

ECONOMYWIDE RISK ASSESSMENT

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PAPUA NEW GUINEA

Systematic Analysis of World Market and Domestic Production Shocks

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This study is part of a series of country briefs by IFPRI that leverages economywide models to deliver detailed risk assessments of key economic indicators. This initial analysis evaluates vulnerabilities across economic sectors and key population groups to answer two questions: (1) How vulnerable are national economy and population of Papua New Guinea (PNG) to world market and domestic production shocks? (2) What are the largest risks to PNG's overall economic performance, private consumption, and reductions in poverty and undernourishment?

Overview

Achieving development goals is subject to economic uncertainties, yet policymaking rarely accounts for these risks. This Country Brief quantifies the risks facing Papua New Guinea's (PNG) economy and population, focusing on two primary sources:

- 1) **External risks** stemming from shocks in international commodity prices and foreign capital flows and
- 2) **Domestic risks** associated with production shocks in volatile sectors of the PNG economy, such as primary agriculture and hydropower electricity generation, are often caused by extreme weather.

The significance of these risks is assessed based on the range of the shocks' impacts on four main economic and development indicators: total GDP, private consumption, poverty rate, and prevalence of undernourishment.

The analysis uses data mining methods to simultaneously sample many shocks from historical data, constructing a comprehensive set of realistic shock scenarios for PNG. A country-specific, economywide Computable General Equilibrium (CGE) model then simulates the impacts of these shocks on both total and sector-specific economic outcomes, deriving changes in poverty and undernourishment for each shock

scenario. Finally, machine learning techniques are applied to obtain metrics for the relative importance of different risk factors.

The results suggest that PNG's economy is predominantly exposed to external risks, with world price and foreign capital flows together accounting for approximately two-thirds of the potential variation in GDP and three-fourths of the potential variation in private consumption, poverty, and undernourishment (domestic production volatility contributes the remaining one-third and one-fourth, respectively). The current structure of the PNG economy underpins these results. While agriculture is the most uncertain sector, it is relatively less important compared to the overall economy; export earnings from energy and metals, as well as volatile foreign exchange capital inflows, play a much more significant role in the country's current economic risks.

Understanding these economic risks is a critical first step in facilitating discussions on potential risk management strategies, such as promoting domestic productivity growth and diversifying economic activity away from high-risk sectors.

1. Background and Objectives

Since gaining independence from Australia in 1975, PNG has experienced both opportunities and challenges in its economic development. A brief overview of the historical dynamics of the country's key indicators is presented in Figure 1, with some of the key features outlined below:

- **Reliance of economy on natural resources rents:** Historically, the backbone of PNG's economy has been the extraction of natural resources (Figure 1B). In the 1980s, copper mining was the key commodity; in the 1990s, gold mining projects were added; and by the 2000s, energy mining—particularly Liquefied Natural Gas (LNG) - became significant. Due to the volatility of global commodity prices (Figure 1C) and internal factors affecting mining operations (e.g., the closure of the Panguna mine on Bougainville Island in 1989), the country's economic growth has been volatile, characterized by alternating periods of rapid growth and sharp declines (Figure 1A).
- **Structural adjustment programs:** In the second half of the 1990s, PNG faced an economic crisis caused by low commodity prices (Figures 1A-E), and the country undertook a series of structural adjustment programs with the IMF and World Bank aimed to restore macroeconomic stability.
- **Recent Commodity Boom:** The early 2000s brought a commodities boom that bolstered PNG's economy, driven by soaring prices for gold, copper, and energy. Major LNG projects completed by 2014 marked a turning point for GDP growth. By the early 2020s, GDP per capita reached levels comparable to those of the early 1990s (Figure 1A).
- **Primary Agriculture:** Although the share of agriculture in GDP decreased from 33 percent in 1980 to 18 percent in 2019, the sector remains vital for employment, accounting for 65 percent of total employment in 2019 (Table 1). However, agricultural productivity has steadily declined since independence (Figure 1f). In response, PNG introduced the National Agriculture Development Plan in 2007, aiming to modernize agriculture, increase productivity, and improve market access for small-holder farmers. Despite these efforts, implementation challenges have prevented a reversal of the declining trend in agricultural productivity.

According to the Systematic Country Diagnostic by the World Bank (2018), PNG's current economy is particularly vulnerable to three types of risks:

- **Resource Dependence:** Reliance on resources like metals and LNG exposes the economy to volatile global commodity prices.

- **Natural disasters:** Key hazards include floods, droughts, landslides, and earthquakes, all impacting the agriculture and fisheries sectors critical to rural livelihoods.
- **Social and political risks:** The rapid modernization of PNG’s society, combined with high youth unemployment, has led to tensions within urban and rural areas. Urbanization stresses traditional social structures, resulting in increased social strife and risks of entrenched poverty in informal settlements. Historical tensions, such as those seen in Bougainville, reveal the risks associated with unresolved compensation and benefit-sharing disputes in resource-rich regions. High fragmentation of political loyalty and dependence on patronage have led to regular government instability and risks of disenfranchisement among citizens.

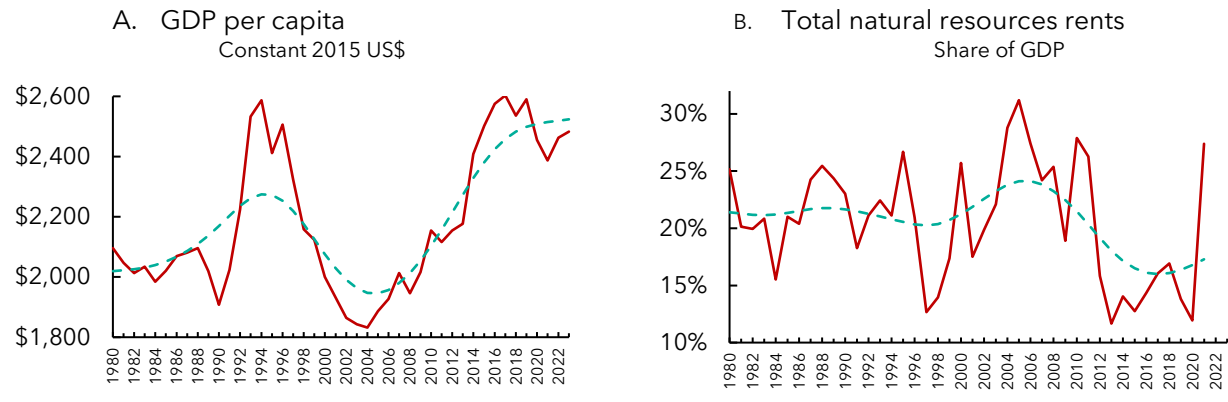
Governments in PNG and around the world rely on economic projections to inform policy decisions and achieve development goals. However, the accuracy of projected trends and, even more so, the occurrence of economic shocks are naturally uncertain. Recent economic crises such as the global COVID-19 recession and global food and market disruptions due to Russia’s invasion of Ukraine are stark reminders of the unpredictability of future events and the severity of these crises’ impacts on the national economies and populations of many countries highlighted the unpreparedness of their governments. Major impacts in developing countries included setbacks in poverty and hunger reduction, jeopardizing the achievement of the first two Sustainable Development Goals of UN Member States by 2030.

Policymaking rarely considers the economic risks around projections and shock occurrence. This is mainly because systematic analyses of economic shocks and quantification of the associated risks are lacking, especially for developing countries. We address this gap by providing country-specific economywide risk assessments and detailed risk profiles for key economic and development indicators.

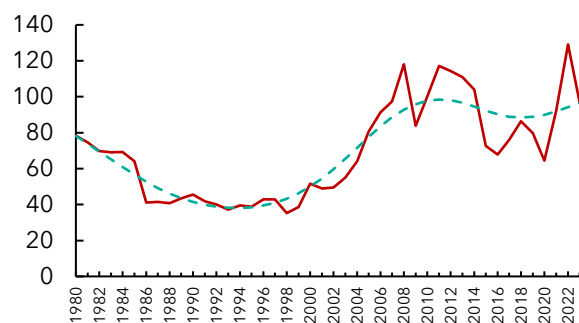
Our analysis addresses two main questions:

- 1) How vulnerable are PNG’s national economy and population to world market and domestic production shocks?
- 2) What are the largest risks to PNG’s overall economic performance, private consumption, and progress toward ending poverty and hunger?

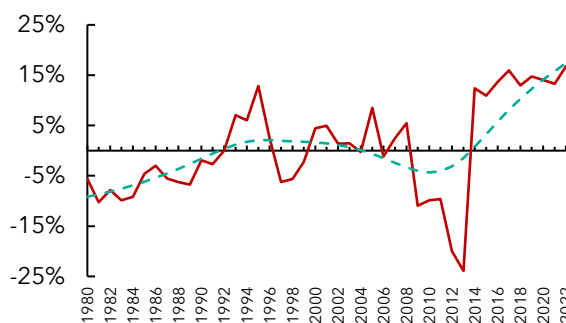
Figure 1. Historical movements of main economic indicators in PNG



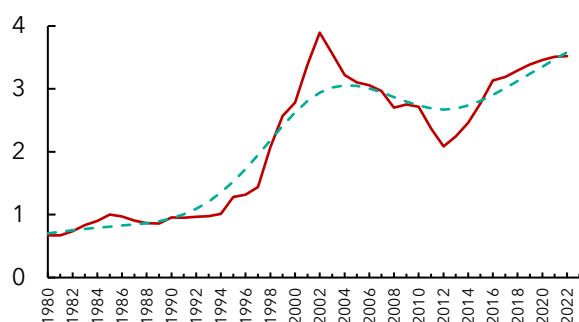
C. Global Commodities Price Index
Constant 2010 US\$



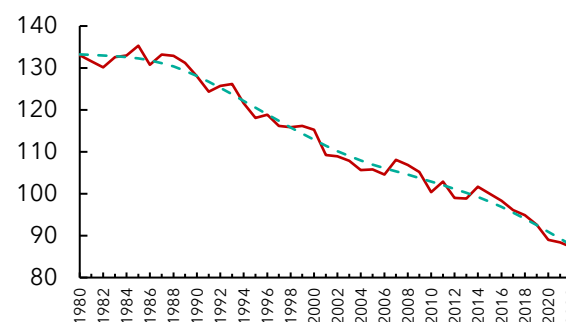
D. Current account
Share of GDP



E. Official exchange rate of Kina
Per 1 US\$



F. Agricultural production
Gross per capita production index (2014-2016 = 100)



Note: Dashed blue lines indicate long-term trends. The trend calculation uses the Hodrick-Prescott filter for annual data (Hodrick and Prescott 1997).

Source: Own presentation based on GDP per capita, total natural resources rents, and official exchange rate data from World Bank (2024a), global commodity price index data from World Bank (2024b), and agricultural production data from FAO (2024).

2. Concept and Methodological Overview

Unlike conventional economic projection analysis, our assessment of economic risks does not require speculation of PNG's future long-term economic performance. Instead, we focus on economic *volatility* and analyze simulated outcomes for the entire bandwidth of potential but realistic shock scenarios. Innovatively, we adopt the concept of *risk* as understood in finance to a macroeconomic policy analysis framework (Box 1).

Due to data limitations, we are unable to quantify the impact of social and political challenges on PNG's economy. Instead, we assess risks to the national economy and population of PNG belonging to two risk types:

- 1) **External risks** associated with shocks in international commodity prices and foreign capital flows (*world market shocks*)¹ and
- 2) **Domestic risks** associated with production shocks in volatile sectors of the PNG economy (*domestic production shocks*) caused by extreme weather, for example.

¹ International trade flows and foreign capital flows are closely linked, and both affect Ghana's trade balance and exchange rate (see Section 4). We therefore refer to sudden changes in either or both flows as "world market shocks" for brevity.

The considered commodities are the goods and services that PNG trades. The considered sectors are primary agriculture and hydropower electricity generation, which are essential to PNG's economic performance and citizens' wellbeing. Given the size and diversity of the agricultural sector and its role in achieving development goals such as rural development, food security, and poverty and hunger eradication, we disaggregate agriculture into different crop and livestock production, forestry, and fishery subsectors. Our analysis focuses on exogenous shocks, which are beyond the government's direct control.

Box 1. Terminology

Risk is defined as the measurable likelihood of variation in an economic variable and, therefore, differs from *uncertainty*, which broadly refers to the (unquantifiable) unknown. *Risk* can be quantified by using statistical metrics such as variance or standard deviation that measure the degree of variation around a variable's average. Following the terminology in finance, *risk* and *volatility* have similar meanings in our analysis, but we use *volatility* in a more generic sense. *Risk* is inherent in both economic *shocks* and *outcomes*, with the risks of shocks influencing the risks of outcomes. We refer to the contribution of a given shock variable to the volatility of an outcome as a *risk factor*. The representation of the *risk factors* of an economic or development outcome ranked by their relative importance is referred to as *risk profile*. A *shock* is a sudden, measurable change that significantly disrupts the functioning of an economy or a part thereof, and an *outcome* is the resulting, measurable change in an indicator of economic performance or development.

We examine the external and domestic risks in PNG's current economic volatility environment using available historical information for realistic scenario formulation. To do that, we developed a novel methodology – called *Systematic Risk Profiling (SRP)* – that integrates CGE modelling, data mining, and machine learning methods (Mukashov et al. 2024).

The SRP consists of three sequential steps:

- 1) **Data mining methods** are employed to simultaneously sample world market and domestic production shocks from annual time-series data spanning over four decades (1980 – 2023) to construct a comprehensive set of shock scenarios that realistically represent all possible combinations of exogenous shocks for PNG.
- 2) An **economywide CGE model** for PNG is used to simulate the impacts on various (sub)sector-specific economic outcomes for each shock scenario and derive corresponding changes in development outcomes from a linked microsimulation model and
- 3) **Data mining and machine learning techniques** are applied to quantify the contributions of individual shock variables to the volatility of key economic and development outcomes that are then used to rank these risk factors and produce detailed risk profiles.

The selected economic outcomes are (1) the overall performance of the national economy, as measured by GDP per capita, and (2) private (or household) consumption, as measured by total consumer spending. The development outcome indicators are (3) the poverty headcount rate (measured at the official national poverty line and using per capita expenditure as a proxy for income) and (4) the prevalence of undernourishment (i.e., the share of people with insufficient calories, interchangeably referred to as "hunger" in this brief). The results of our analysis are summarized in separate risk profiles that rank the risk factors by their relative importance for each of these four outcomes.

3. Structure of the National Economy

To contextualize our SRP analysis and identify vulnerabilities in PNG's national economy that may predefine its exposure to exogenous shocks, we first examine the economy's current structure.

PNG is a lower-middle-income country with a GDP per capita of 2,593 USD (2019), a national poverty rate of 39.9 percent (based on the most recent nationally representative household survey in 2009), and an undernourishment rate² of 23.1 percent (based on the most recent FAO estimate in 2019) (World Bank, 2024a).

The sectoral decomposition of PNG's economy (Table 1) exhibits features typical of low and lower-middle-income countries. The primary sectors—agriculture and mining—constitute a significant share of economic activity (agriculture: 18.0 percent of GDP and 64.6 percent of employment; mining: 29.8 percent of GDP and 2.4 percent of employment). The secondary sector remains underdeveloped, with nonfood manufacturing contributing only 0.6 percent to GDP despite comprising 10.3 percent of total domestic demand and 37.5 percent of total imports. Additionally, the country's agro-processing sector is also underdeveloped (2.4 percent of GDP and 2.3 percent of employment). PNG relies heavily on food imports (particularly urban populations), with 66.4 percent of the nation's agro-processing demand being imported (e.g., milled grains and other processed agricultural products) and food constituting 25.7 percent of total imports. PNG primarily exports mining commodities—metals and energy (88.5 percent of total exports).

The decomposition of GDP by expenditure (Figure 2) also highlights some distinct features of the PNG economy. In particular, the country is characterized by a high trade intensity (exports are 44 percent of GDP, imports are 38 percent of GDP);³ government consumption is also relatively large (23 percent of GDP).

In sum, PNG's economy exhibits structural characteristics that predispose it to greater vulnerability to world market shocks than to domestic production shocks. This is evident from the country's strong trade orientation and the relatively small share of primary agriculture, which is typically the most volatile sector of the economy. However, a snapshot of the current economic structure does not provide sufficient detail. The SRP analysis, with its specification of exogenous shock sizes and economic linkages—captured in the CGE model—offers a more comprehensive foundation for developing PNG's economic risk profile.

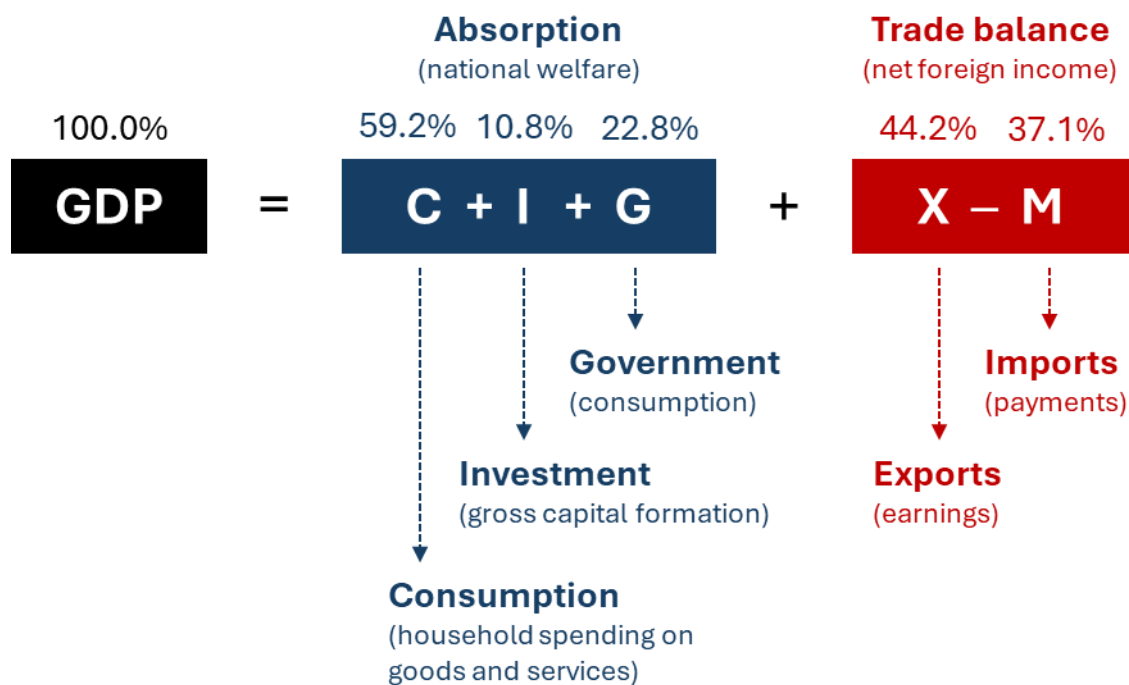
² Share of the population whose adult-equivalent daily consumption is below the minimum calorie requirement defined by the Food and Agriculture Organization of the United Nations (approximately 1,800 kilocalories per person per day).

³ For comparison, in 2019, lower-middle-income countries had average exports equivalent to 27.8 percent of GDP, imports at 24.1 percent of GDP, and government consumption at 11.2 percent of GDP (World Bank, 2024a).

Table 1. Composition of PNG's economy by sectors

	% of total GDP	% of employment	% of total demand	Export		Import	
				% of sectoral output	% of total export	% of sectoral demand	% of total import
Primary Agriculture	18.0	64.6	8.8	14.0	4.1	1.8	0.6
Crops	13.4	51.2	4.1	14.6	1.9	3.8	0.6
<i>Roots and tubers</i>	4.5	20.6	0.7				
<i>Fruits</i>	3.2	6.9	1.1	2.8	0.1	4.0	0.2
<i>Beverage crops</i>	0.8	1.6	0.1	80.3	1.6	3.9	0.0
Livestock	2.0	4.7	1.4				
Forestry	1.1	3.6	2.0	24.5	2.2		
Fishing	1.5	5.1	1.3				
Mining	29.8	2.4	9.0	81.1	88.5	28.2	10.1
Manufacturing	3.0	3.4	21.3	18.7	3.9	78.2	63.2
Agroprocessing	2.4	2.3	11.0	12.8	1.9	66.4	25.7
Other manufact.	0.7	1.1	10.3	34.6	2.0	90.9	37.5
Utilities	0.9	0.4	1.4				
Construction	4.9	4.2	6.9			18.8	5.5
Services	43.5	24.9	52.6	2.3	3.6	8.9	20.6
Food services	1.8	1.3	1.9	0.7	0.0	10.9	0.9
Social services	9.6	2.7	11.1				
Other services	32.1	20.9	39.6	3.1	3.6	11.3	19.7
Total	100	100	100	28.4	100	25.3	100

Figure 2. Composition of PNG's economy by expenditure



Source: Own calculations based on official national accounts data for 2019 presented in the form of the Social Accounting Matrix for 2019 (IFPRI, 2022).

4. Exogenous Shocks

In the first step of our SRP analysis, we use historical time-series data and data mining methods to simultaneously sample world market and domestic production shocks.

World market shocks consist of international commodity price shocks and foreign capital flow shocks. International commodity price shocks are changes in export and import prices of the goods and services in which PNG trades. The volatility of these prices is typically driven by global economic and financial market conditions. Foreign capital flow shocks are changes in the flow of foreign capital into the national economy. These capital inflows (comprising foreign direct investment, government and private borrowing abroad, and central bank operations) finance PNG's trade deficit.⁴ The volatility of foreign capital inflows is influenced by both PNG's attractiveness to foreign investors and global financial market conditions.

Domestic production shocks represent productivity changes in primary agriculture and hydropower electricity generation. These sectors are most susceptible to extreme weather events (particularly droughts and river floods in the case of PNG) and other natural hazards (such as crop pest infestations and livestock diseases).⁵

The time-series data consists of 28 shock variables over the period of 1980 - 2023. These include international commodity prices, foreign capital flow, agricultural production activities, and power electricity generation.

All observations form the dataset from which we randomly sample 10,000 shock scenarios.⁶ These shock scenarios together provide a realistic representation of PNG's economic volatility at present and in the future, as they capture all possible combinations of all observed exogenous shocks, as well as the shocks' size and direction.

The procedure involves three steps:

- 1) **Trend Calculation:** for each shock variable, we calculate the long-term trend over the 44-year period that is represented by a smoothed curve (shown as a dashed blue line in the graphs of Figure 1).⁷
- 2) **Shock Derivation:** We derive the shocks for each variable by calculating the relative deviations of the annual observations from the long-term trend.
- 3) **Multivariate Estimation:** From the relative deviations of all shock variables, we estimate a multivariate normal distribution and sample 10,000 multivariate shock scenarios. By randomly drawing

⁴ The link of foreign capital flows to international trade flows, as well as the implications of both flows for Ghana's exchange rate, relates shocks in foreign capital flows to international commodity price shocks, but the different mechanisms of the two shock categories make them distinct. We therefore combine international commodity price shocks and foreign capital flow shocks in our simulations of world market shocks but discuss the two shock categories and the related risks separately.

⁵ Domestic production shocks enter the CGE model as sector-specific total factor productivity (TFP) changes. We therefore use productivity metrics (e.g., agricultural yields) as TFP proxy indicators, whenever possible. For some (sub)sectors for which productivity metrics unavailable (that are meat and milk production, forestry, and hydropower electricity generation), we use per capita production as a proxy. See Mukashov et al. (2024) for details.

⁶ The configuration of our data mining exercise to 28 shock variables and 10,000 shock scenarios is chosen to balance tradeoffs between data availability and computational intensity. It ensures that shock sampling and scenario building are well-supported by the historical data while keeping simulation and post-simulation calculations computationally feasible.

⁷ To calculate the long-term trend, we use the Hodrick-Prescott filter for annual data (Hodrick & Prescott 1997). The resulting smoothed curve is less sensitive to short-term than long-term fluctuations.

shocks from this distribution (with assumed zero means and an estimated variance-covariance matrix), our analysis remains agnostic about future shocks, as the deviations found in the historical data are not strictly symmetric around zero.

Figure 3 shows the estimated marginal distributions for the 28 shock variables as box plots in Panel A and the variables' correlation structure as heatmaps in Panel B. Hence, the graphs in Figure 3A compare the scales of the sample shocks, highlighting the most and least volatile shock variables, and the graphs in Figure 3B illustrate which shocks are most and least likely to occur at the same time. In the following, we discuss the results of the first step of our SRP analysis organized by shock category.

International commodity price shocks

Our analysis of international commodity price shocks, derived from data from the World Bank (2024b) and other public databases, reveals *significant differences in volatility across sectors*. Primary commodities show particularly high volatility. Fertilizer, energy, and metal and mineral prices are the most volatile (in respective order). Within agricultural commodities, prices of beverage crops (coffee, cocoa, and tea), followed by grain prices, are the most volatile. In contrast, prices of manufactured goods and services exhibit greater stability (Figure 3A).

International price shocks for energy, metals and minerals, and fertilizers are strongly positively correlated (Figure 3B), as global production of these commodities is interconnected. Energy and fertilizer are critical inputs into the production and processing of main agricultural crops such as grains and oilseeds, which explains the strong and positive correlation between the price shocks for these primary commodities. Similarly, the correlations between grain and oilseed price shocks and price shocks for livestock products (meat and milk and dairy products) are strong and positive because grains and oilseeds are used for animal feed in addition to direct human consumption. Altogether, the correlation patterns suggest that international price shocks are likely to affect multiple primary commodities simultaneously, mainly due to their joint dependence on global business cycles (Erten and Ocampo, 2013). The international price shocks for all goods are negatively correlated with the international price shocks for services. Thus, when the prices of goods in global markets rise above their long-term averages, the price of services tends to drop below its long-term average. Price fluctuations for services, however, are small (Figure 3A).

Foreign capital flow shocks

PNG's current account deficit (Figure 1F) needs to be financed through foreign capital inflows. For our analysis, we assume that these flows enter the economy as foreign savings denominated in foreign currency, influencing both the exchange rate and investment demand, particularly in the construction sector.

Based on current account data from IMF (2024), fluctuations in estimated foreign savings can reach up to \pm US\$ 2 billion around the long-term average, equivalent to about 8 percent of total GDP (Figure 3A). Despite the link between foreign capital flows and international trade flows, *correlations between shocks in foreign capital flows and international prices of traded commodities are weak* for PNG (Figure 3B).

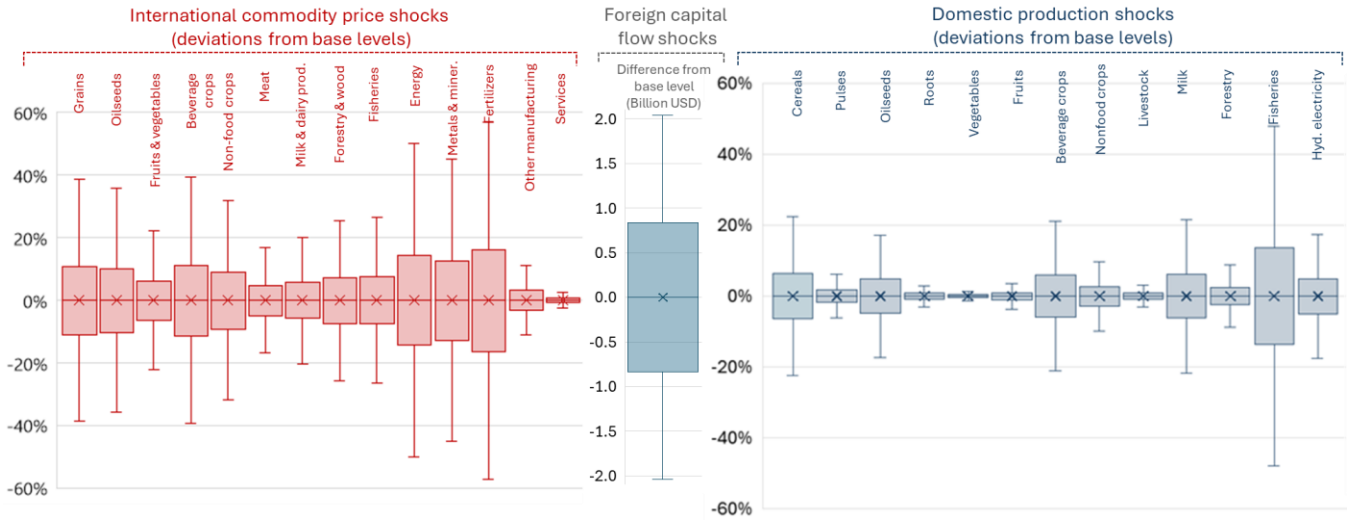
Domestic production shocks

According to our historical analysis of domestic production based on the World Bank (2024a) and FAO (2024), the fisheries sector in PNG has demonstrated the highest production volatility, with annual variations ranging from -50% to +50% relative to long-term averages. This significant fluctuation is, at least in part, attributable to the effects of El Niño on tuna migration in the Pacific region, which is a critical component of PNG's fisheries (Bell et al., 2021; Domokos, 2023). At the same time, it should be noted that FAO

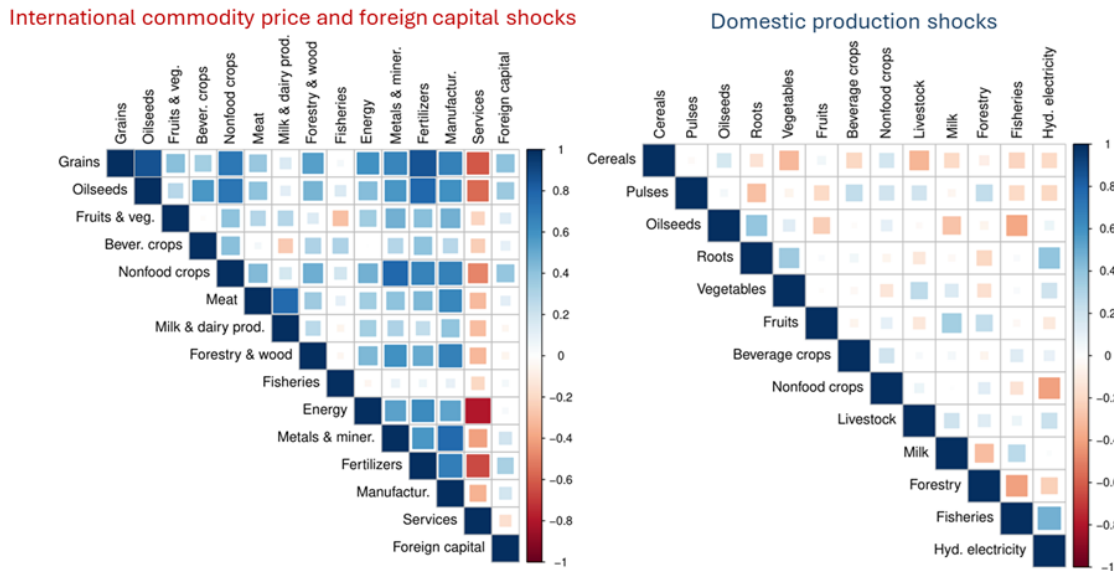
(2024) data on crop yield volatility is exclusively based on FAO staff estimates and lacks the official data typically provided to FAO by government officials in other countries. In this context, it is possible that our estimation of domestic crop yield volatility is imprecise—most likely underestimating volatility—because, in a substantial number of instances, yield entries in FAO data do not change from year to year. Given the absence of alternative data sources, we have used this data for our analysis, which suggests that the yield volatilities of most crops in PNG do not exceed $\pm 25\%$ from long-term averages, even under the most extreme weather scenarios.

Figure 3. Descriptive statistics of the sampled shocks for all shock variables

A. Marginal distributions



B. Correlations



Note: The cells in the correlation heatmaps in Panel B show the strength and direction of the correlations between two variables. The sizes of the squares indicate the strength of the correlations, with non-colored cells indicating no or near zero correlations and full-colored cells indicating perfect or near-perfect correlation. Blue-colored squares indicate positive correlations, and red-colored squares indicate negative correlations.

Because of missing data, the international prices for some commodities are approximated using related price indexes or prices of similar commodities as available from the World Bank's Commodity Price Outlook Database (World Bank 2024b). The grain price index is used as a proxy for cereal, pulse, root, and milled grain prices. Orange and banana prices are used as proxies for all fresh fruit and vegetable prices (while international vegetable prices are unavailable). Energy and metal price indexes are used as proxies for all energy and metal prices, respectively. For prices of all other (non-agricultural/energy/metal) manufacturing goods, the manufacturing unit value index is used as a proxy. Additionally, the United States consumer price index for services from FRED (2024) is used as a price proxy for all internationally traded services in PNG.

Source: Own calculation based on data from World Bank (2024a, 2024b), FRED (2024), FAO (2024), and IMF (2024).

5. Risk Profiles

In the second step of our SRP analysis, we feed the shock scenarios into an **economywide CGE model** for PNG to simulate their impacts on various (sub)sector-specific economic outcomes.

We use IFPRI's standard CGE model, which forms part of the larger Rural Investment and Policy Analysis (RIAPA) modeling system (IFPRI 2025a). The model is calibrated to a Social Accounting Matrix (SAM) for PNG for 2019 (IFPRI 2022; 2025b). The SAM has 46 separate domestic production activities and an equal number of separate commodity groups. A survey-based microsimulation module is linked to the CGE model to translate the simulation results into changes in household-level development outcomes such as poverty or undernourishment.

In the third step of the SRP analysis, we apply **data mining and machine learning** to:

- 1) Quantify how individual shocks contribute to the volatility of our four key economic and development outcomes⁸
- 2) Rank risk factors by their importance for overall economic performance, private consumption, poverty, undernourishment

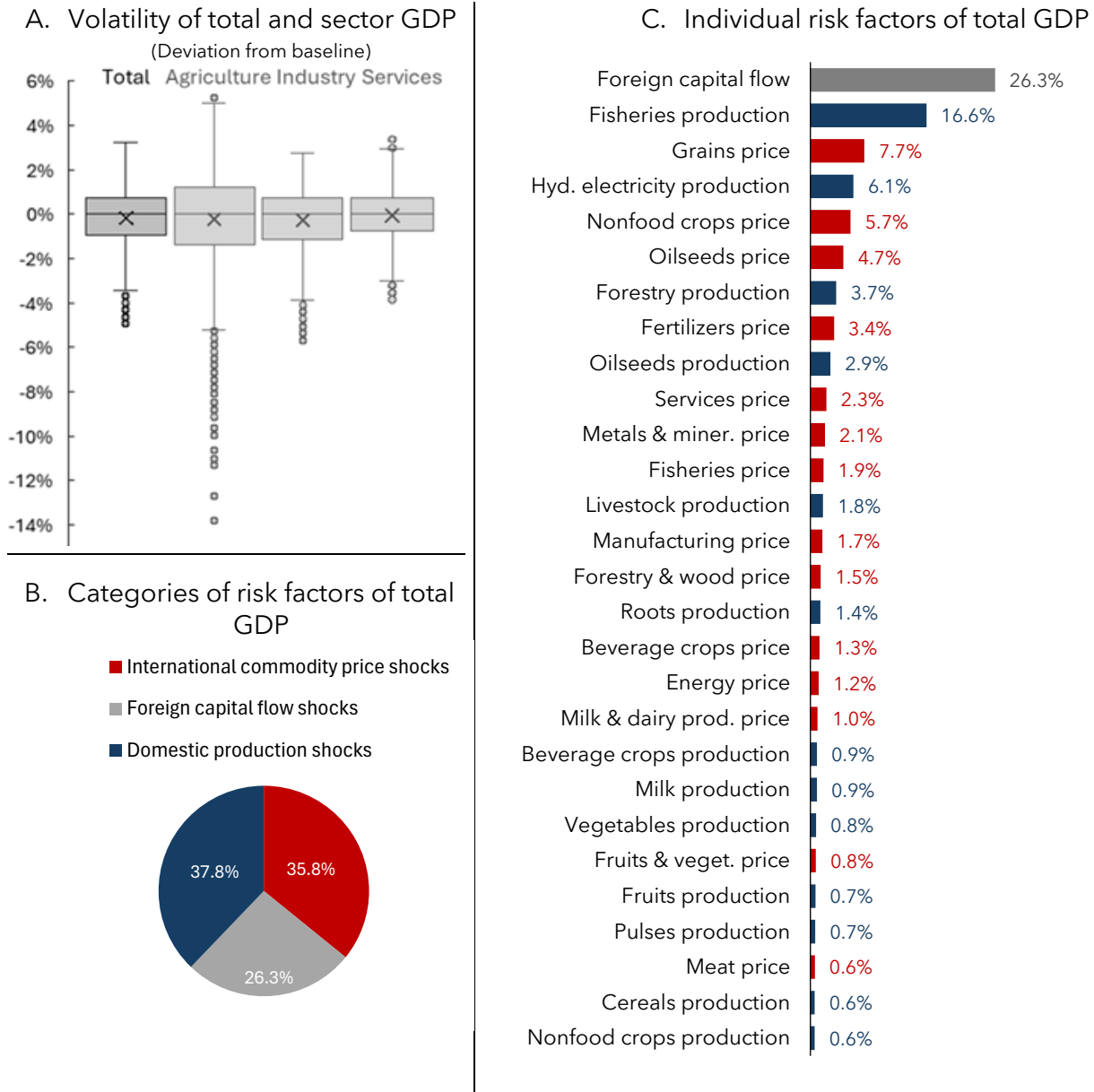
The resulting risk profiles are discussed below.

Risk profile for overall economic performance

The results of our SRP analysis show that exogenous shocks can lead to an increase of PNG's total GDP by 3.2 percent from the baseline in the *best-case scenario* and a reduction of 4.9 percent in the *worst-case scenario* (Figure 4A) (the baseline reflects a situation in which exogenous shocks are absent). Agriculture, which is directly exposed to sampled productivity shocks, is the riskiest sector. However, its variation is not significantly different from that of the industrial and service sectors (the area within the box - between the 1st and 3rd quartiles of the distribution - of the box and whiskers plot), except in extremely negative scenarios. Domestic production risk factors account for 37.8 percent of total GDP volatility, with fishery production being the most significant risk factor. Volatility in foreign capital flows, which directly influences the exchange rate and investment demand (primarily in construction), explains 26.3 percent of total GDP volatility. Finally, international commodity price shocks account for the remaining 35.8 percent.

⁸ We use relative importance methods by Lindeman et al. (1980) and Random Forest methods (Breiman 2001), as described in Mukashov et al. (2024) in detail.

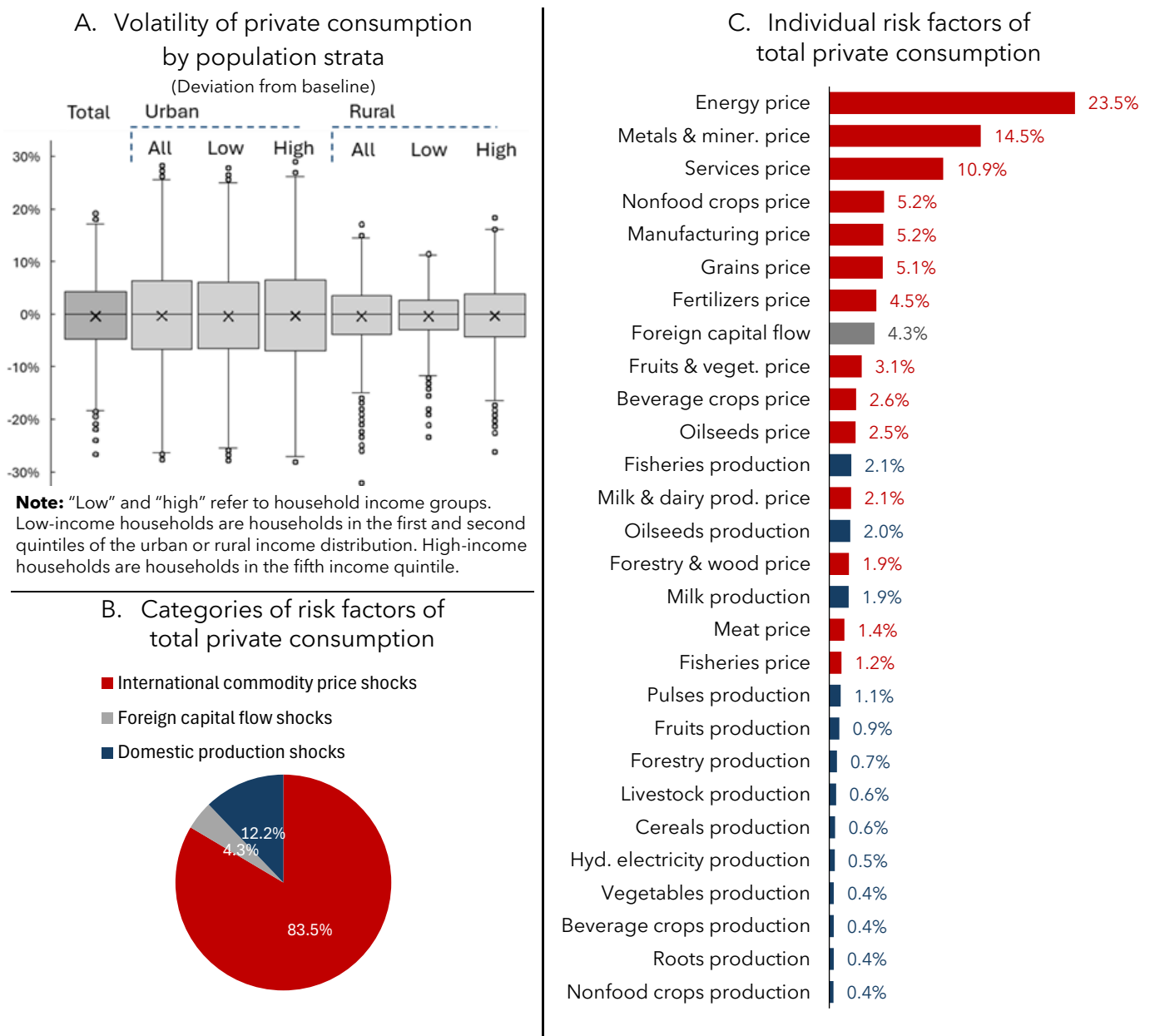
Figure 4. Components of the risk profile for overall economic performance



Risk profile for private consumption

Due to high trade dependence, private consumption is much more volatile than GDP, with total consumption fluctuating from +19.5 to -26.7 percent relative to the base in the best- and worst-case scenarios (in terms of standard deviation, private consumption is 5.5 times more volatile than GDP). Furthermore, urban households, which have a higher dependence on imported goods, have greater consumption volatility than rural households (in terms of standard deviation, urban consumption is 1.7 times more volatile than rural). For total consumption, world prices are the primary source of volatility, accounting for 83.5 percent of consumption risk, with prices of the country's key exports - energy and metals - being the main factors. However, there are notable differences across household types (Table 2).

Figure 5 Components of the risk profile for private consumption



In particular, although world risks also dominate consumption volatility of all households, domestic agricultural production is a more significant risk factor for rural households (18.6 percent for total rural versus 10.4 percent for total urban). Notably, the production volatility in the fishery sector is an especially important risk for rural middle-income households, resulting in the highest importance of domestic factors among all households (28.4 percent). At the same time, it is essential to remember that rural household consumption is less volatile, meaning that turbulence in world markets essentially poses less risk to rural households. This is largely due to the subsistence agriculture economy in rural PNG, where more than 50 percent of household food consumption is produced (Schmidt et al., 2024). In contrast, the greater volatility in urban household consumption is almost entirely attributed to world market factors, given their greater reliance on marketed food goods.

Table 2. Detailed decompositions of risk factors in consumption across household types

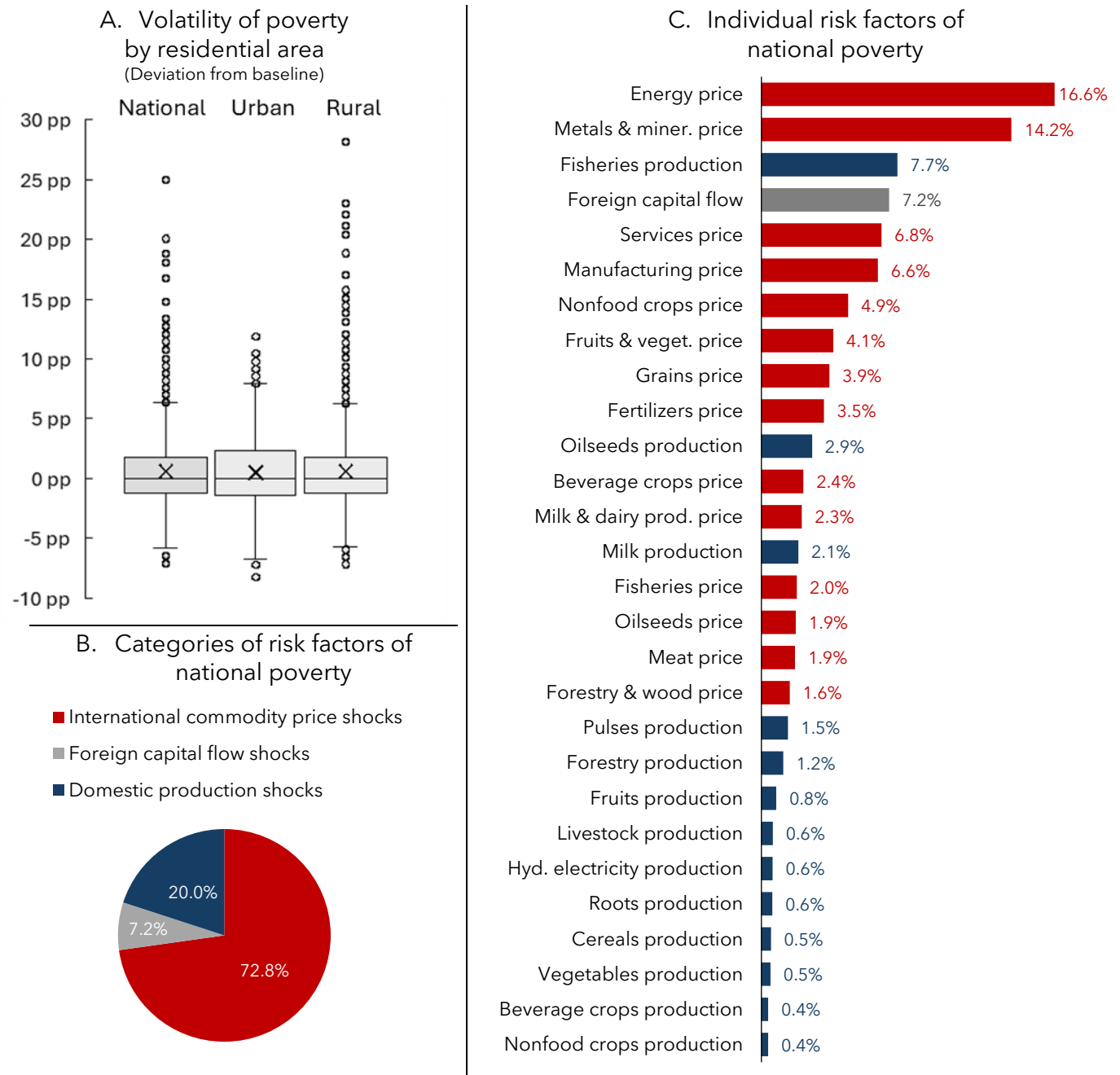
	Total	Urban				Rural			
		Total	Low	Middle	High	Total	Low	Middle	High
Total external	87.8	89.6	88.9	89.4	89.6	81.4	85.8	71.6	85.3
World prices									
Grains	5.1	7.3	7.3	7.0	7.5	3.4	5.1	2.6	3.6
Oilseeds	2.5	3.5	3.5	3.3	3.6	2.0	2.6	1.5	2.4
Fruits & vegetables	3.1	2.1	1.8	1.9	2.1	3.9	3.0	4.6	3.5
Beverage crops	2.6	2.3	3.3	3.2	1.9	2.7	2.6	2.7	2.6
Nonfood crops	5.2	6.4	6.8	6.3	6.3	3.9	5.9	3.2	3.8
Meat	1.4	1.2	1.4	1.3	1.2	1.6	1.9	1.8	1.3
Milk & dairy products	2.1	1.5	1.6	1.7	1.4	2.5	2.2	2.6	2.4
Forestry & wood	1.9	2.1	1.9	1.9	2.1	1.6	1.8	1.4	1.9
Fish	1.2	0.5	0.4	0.4	0.5	2.1	1.2	2.8	1.8
Energy	23.5	20.5	16.0	20.1	20.9	23.3	15.8	17.9	27.1
Minerals	14.5	12.7	11.6	12.1	12.9	14.4	14.0	12.9	14.6
Fertilizers	4.5	5.6	5.3	5.3	5.7	3.3	4.4	2.6	3.5
Manufacturing	5.2	4.2	4.2	4.0	4.3	5.7	6.2	6.4	5.0
Services	10.9	11.6	9.3	11.3	11.9	9.2	7.8	6.5	11.0
Foreign capital	4.3	8.2	14.4	9.7	7.3	1.8	11.5	2.0	0.9
Total domestic	12.2	10.4	11.1	10.6	10.4	18.6	14.2	28.4	14.7
Domestic productivity									
Cereals	0.6	0.5	0.5	0.5	0.5	0.6	0.5	0.7	0.6
Pulses	1.1	0.8	0.7	0.8	0.8	1.4	1.2	1.8	1.1
Oilseeds	2.0	1.6	2.1	1.7	1.5	2.3	2.3	2.6	1.9
Roots	0.4	0.4	0.4	0.4	0.4	0.4	0.9	0.6	0.4
Vegetables	0.4	0.5	0.6	0.5	0.5	0.4	0.7	0.4	0.5
Fruits	0.9	1.0	1.0	1.0	1.0	0.8	0.9	0.7	0.9
Beverage crops	0.4	0.5	0.4	0.5	0.5	0.4	0.4	0.4	0.5
Nonfood crops	0.4	0.5	0.5	0.4	0.5	0.3	0.5	0.3	0.3
Livestock	0.6	0.6	0.7	0.6	0.6	0.7	0.7	0.6	0.8
Milk	1.9	1.3	1.3	1.3	1.4	2.2	1.8	2.5	2.1
Forestry	0.7	0.8	0.9	0.8	0.7	1.3	0.8	2.3	1.0
Fisheries	2.1	0.9	1.1	1.1	0.8	7.1	3.1	14.4	4.2
Hyd. electricity	0.5	1.0	1.0	0.9	1.1	0.6	0.5	1.1	0.5

Note: "Low," "Middle," and "high" refer to household income groups. Low comprises the first- and second-income quintiles, middle comprises the third- and fourth-income quintiles, and high comprises the fifth-income quintile of urban and rural households, respectively.

Risk profile for poverty

The national poverty rate can fluctuate with the consumption of low-income households, ranging from -7.1 to +25.0 percentage points relative to the baseline national poverty headcount rate of 39.9 percent. In absolute terms, this translates to 0.6 million people possibly rising above the poverty line in the best-case scenario and 2.1 million people falling below it in the worst-case scenario (+25 percent of the total population). Nationally, external risks are the dominant factors, accounting for 80 percent of total poverty risk, though notable differences exist across household types (Table 3).

Figure 6. Components of the risk profile for poverty



Note: The baseline reflects a situation in which exogenous shocks are absent.

Similar to consumption volatility, production in the highly volatile fishery sector is a significant risk factor for rural poverty, as middle-income rural households may be pushed below the poverty line if negative scenarios occur. Consequently, domestic productivity volatility factors (e.g., fishery, oilseeds, etc.) represent 23.8 percent of the total risk for rural poverty, which is more than two times higher than the 11.0 per cent risk for urban poverty.

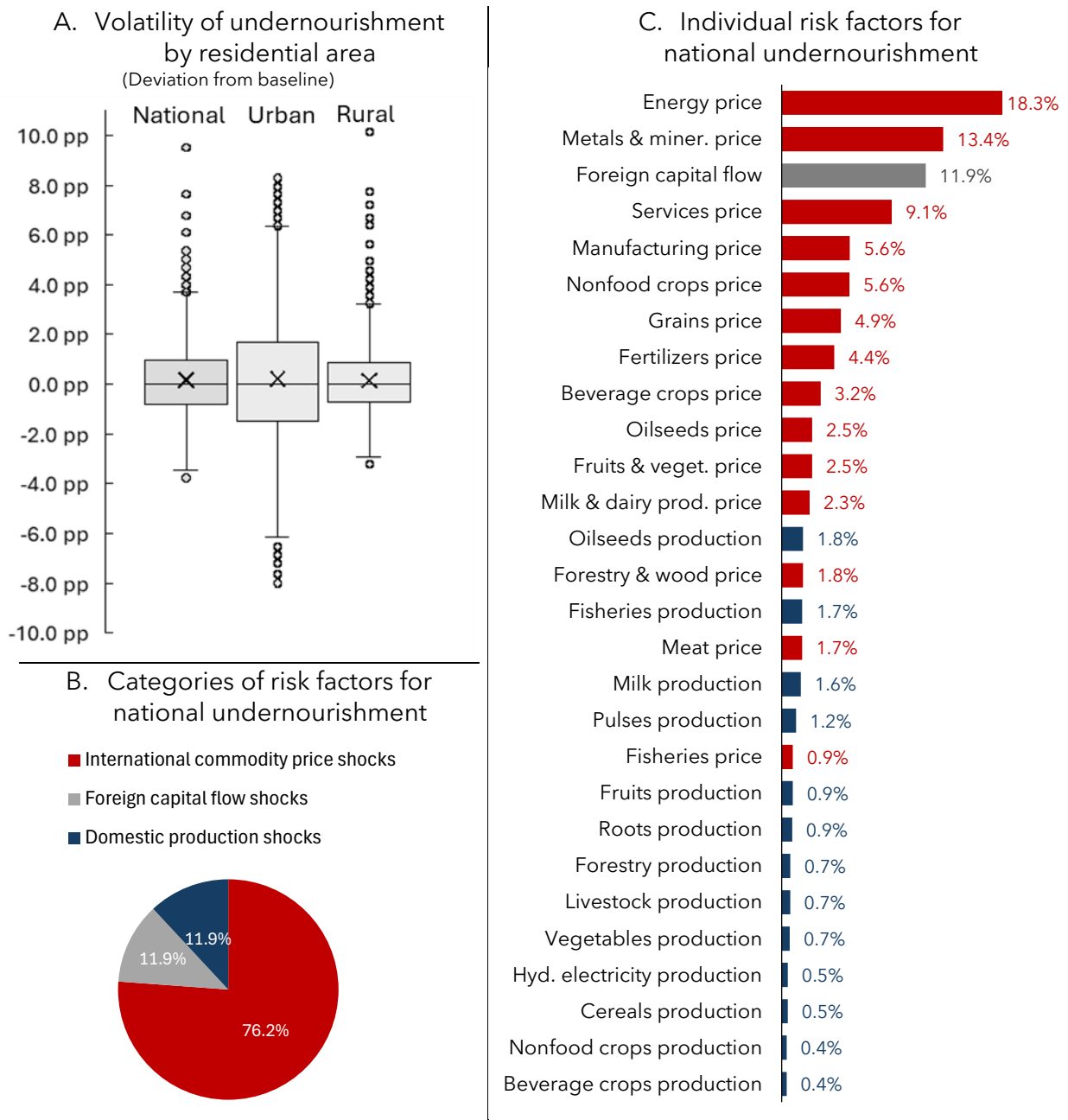
Table 3. Detailed decompositions of risk factors in poverty and undernourishment across household types

	Poverty			Undernourishment		
	National	Urban	Rural	National	Urban	Rural
Total external	80.0	89.0	76.2	88.1	89.3	86.0
World prices						
Grains	3.9	7.0	3.3	4.9	6.2	4.4
Oilseeds	1.9	3.4	1.7	2.5	3.0	2.3
Fruits & vegetables	4.1	1.8	4.4	2.5	1.8	2.8
Beverage crops	2.4	2.8	2.3	3.2	4.1	2.9
Nonfood crops	4.9	6.8	4.4	5.6	6.0	5.3
Meat	1.9	1.3	2.0	1.7	1.3	1.8
Milk & dairy products	2.3	1.5	2.4	2.3	1.9	2.4
Forestry & wood	1.6	2.0	1.6	1.8	1.9	1.7
Fish	2.0	0.4	2.4	0.9	0.4	1.2
Energy	16.6	17.3	15.7	18.3	19.5	17.3
Minerals	14.2	12.0	13.9	13.4	12.1	13.5
Fertilizers	3.5	5.3	3.2	4.4	4.8	4.1
Manufacturing	6.6	4.2	6.9	5.6	4.2	6.2
Services	6.8	9.9	6.1	9.1	10.5	8.4
Foreign capital	7.2	13.3	6.0	11.9	11.7	11.7
Total domestic	20.0	11.0	23.8	11.9	10.7	14.0
Domestic productivity						
Cereals	0.5	0.5	0.6	0.5	0.5	0.5
Pulses	1.5	0.7	1.6	1.2	0.8	1.3
Oilseeds	2.9	2.0	3.0	1.8	1.8	1.8
Roots	0.6	0.4	0.7	0.9	0.4	1.1
Vegetables	0.5	0.6	0.5	0.7	0.6	0.7
Fruits	0.8	1.0	0.8	0.9	1.0	0.9
Beverage crops	0.4	0.4	0.4	0.4	0.5	0.4
Nonfood crops	0.4	0.5	0.4	0.4	0.4	0.4
Livestock	0.6	0.6	0.6	0.7	0.6	0.7
Milk	2.1	1.2	2.2	1.6	1.3	1.7
Forestry	1.2	1.0	1.6	0.7	0.9	0.8
Fisheries	7.7	1.1	10.7	1.7	1.0	3.1
Hyd. electricity	0.6	1.1	0.8	0.5	0.9	0.5

Risk profile for undernourishment

The national undernourishment rate can fluctuate from -3.8 to +9.5 percentage points relative to the baseline national undernourishment headcount rate of 23.1 percent (using the global calorie threshold proposed by the FAO). This translates to 0.3 million people above the undernourishment line in the best-case scenario and 0.8 million below it in the worst-case scenario. Similar to other outcomes, external risks play the most critical role in undernourishment uncertainty. The country's ability to import food depends on both import prices and foreign exchange earnings (see Section 3), which, in turn, are influenced by global business cycles and commodity prices.

Figure 7. Risk profile for undernourishment



Note: The baseline reflects a situation in which exogenous shocks are absent.

6. Conclusions

Achieving development goals—like becoming a higher middle-income country or ending poverty and hunger by 2030—is subject to economic uncertainties. Yet policymaking rarely incorporates risk assessments, relying instead on deterministic trend projections.

To address this gap, inform national development strategies, and complement standard economic projections, *Systematic Risk Profiling* (SRP) provides a novel approach integrating CGE modeling, household microsimulation, and machine learning. Our SRP exercise for PNG assesses the risks from exogenous shocks for the national economy and population and simulates the potential impacts of these shocks on the country's overall economic performance, private consumption, poverty, and undernourishment.

We find that, under PNG's current economic structure, household consumption (which is highly dependent on imports, particularly in urban areas) is 5.5 times more uncertain than GDP, indicating PNG's high vulnerability to import prices and foreign exchange export earnings from metal and energy commodities needed to finance imports. Overall, the country's high integration into world markets and significant trade intensity make PNG's economy more dependent on world markets than on domestic yield volatilities across all economic outcomes.

The analysis presented in this Country Brief provides an initial assessment of major economic risks in PNG. Understanding these risks is a critical first step in facilitating discussions on potential risk management strategies such as promoting domestic productivity growth, adopting technologies and practices for reducing production uncertainty, and diversifying economic activity away from high-risk sectors. The next step would be for national policymakers or advisors to evaluate alternative risk management strategies.

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