factored into, for a more thorough analysis of the region.

Limited cross-country data for Energy and Fertiliser shocks

There is no doubt we are living in an increasingly volatile world where global shocks are exacerbating even more shocks at regional and country levels. For example, the ongoing Ukraine crisis caused large scale energy shocks, fertiliser shocks, and grain/cereal import dependency shocks globally (The Guardian 2022[57]). While this study was able to capture shocks in the form of food price inflation, unemployment, political instability & violence, natural disasters, and cereal import dependencies, what this study was not able to capture were more resource specific shocks in food systems in the form of energy price shocks and fertiliser price shocks simply due to the lack of cross-country data.

Energy prices and fertiliser prices heavily impact the greater food system as we know it since both energy prices and fertiliser prices complicate the production, processing, distribution, storage, and transportation of food commodities within national and globalised food systems. This study attempted to include these two food-system input price shocks in the study. The only available datasets found online was the International Monetary Fund's commodity price data (IMF[58]) which did have commodity price data for energy and fertilisers. However, there were several methodology & assumption related issues with utilising this data. First and most importantly, this data is not cross-country and only shows the international market prices of energy in the form of crude oil (petroleum), natural gas, coal price, propane indices and DAP, potash, urea for fertilisers. Thus, this data is unusable since it's not showing any variation across countries. Moreover, it is a difficult assumption to make that all countries across the Asia-Pacific specifically use these exact commodities in the case of fertilisers. Complementary to

[57] The Guardian, 2022, https://www.theguardian.com/world/2022/may/19/ukraine-war-has-stoked-global-food-crisis-that-could-last-years-says-un

[58] International Monetary Fund, Commodity Price Indices, https://www.imf.org/en/Research/commodity-prices

that, it is an even more challenging assumption to make that all Asia-Pacific countries purchase energy & fertilisers at the exact same international market price. With reference to the Ukraine crisis again, this is simply not true (BBC[59]) as governments buy energy from various sources at different price ranges. Thus, for these reasons fertiliser and energy price shocks could not be factored into this study.

Lack of external validity for health shocks and addressal of the Covid argument

One might read this study and argue that while most multifaceted shocks to food systems are covered, there is no inclusion of health-related shocks which may increase the incidence of undernourishment within Asia-Pacific countries. There are several reasons why this study has not included health shocks. The first issue is separating which health related issues are shocks and which ones are longer term stresses, vulnerabilities, and lack of coping capacities. It is straightforward to make the argument that non-communicable diseases such as obesity, cancer, diabetes, and more are long term stresses rather than shocks since these diseases are a build-up of poor individual choices, poor lifestyles, and lack of coping capacities made by either governments or individuals to improve health outcomes (Prabhakaran et al 2017[60]).

However, it is a much more challenging decision to evaluate whether communicable diseases such as respiratory infectious diseases epidemics are considered as shocks to local populations or if they are categorised as a symptom of existing long term systemic vulnerabilities and lack of coping capacities. The argument for communicable diseases acting as shocks is that once an infectious disease spreads rapidly in a geographical area it is a shock to the surrounding community/food system with increased infections and affected populations. But the counterargument is that communicable respiratory infectious disease epidemics are actually the unfortunate symptom of long-term systemic vulnerabilities and lack of coping capacities. For example, an outbreak of cholera in a community is a result of systemic long-term societal breakdowns such as contaminated water access, high population densities/slums, and unsanitary sewage systems (CDC[61]).

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[59] British Broadcasting Corporation, BBC, https://www.bbc.com/news/world-asia-india-60783874
[60] Mendenhall, E., Kohrt, B. A., Norris, S. A., Ndetei, D., & Prabhakaran, D. (2017). Non-communicable disease syndemics: poverty, depression, and diabetes among low-income populations. *The Lancet*, *389*(10072), 951-963.
[61] Center for Disease Control and Prevention, https://www.cdc.gov/cholera/infection-sources.html

Furthermore, if communicable health epidemics are a result of specific long term systemic vulnerabilities and lack of coping capacities, then the issue of external validity also arises. The purpose of this study was to capture shock trends of food insecurity across the Asia-Pacific countries in the region and this was possible with the study of shocks that are generalisable across countries. However, analysing communicable health epidemic shocks raises the challenging discussion regarding generalisability. With the existence of over hundreds of communicable infectious diseases globally (SFCDCP[62]) with varying causes and symptoms, it is erroneous to treat all communicable infectious diseases as one. For example, comparing the incidence of influenza in Australia and cholera in Bangladesh on the effect of undernourishment prevalence will have extremely non-comparable and varying results. In addition to the difficulty of collating cross-country data for different kinds of outbreaks, communicable infectious health epidemics are simply too context-specific to be treated as shocks for this study.

Lastly, a limitation could be raised as to why Covid-19 wasn't factored into this study since it arguably became the most prominent and unique shock of the decade. My counterargument is that the effects of Covid-19 on undernourishment prevalence have already been included in this study by proxy of various independent variables such as food price inflation, unemployment rates, and import dependencies. Since the World Bank reported a multitude of economic shocks from Covid-19 ranging from unemployment, inflation, and trade vulnerabilities (World Bank [63]), this study already accounts for the early onset of Covid-19. However, its full impact is not captured as countries are also *still* recovering from the wide-ranging impacts of Covid-19 after 2021 which my study does not account for simply due to the lack of data after 2021. In conclusion, the effects of health-related shocks (which is inclusive of Covid-19 and many other infectious diseases) on undernourishment prevalence can be analysed in future research which account for the various complexities related to using health shock data.

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[62] San Francisco Department of Public Health, Population Health Division, https://www.sfcdcp.org/infectious-diseases-a-to-z/

[63] World Bank, Economic Impacts of Covid-19
https://www.worldbank.org/en/publication/wdr2022/brief/chapter-1-introduction-the-economic-impacts-of-the-covid-19-crisis

Policy Relevance, Contributions to Literature, and Overall Conclusion

Overall, this study aimed at understanding the nature of multifaceted shocks in relation to undernourishment prevalence within the Asia-Pacific region from 2002-2021. The results found that economic shocks in the form of unemployment and food price inflation had the most statistically significant effect in increasing undernourishment prevalence throughout the region from 2002-2021, with food price inflation showing the stronger effect. These results displayed that the access dimension of food insecurity is considered the most at-risk to increase the prevalence of food insecurity in comparison to other dimensions analysed in this study. Moreover, this study finds that volatile shocks do indeed affect undernourishment prevalence in the Asia-Pacific region but this variation in explaining undernourishment prevalence is largely explained by long term systemic vulnerabilities, lack of resilient coping capacities, and other factors.

The comprehensive contribution that this study made to the literature is having an in-depth understanding & analysis of volatile shocks and resulting risk to food systems in comparison to the traditional literature which has placed greater emphasis on vulnerabilities and lack of resilience or coping capacity. This study opens the floodgates for more research papers which focus on the study of multifaceted shocks and further conceptualizations of risk present in food systems. Moreover, while the variation of undernourishment prevalence explained by shocks was low, I do believe this key finding can further our understanding of shocks. Since long-term systemic vulnerabilities and lack of adaptive capacity explain majority of the variance in undernourishment prevalence rather than shocks, future research can look into which specific conditions of vulnerability and adaptive capacity are able to offset or increase the occurrence of shocks to food insecurity prevalence. Essentially, assessing whether resilient adaptive capacity or existing vulnerabilities exacerbates or prevents shocks to food systems is where future research can be expanded upon.

In terms of policy relevance, this study makes quite a few contributions, one of which includes the understanding that food insecurity risk throughout the Asia-Pacific has mainly been characterised by economic shocks. This finding has several implications for future research and policymakers. First, it encourages cross-regional policy research to determine whether the results seen within the Asia-Pacific over the last two decades are similar to how other regions

of the world have performed in food insecurity outcomes as a result of various shocks to food systems which would deepen a global understanding of shocks, resulting risk, and food insecurity. Second, this finding enables a broader comprehension of the access dimension which is dependent upon key conditions such as affordability and income/monetary inflows. This can encourage future researchers to dive deeper into potential variables that amplify risk from shocks concerning decreased affordability and reduced income flows. Additionally, policymakers across the Asia Pacific can view the results of this paper as an avenue for efficient resource allocation in improving affordability and income/monetary inflows to reduce the incidence of undernourishment in populations such as subsistence agriculture, alternate sources of income, social safety nets, microcredit financing, entrepreneurship, and more.

In summary, this study has concluded how shocks in the form of economic shocks affect food insecurity which is measured through undernourishment prevalence in the Asia Pacific region over the past two decades. Furthermore, this study has made contributions to the limited literature on shock analysis, and how this study is potentially relevant for development outcomes by improving food security access within the Asia-Pacific region.

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