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Systematic Analysis of Domestic Production and World Market 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 in countries and across key population groups to answer two questions: (1) What is the country's current vulnerability to world market prices and domestic production risks that are consistent with historical data? (2) How much do these shocks contribute to the country's current vulnerability, and which shocks contribute most to economic uncertainty?

Abstract

This study explores Bangladesh's vulnerability to economic shocks and identifies those contributing most to economic uncertainty. The Bangladesh Computable General Equilibrium (CGE) model was employed to simulate a range of potential economic outcomes under various shock scenarios sampled using historical data to capture domestic agricultural yield volatilities and world market price uncertainty for traded goods. Data mining and machine learning methods were applied to quantify the contribution of each shock to the uncertainty of economic outcomes (gross domestic product [GDP], private consumption, poverty, and undernourishment). Our findings suggest that potential variation in Bangladesh's GDP ranges from +0.8 to -1.0 percent to baseline, with domestic shocks accounting for 53.7 percent of uncertainty, and remaining 41.7 percent are explained by the volatility of world market prices and Foreign Exchange (FX) flows. At the same time, private consumption is more uncertain (from +4.0 to -3.5 percent to base), and external factors are the most important risk contributors (70.1 percent is world prices and 2.9 percent is FX flows). Similarly, external factors contribute roughly two-thirds to the potential variation of national poverty and undernourishment rates that fluctuate from -2.4 to +1.8 and –2.2 to +1.9 relative to the baseline rates percentage points respectively. Understanding how potential shocks might impact various segments of the Bangladesh economy and population is a critical first step in facilitating a discussion on risk mitigation strategies that include increasing sectoral productivity or diversifying production to reduce reliance on high-risk sectors.

Keywords: risk profiling; yield volatility; world market uncertainty; CGE modeling, machine learning.

1. Analyzing the impacts of simultaneous variability of exogenous shocks

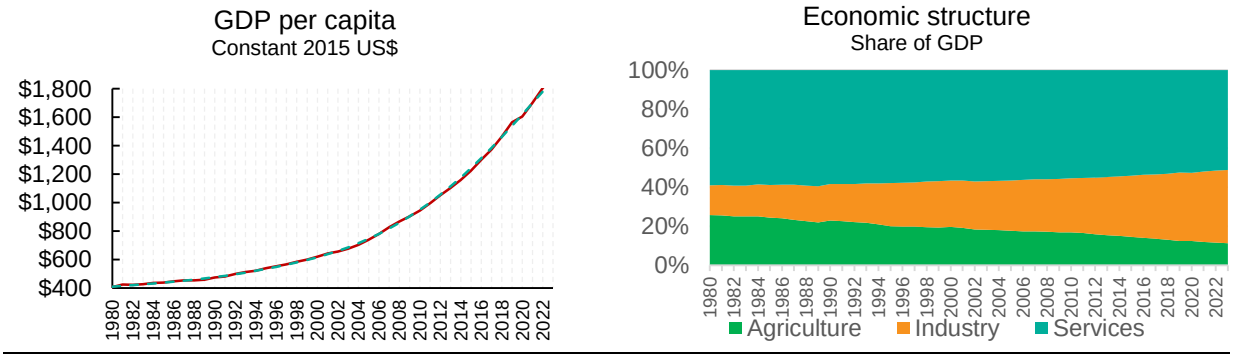
An examination of the historical dynamics of Bangladesh's key economic indicators (Figure 1) highlights several critical aspects of the country's development. The country has been steadily growing, and since 2015 has been classified as a lower-middle-income country (LMIC) by the World Bank (World Bank 2021). The key to the country's growth has been structural transformation, as the share of agriculture has been steadily declining, while the importance of the industrial sector has been steadily growing. The primary locomotive of such transformation is manufacturing of readymade garments, whose export orientation and labor intensity paved the way for a successful economic transformation and job creation in the country (World Bank 2021).

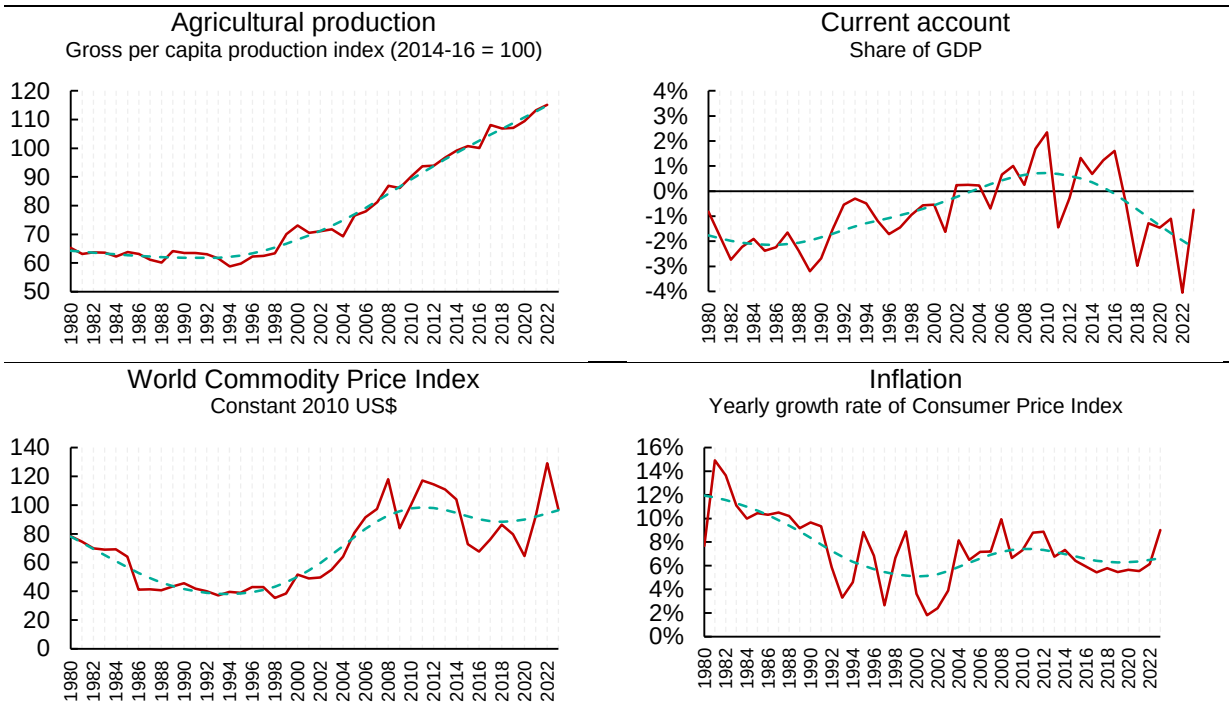
In addition to long-term development factors, such as institutions, infrastructure, and human capital, short-term uncertainty factors are also important for Bangladesh, including production shocks that affect agriculture and farmers (World Bank 2021) and international commodity and food prices that affect inflation and macroeconomic stability (IMF, 2024a). In this context, our goal is to create a realistic map of these shocks and to develop a risk profile of Bangladesh's baseline economic structure. The methods and analyses used in this note seek to answer two questions:

- What is the country's current vulnerability to world market prices and agricultural risks, as captured by *historical data*?
- How much do these shocks contribute to the country's current vulnerability, and which shocks contribute most to economic uncertainty?

To answer these and related questions, we use a novel methodology called Systematic Risk Profiling (SRP). The method applies machine-learning and data-mining techniques to dissect complex relationships between sampled shocks and outcome variables in an economywide Computable General Equilibrium (CGE) model . Our SRP approach consists of three sequential steps: (1) using historical data to sample scenarios that realistically represent the parameter space of exogenous shocks; (2) creating potential shock scenarios and supplying them to the CGE model of Bangladesh to estimate the corresponding economic outcomes; and (3) applying machine-learning and data-mining methods to quantify the contribution of each shock to the overall uncertainty of various economic outcomes. For details on SRP, see Mukashov et al. (2024).

Figure 1. Historical dynamics of key indicators (long term trend line in dashed blue)





Note: Trend calculation using Hodrick–Prescott filter for yearly data (see Hodrick and Prescott 1997).
Source: Own calculations using World Bank (2024a) data (GDP per capita, economic structure); FAO (2024) data (agricultural production); IMF (2024b) data (current account, inflation) and World Bank (2024b) data (global commodities price index).

2. Current economic structure and shock scenarios

2.1 The Structure of the Bangladesh Economy

Bangladesh has a GDP per capita of 2,129 USD (in 2019), a national poverty rate of 24.3 percent (based on the most recent household survey in 2016), and a national undernourishment[1] rate of 11.8 percent (in 2019) (World Bank, 2024a).

The economy's sectoral structure is typical of an LMIC country (Table 1a). Primary agriculture still accounts for a large share of economic activity, especially in terms of employment (12.5 percent of GDP and 38.6 percent of employment), with cereals being the most important subsector (3.5 percent of GDP and 10.9 percent of employment). The agroprocessing sector, at 3.1 percent of total GDP, is underdeveloped, as its demand (7.6 percent of total demand) surpasses domestic production capacity. Overall, Bangladesh imports 11.6 percent of primary and 16.2 percent of processed agricultural commodities consumed in the country (these are the biggest import categories after equipment and petroleum). At the same time, textile and clothing is the country's key industrial sector, with 7.8 percent of GDP and employment and 72.5 percent of the country's exports. Yet, Bangladesh is a net importer, with 6.6 percent of total demand being imported, and other industrial products (energy, machinery, etc.) constituting the largest share of imports (49.4 percent), followed by agricultural products (primary agriculture 15.7 percent, agroprocessed products 12.8 percent) and services (mostly transport and communication).

On the expenditure side, Bangladesh's economy also has features typical of an LMIC (Table 1b). In particular, the country has a large share of investment demand (32 percent of GDP, primarily construction

1 Share of the population whose adult-equivalent daily consumption below the minimum calorie requirement defined by the Food and Agriculture Organization of the United Nations.

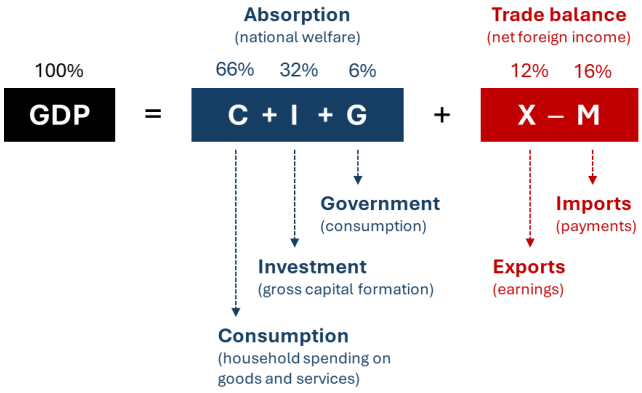
and imported machinery) and relatively high trade intensity (exports are 12 percent of GDP and imports are 16 percent of GDP), but the trade balance is still negative (4 percent of GDP).

Table 1. Structure of Bangladesh's Economy

a. Sectoral decomposition

	% of total GDP	% of employ-ment	% of total demand	Export		Import	
				% of sectoral output	% of total export	% of sectoral demand	% of total import
Primary Agriculture	12.5	38.6	13.0			11.6	15.7
Crops	6.3	19.5	5.9			25.7	15.7
Cereals	3.5	10.9	2.7			13.3	3.8
Non-food crops	1.1	3.4	1.1			34.8	4.0
Vegetables	0.4	1.3	0.5			36.2	2.0
Livestock	2.0	6.1	2.3				
Forestry	1.5	4.5	2.0				
Fishing	2.8	8.6	2.8				
Mining	1.8	0.9	2.1			21.4	4.7
Manufacturing	21.7	14.7	37.0	14.5	88.9	17.6	67.9
Agroprocessing	3.1	3.1	7.6	1.8	2.2	16.2	12.8
Textile and clothing	7.8	7.8	6.1	41.2	72.5	9.0	5.7
Other manufact.	10.8	3.8	23.3	4.4	14.2	20.3	49.4
Utilities	1.5	0.8	2.6				
Construction	9.2	4.6	11.8				
Services	53.3	40.4	33.4	1.7	11.1	3.4	11.8
Food services	1.2	1.7	2.0	3.1	1.2	8.0	1.7
Social services	9.5	7.0	6.0	6.4	8.3		
Other services	42.6	31.7	25.4	0.3	1.6	3.8	10.1
Total	**100.0**	**100.0**	**100.0**	**5.6**	**100.0**	**9.6**	**100.0**

b. GDP decomposition 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 2023).

2.2 Characteristics of sampled shocks

The first step of SRP—estimating the historical volatility of shocks—helps us understand the scale of potential shocks the *current* Bangladesh economy could face. We consider two broad categories of shocks: (1) changes in world prices of goods and services (those in which Bangladesh trades and which are mostly affected by global business cycles) and (2) abrupt shifts in domestic production[2] often linked to droughts and other natural shocks such as pest infestations and diseases. Although the variation of shocks around historical trends is not strictly symmetric around zero, we remain agnostic about *future* shocks. We draw random hypothetical scenarios from a multivariate normal distribution with zero means and a history-based estimated variance-covariance matrix depicted in Figure 2 (panel A shows the modeled individual (marginal) distributions of sampled shocks, and panel B shows correlation structure of sampled shocks).

World price volatility: World prices of primary commodities are highly volatile, whereas manufactured goods and services exhibit much greater stability (Figure 2a). Among agricultural commodities, beverage crop prices are the most volatile, followed by grains. The prices of primary commodities show a strong positive correlation (Figure 2b), suggesting that price shocks often occur simultaneously due to their dependence on global business cycles (see Erten and Ocampo, 2013). In contrast, services exhibit a moderate negative correlation with most commodities, suggesting that when the prices of other commodities rise in real USD terms, the price of services in real USD may sometimes decline (however, the overall variation in service prices remains very low, see Figure 2a).

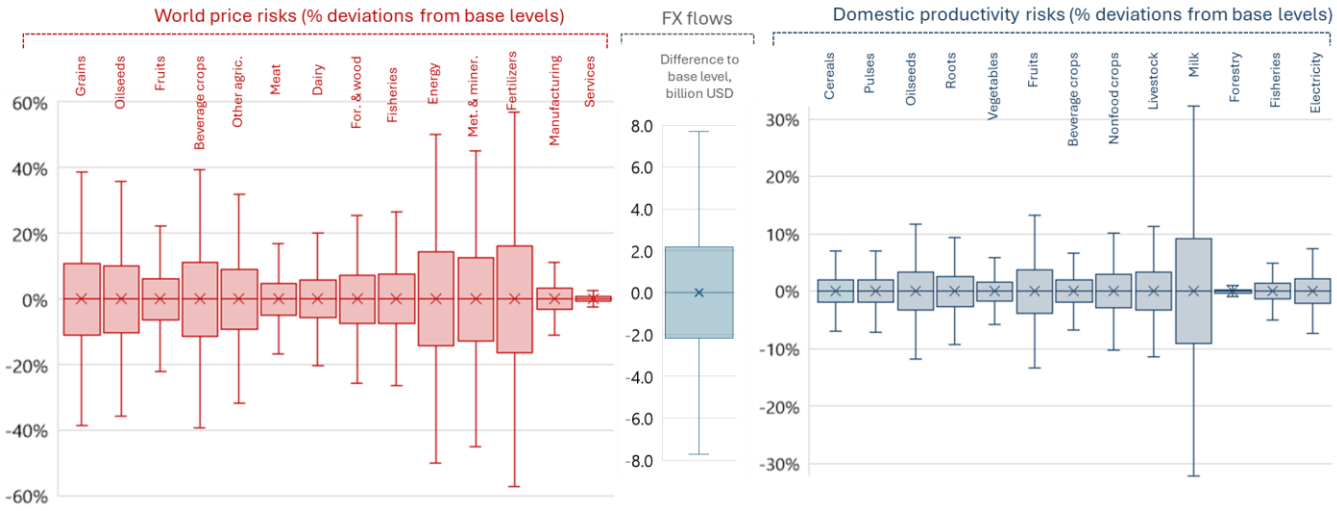
Volatility of FX flows: We assume that foreign exchange (FX) flows enter the economy as foreign savings denominated in USD, influencing both the exchange rate and investment demand (primarily in construction). To estimate changes in FX flows, we use current account data from the IMF (2024b), which indicates that FX flows deviate by approximately ±7.7 billion 2019 USD from the baseline (equivalent to 2.1% of 2019 GDP).

Domestic production volatility: According to our analysis based on FAO (2024) data, milk production was the most volatile in the country, with a range of ±30 percent from the long-term base (best- and worst-case scenarios), and it had high correlation with the livestock sector (meaning that shocks to production of these two are likely to be simultaneous). At the same time, all other sectors, including the most important crops, showed stable yields, with much lower fluctuations (around ±5 percent from the long-term baseline).

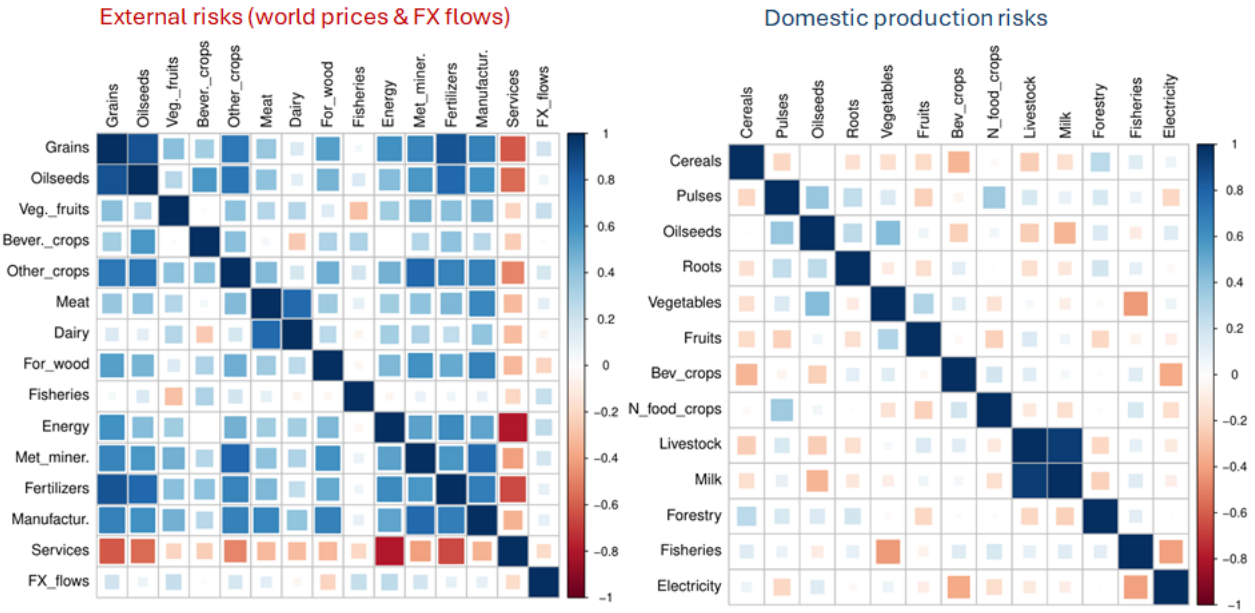
2 Whenever possible, we use agricultural yield as a measure of productivity. For some sectors where historical yield data do not exist (livestock, milk, forestry, electricity), we use historical per capita production as a proxy for total factor productivity (see Mukashov et al. (2024) for details).

Figure 2. Sampled risks

a. Marginal distributions



b. Correlation structure



Note: Each cell in the correlation figure is a correlation between two variables, with cell sizes ranging from empty (0 correlation) to full squares (max correlation=1) and colors ranging from red (-) to blue (+).

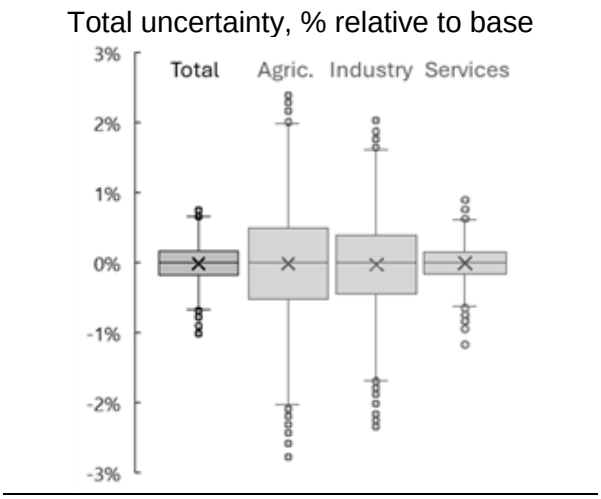
Source: Own calculations using World Bank (2024a, 2024b), FAO (2024), and IMF (2024b) data.

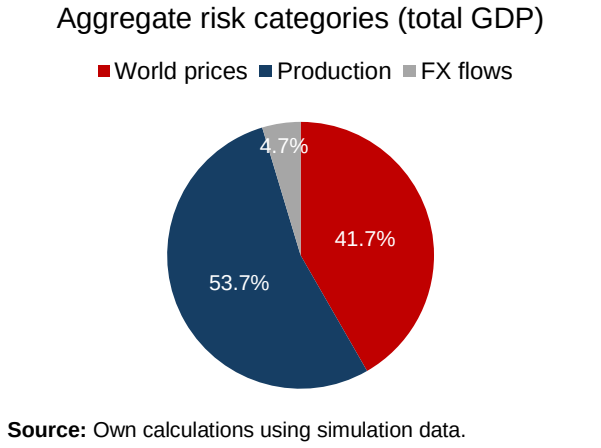
3. Measuring and understanding Bangladesh's economic uncertainty

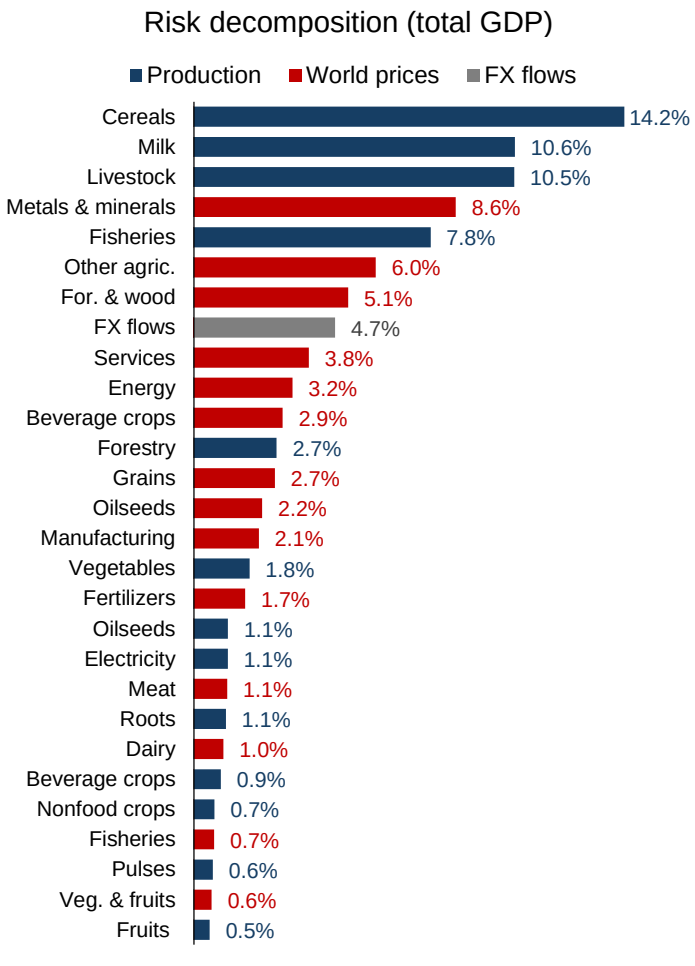
The second step of SRP models the economic uncertainty resulting from the 10,000 sampled scenarios supplied to the Bangladesh CGE model, while the third step employs machine-learning and data-mining methods to quantify each shock's contribution to outcome uncertainty[3]. Figures 3 to 6 represent the total uncertainty and its decomposition for GDP, private consumption, poverty, and undernourishment, respectively.

Potential variation of GDP (Figure 3): Total GDP can fluctuate from -1.0 percent (worst case) to +0.8 percent (best case) relative to the base year. Among the factors considered, cereal yield volatility emerges as the most important risk (14.2 percent). Given the high weight of cereals in the economy (see Section 2.1), this is not surprising, even considering the relatively low volatility of cereal yields. Production volatility of correlated milk and livestock sectors (see Section 2.2) are the second- and third-most-important risk factors, contributing to total GDP uncertainty 10.6 and 10.5 percent respectively. The agricultural sector, being directly exposed to productivity shocks, is the most volatile, varying from +2.4 to -2.8 percent relative to the base. Overall, domestic production shocks account for 53.7 percent of total GDP uncertainty, while external factors account for the remaining 46.3 percent (41.7 percent from world prices and 4.7 percent from FX flows).

Figure 3. Potential variation of GDP







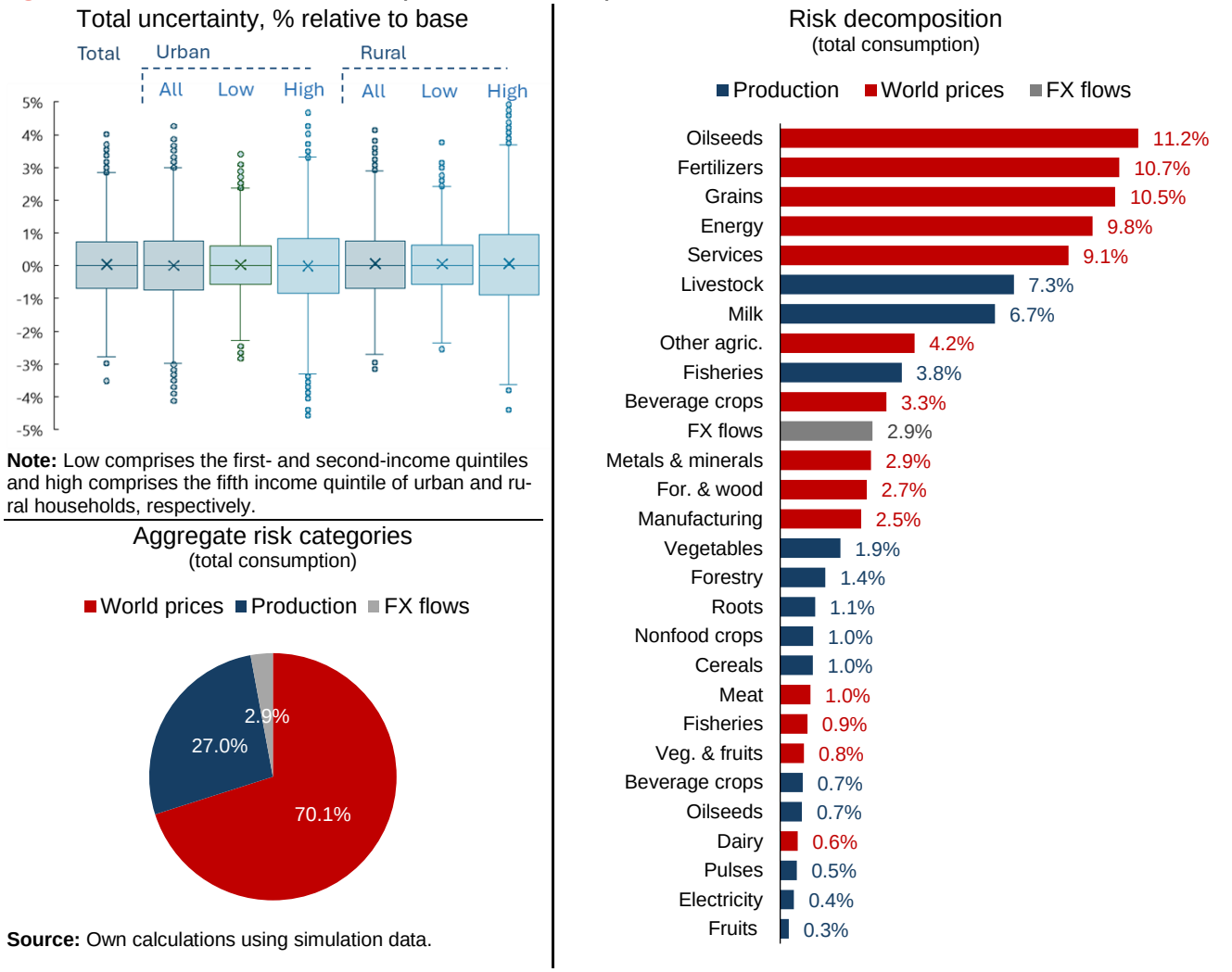
Source: Own calculations using simulation data.

3 We use Random Forest and Lindeman, Merenda, and Gold relative importance metrics; for details, see Mukashov et al. (2024).

Potential variation of private consumption (Figure 4 and Table 2): Private consumption is more uncertain than GDP and ranges from +4.0 to -3.5 percent relative to base values. In terms of standard deviations, total private consumption is four times more uncertain than total GDP, and consumption of high-income households is the most uncertain (urban high income from +4.7 to -4.6 percent, and rural high income from +5.1 to -4.4 percent).

The structure of Bangladesh's economy explains this outcome. Given the high import dependency (Table 1b), it is unsurprising that external factors are more important sources of consumption risk. Aggregate domestic yield volatility contributes only 27.0 percent to total consumption uncertainty, while world market prices and FX capital flow volatility together account for the remaining 73.0 percent. World prices of oilseeds, fertilizers, grains, energy, and services are the most important risks, contributing 11.2, 10.7, 10.5, 9.8, and 9.1 percent, respectively. Production volatility in livestock and milk are the most significant domestic factors, contributing 7.3 and 6.7 percent, respectively. At the same time, significant differences exist across household types (Table 2).

Figure 4. Potential variation of private consumption



Note: Low comprises the first- and second-income quintiles and high comprises the fifth income quintile of urban and rural households, respectively.

Source: Own calculations using simulation data.

In particular, domestic production volatility is a more important risk factor for urban households than for rural households. This is because wealthier urban households (e.g., middle- and high-income) have higher consumption of livestock and milk products, making volatility in these two sectors a more substantial contributor to variations in their consumption than it is for rural households.

Table 2. Detailed risk decompositions of consumption uncertainty

		Total	Urban				Rural			
			Total	Low	Middle	High	Total	Low	Middle	High
Total external		**73.0**	**59.0**	**72.3**	**59.5**	**57.6**	**80.2**	**77.7**	**81.3**	**73.3**
World prices	Grains	10.5	6.8	11.3	7.6	6.1	12.0	12.1	11.8	10.7
	Oilseeds	11.2	7.2	12.6	8.0	6.4	12.8	15.1	12.4	10.8
	Vegetables & fruits	0.8	0.6	0.6	0.6	0.7	0.9	0.7	0.9	1.1
	Beverage crops	3.3	2.5	3.9	2.4	2.3	3.6	4.0	3.2	3.3
	Other agriculture	4.2	3.1	5.1	3.5	2.8	4.9	3.6	4.7	5.2
	Meat	1.0	0.8	0.9	0.8	0.8	1.3	1.6	1.4	1.1
	Dairy	0.6	0.6	0.8	0.6	0.5	0.6	0.8	0.6	0.6
	Forestry & wood	2.7	2.5	2.6	2.8	2.4	2.8	1.6	3.1	3.0
	Fish	0.9	1.7	0.7	1.4	1.9	0.5	0.6	0.4	0.8
	Energy	9.8	6.0	7.4	6.2	5.8	11.5	9.2	12.6	10.1
	Metals & minerals	2.9	5.2	2.0	3.8	6.5	2.7	2.5	2.8	2.8
	Fertilizers	10.7	7.0	9.1	7.2	6.5	12.1	11.9	12.2	10.6
	Manufacturing	2.5	2.6	4.0	2.6	2.5	3.1	3.1	3.3	2.7
	Services	9.1	6.1	8.2	6.1	5.8	10.1	9.7	10.5	8.7
FX flows		2.9	6.4	3.3	6.1	6.7	1.4	1.2	1.1	1.7
Total domestic		**27.0**	**41.0**	**27.7**	**40.5**	**42.4**	**19.8**	**22.3**	**18.7**	**26.7**
Domestic production	Cereals	1.0	1.0	1.4	1.0	0.9	1.0	1.9	0.8	0.9
	Pulses	0.5	0.8	0.5	0.8	0.9	0.4	0.5	0.3	0.6
	Oilseeds	0.7	1.0	0.7	0.9	1.0	0.5	1.2	0.4	0.6
	Roots	1.1	1.1	0.8	1.1	1.2	1.0	0.7	1.0	1.1
	Vegetables	1.9	1.3	3.3	1.5	1.1	2.1	3.2	2.2	1.5
	Fruits	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
	Beverage crops	0.7	0.9	0.6	0.7	1.0	0.6	1.0	0.5	0.5
	Nonfood crops	1.0	1.0	0.8	0.9	1.0	1.0	1.4	0.9	0.9
	Livestock	7.3	15.8	6.8	15.3	16.7	3.2	1.8	2.5	7.7
	Milk	6.7	14.1	5.9	13.5	15.0	3.1	2.0	2.5	7.4
	Forestry	1.4	1.1	1.2	1.0	1.1	1.5	1.2	1.6	1.5
	Fisheries	3.8	2.2	4.5	2.9	1.8	4.6	6.3	5.2	3.2
	Electricity	0.4	0.5	1.1	0.6	0.5	0.5	0.8	0.5	0.4

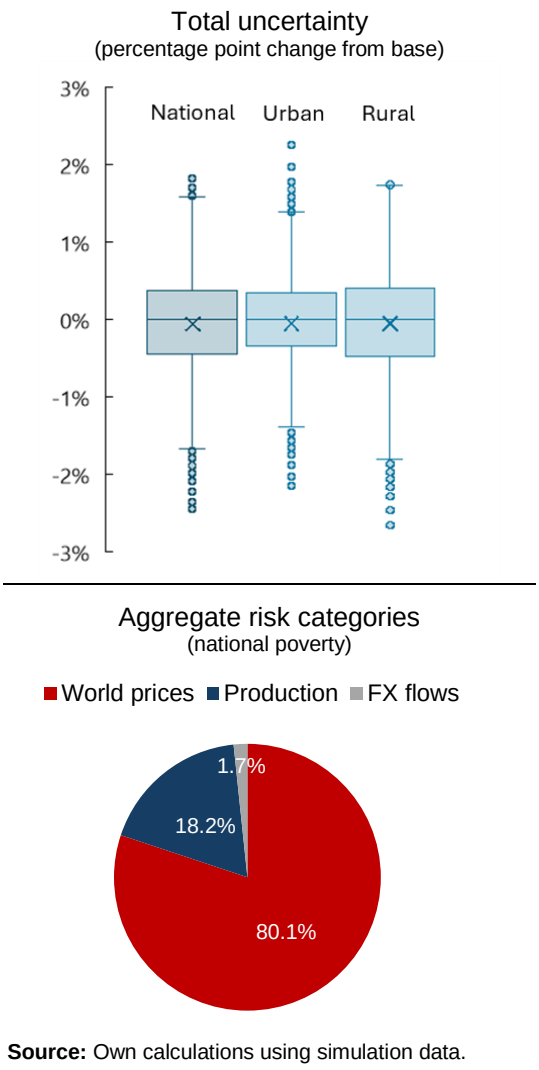
Note: Low comprises the first- and second-income quintiles, middle comprises the third- and fourth-income quintiles, and high comprises the fifth income quintile of urban and rural households, respectively.

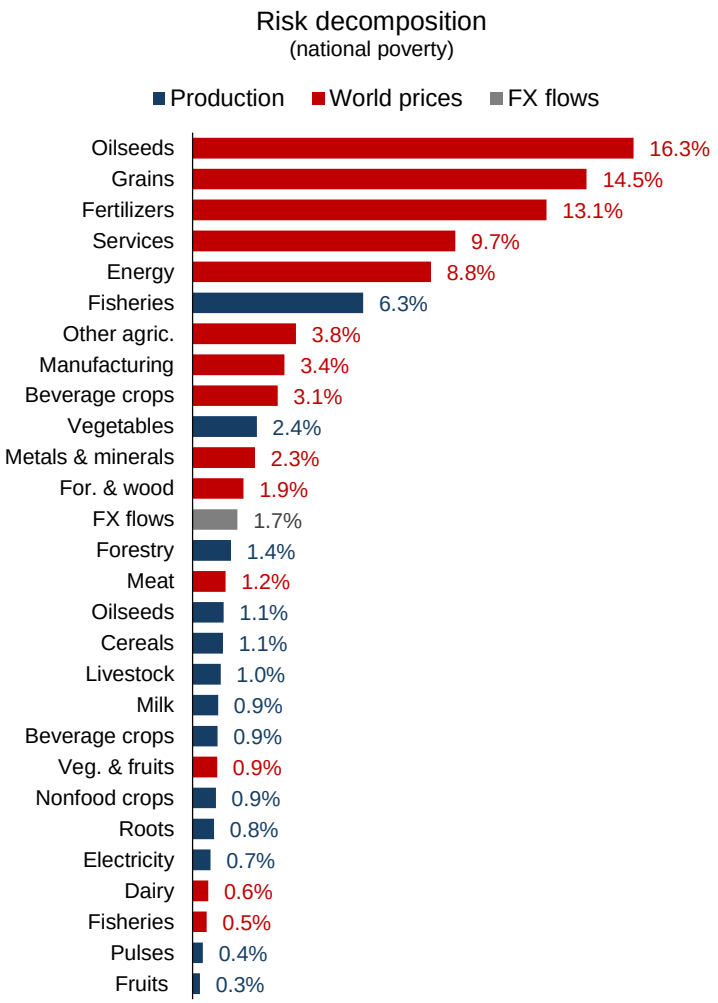
Source: Own calculations using simulation data.

Potential variation of poverty headcount (Figure 5 and Table 3): Poverty can fluctuate from -2.4 to +1.8 percentage points relative to the baseline national poverty headcount rate of 24.3 percent. In absolute terms, this equates to 4.0 million people moving above the poverty line in the best case and 3.0 million people falling below it in the worst case, which primarily affects rural households.

As with private consumption, the economy's high import dependence shapes the importance of shocks. External factors - world market prices and FX capital flows - are much more important to poverty risk than domestic yield volatility. Only 18.2 percent of the potential national poverty rate variation is attributed to domestic yield factors. At the same time, similar to consumption uncertainty, differences exist across household types (Table 3).

Figure 5. Potential variation of poverty headcount rate





Source: Own calculations using simulation data.

In particular, because volatility in the domestic livestock and milk sectors was a substantial contributor to variations in consumption for urban middle-income households, it is unsurprising that these two risks remained important risk factors for urban poverty (and not rural poverty).

Table 3. Detailed risk decompositions of poverty and undernourishment uncertainty

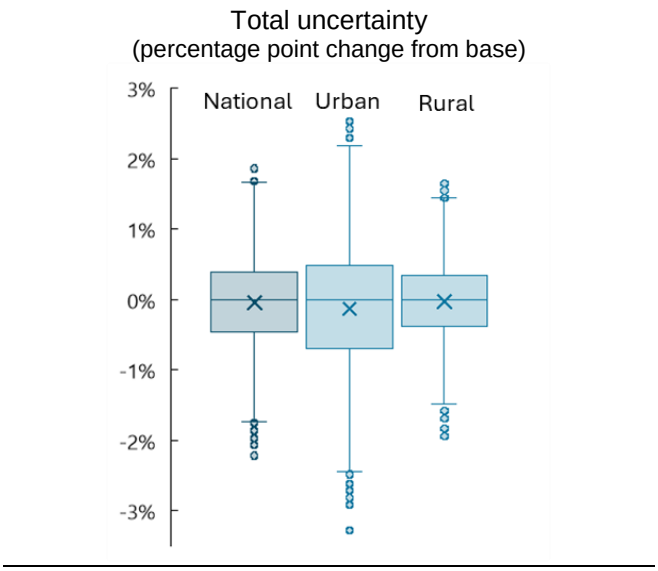
		Poverty			Undernourishment		
		National	Urban	Rural	National	Urban	Rural
Total external		81.8	70.4	81.6	79.5	75.8	79.2
World prices	Grains	14.5	12.4	14.2	16.2	15.5	15.9
	Oilseeds	16.3	12.7	16.3	20.6	18.7	20.8
	Vegetables & fruits	0.9	1.1	0.8	0.6	0.5	0.6
	Beverage crops	3.1	2.9	3.0	6.7	6.4	6.5
	Other agriculture	3.8	4.6	3.7	4.1	4.2	4.0
	Meat	1.2	0.9	1.5	1.3	1.0	1.6
	Dairy	0.6	0.6	0.6	1.4	1.4	1.4
	Forestry & wood	1.9	2.6	1.7	1.5	1.8	1.4
	Fish	0.5	1.0	0.5	0.5	0.5	0.5
	Energy	8.8	6.1	9.2	2.9	2.6	3.0
	Metals & minerals	2.3	2.1	2.3	2.3	2.4	2.2
	Fertilizers	13.1	9.4	13.4	11.7	10.4	11.9
	Manufacturing	3.4	3.8	3.3	3.0	3.2	3.0
	Services	9.7	7.1	9.9	5.4	4.9	5.4
FX flows		1.7	3.3	1.3	1.4	2.2	1.0
Total domestic		18.2	29.6	18.4	20.5	24.2	20.8
Domestic production	Cereals	1.1	1.0	1.1	5.4	4.7	5.6
	Pulses	0.4	0.6	0.4	0.5	0.5	0.5
	Oilseeds	1.1	0.7	1.4	1.4	0.8	1.9
	Roots	0.8	0.8	0.8	0.9	0.9	0.8
	Vegetables	2.4	2.2	2.3	1.7	1.7	1.6
	Fruits	0.3	0.3	0.3	0.3	0.3	0.3
	Beverage crops	0.9	0.6	1.0	2.3	1.9	2.5
	Nonfood crops	0.9	0.5	1.0	0.8	0.6	0.9
	Livestock	1.0	9.1	0.7	0.9	4.1	0.5
	Milk	0.9	7.8	0.8	0.9	3.8	0.6
	Forestry	1.4	1.2	1.4	1.5	1.4	1.4
	Fisheries	6.3	4.2	6.6	3.3	2.7	3.5
	Electricity	0.7	0.7	0.6	0.8	0.7	0.8

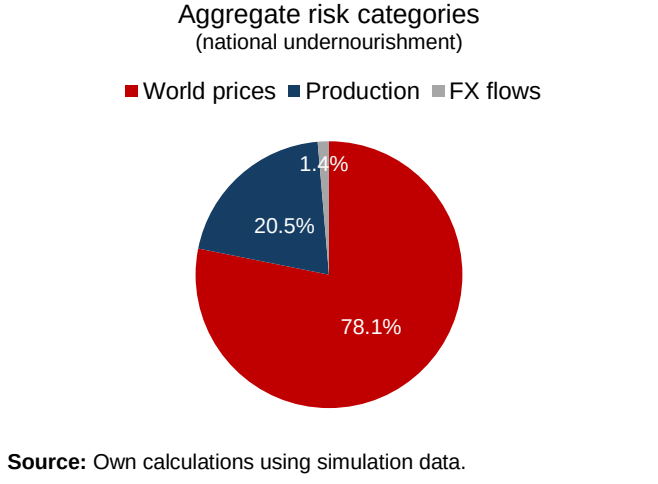
Source: Own calculations using simulation data.

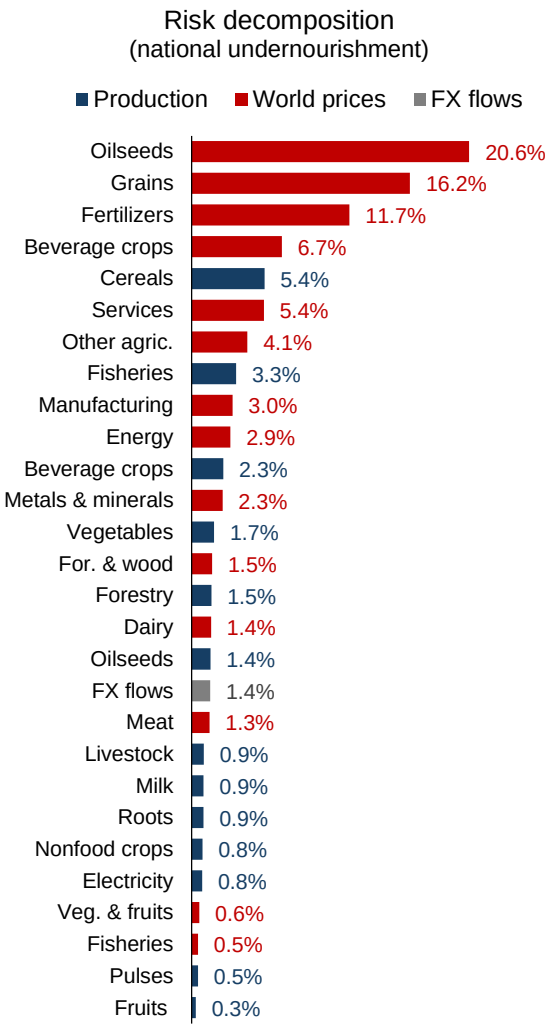
Potential variation of undernourishment headcount (Figure 6 and Table 3): Undernourishment can fluctuate between -2.2 and +1.9 percentage points relative to the baseline national undernourishment headcount rate of 11.8 percent. This corresponds to 3.6 million people moving above the undernourishment line in the best case and 3.0 million falling below it in the worst case.

Similar to other outcomes, imports play a more crucial role than domestic yield volatility. Most variation in national undernourishment is due to external factors, with domestic yield volatility explaining only 20.5 percent. The country's imports of agricultural commodities (see Section 2.1) are an important source of calorie availability in the country, and given high volatility of world prices, it is unsurprising that the world prices of oilseeds and grains are the first two most important risk contributors to national undernourishment (20.6 and 16.2 percent, respectively). Among domestic risk factors, yield volatility of cereals is the most important risk factor but given the low volatility of cereal production in the country, its contribution to undernourishment uncertainty is only 5.4 percent.

Figure 6. Potential variation of undernourishment headcount rate







Source: Own calculations using simulation data.

4. Summary and next steps in the analysis

We employ a new method to construct a systematic risk profile of exogenous shocks for the Bangladesh economy. By analyzing historical data, we derive a consistent parameter space for both world market and domestic production volatility, and sample realistic shock scenarios that can impact the Bangladesh economy. We then apply these scenarios to the Bangladesh CGE model to estimate economic uncertainty, using decomposition methods to identify the most important sources of uncertainty.

Our findings indicate that households' consumption is much more uncertain than GDP, and imports play a crucial role in defining households' risks. Potential variation in Bangladesh's GDP ranges roughly ±1 percent from the baseline, with domestic shocks accounting for about half of this uncertainty. In turn, households' consumption is about 4 times more uncertain, and volatility in import prices is a much more important risk contributor to this uncertainty. Individually, the most important risks are the world prices of oilseeds, fertilizers, grains, and energy. Uncertainty in national poverty and undernourishment rates has a roughly similar risk profile to consumption uncertainty.

This study is part of a series that uses economy-wide models to provide detailed risk assessments of key economic indicators. The analysis presented here provides an initial assessment of vulnerabilities. Future analyses will focus on comparing different risk management strategies, such as boosting sectoral productivity to reduce negative shocks, adopting technologies and practices that narrow production uncertainty, or diversifying production to less risky sectors.

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