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PAPUA NEW GUINEA PROJECT NOTE 07 DECEMBER 2020

Effects of COVID-19 on Papua New Guinea's Food Economy

A Multi-Market Simulation Analysis

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Developments in the agricultural economy of Papua New Guinea have major impacts on household food consumption decisions. A household's ability to produce and sell food is affected by climate and associated agricultural potential, market opportunities (domestic, import and export) and unexpected shocks. Each of these factors affects the overall food system, thereby influencing production and consumption of all food products and the markets in which they are traded.

The COVID-19 pandemic has presented a challenge far more complex than an agricultural production shock, such as those due to El Niño or pests. Rather than directly affecting agricultural output and rural household welfare, the COVID-19 pandemic has affected economies across the globe via trade disruptions (logistic challenges; international trade barriers), social distancing policies (domestic food market and non-essential business closures), and transportation restrictions (road closures; air travel cancellations). The measures aimed to curb the spread of COVID-19 have affected household incomes via urban job losses, reduced market interaction, and dramatic changes in world food prices. While rice prices have increased, luxury food prices, such as for chocolate (i.e. cocoa), have decreased.

Key Policy Messages

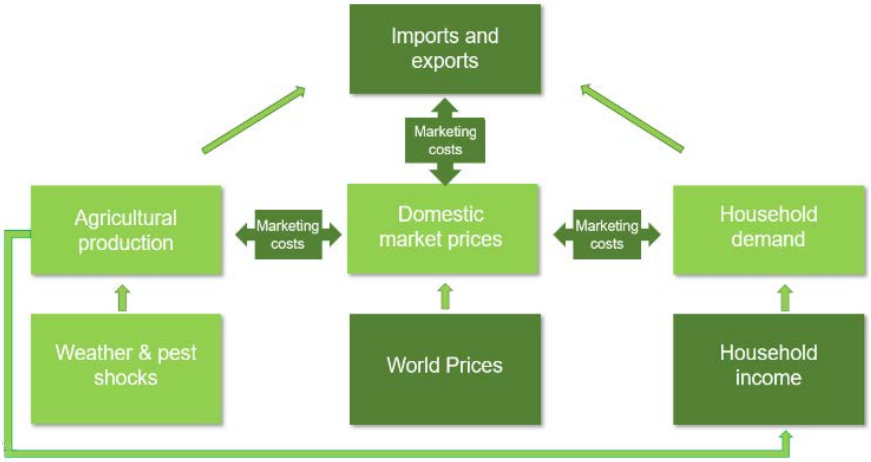
- Urban households, especially the poor, are particularly vulnerable to shocks related to the COVID-19 pandemic.
- Lower economic activity in urban areas, increases in marketing costs due to domestic trade disruptions, and 30 percent higher imported rice prices combine to lower urban incomes by almost 15 percent.
- Rural household incomes, affected mainly by reduced urban demand and market disruptions, fall by only about 4 percent. Nonetheless, calorie consumption for the rural poor and non-poor falls by 5.5 and 4.2 percent, respectively.

PNG's unique and highly varied biophysical landscape has shaped agricultural production patterns, outcomes, and livelihoods for centuries. Understanding how the PNG agri-food economy and resulting household consumption is affected by COVID-19 therefore requires attention to linkages and substitution effects across various products and the markets in which they are traded.

Multi-market Model

The multi-market model built for this analysis can be used to simulate the possible economic impact of a variety of shocks on PNG's economy and, likewise, of policies or investments, such as improvement to transport infrastructure or within the agricultural sector. This research note focuses on the effects of COVID-19 control policies and their related economic effects on PNG's food economy.

Figure 1: Multi-market model



The flow chart in Figure 1 maps the major linkages between production, incomes, prices and consumption that are modeled in the multi-market model. The dark green boxes show the areas where COVID-19 has the greatest effect on the PNG food economy.

- Following the flow chart, agricultural (crop and livestock) production may be affected by a variety of shocks including adverse weather, pests, and diseases.[1]
- Marketing costs, including the costs of transporting goods to domestic markets and receiving agricultural inputs from a market, help determine domestic market prices and incentives for agricultural production.
- Household demand for each specific food good depends on household income (agriculture and non-agriculture) and the current prices of various food and non-food items. Domestic market prices are also influenced by the prices on the world market, as well as trade policies, e.g., import tariffs.
- Finally import and export volumes are determined by the difference between domestic production and domestic demand. For import goods, such as rice, demand by PNG households far exceeds domestic production, so imports account for nearly all of supply.

Data

The multi-market model considers different production and consumption patterns within PNG by region, by rural/urban, and by poor/non-poor households. For Southern and Momase Regions, urban households are further disaggregated by metro vs. other urban, following the survey sample design employed by the PNG Household Income Expenditure Survey (HIES) 2009/10 (NSO 2010). The PNG multi-market model captures the detailed structure of 26 agricultural sectors defined by crop or livestock type and two broad nonagricultural sectors: 1) tradable non-agriculture, which is dominated by manufacturing; and 2) non-tradable non-agriculture, which is dominated by services.[2]

Estimates of Calorie Consumption

The model includes estimates of calories consumed per person per day utilizing the HIES (2009/10) and IFPRI (2018) survey data and calorie conversion factors for individual food items estimated by FAO for PNG. With per capita gross national income (GNI) at

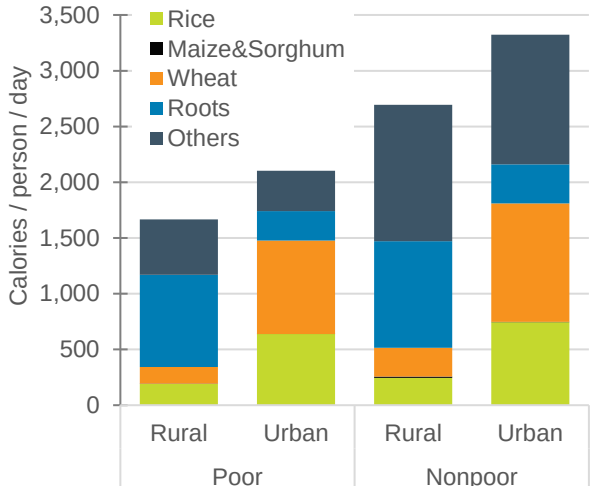
[1] Weather and pest shocks (e.g. El Niño, African swine fever, fall armyworm) are monitored within PNG by a variety of task forces.

[2] Both income and price elasticities for a specific commodity vary across household groups due to differences in consumption patterns and income levels across regions and among poor and non-poor households. A more detailed discussion of the model data, inputs, and assumptions can be found in the forthcoming full working paper: https://www.ifpri.org/country/papua-new-guinea

more than USD 2,000 at current exchange rates and prices, PNG is classified by the World Bank as a low-middle-income country. However, most PNG households can be categorized as poor or low-income – in 2009/10, 10 percent of the population accounted for almost one-third of total national income, and 20 percent accounted for almost half. (World Bank 2020).[3]

While PNG has enjoyed relatively rapid growth in export agriculture in recent years (Schmidt and Fang 2020), growth in total agricultural output was just 2.5 percent per year between 2009 and 2017, only slightly higher than the annual population growth rate of 2.1 percent over the same period. With slow growth in agriculture, we expect that most rural households, and especially low-income households, did not experience significant welfare improvements since 2009/10 when the HIES was conducted, suggesting food insecurity continues to challenge many PNG households.

Figure 2: Estimated total calories per person per day by food source, 2018



Source: Authors' calculation from the data.
Note: Maize and sorghum comprise a very small amount of calorie consumption, which does not show clearly in the figure.

Figure 2 shows the estimated average calories consumed per person per day for both rural and urban poor and non-poor households in 2018. Calorie consumption levels are much lower for rural and urban poor households than for non-poor households. For the rural poor, the average calorie consumption level is about 1,500 Kcal per person per day, about half of the level for an average non-poor urban household. We use these baseline calorie consumption levels to simulate the impact that COVID-19 has had on consumption across different households in PNG.

Model Simulations

This research note focuses on COVID-19 related shocks to household welfare. However, the full working paper presents effects of other production shocks including: 1) a potential negative productivity shock for maize and sorghum due to fall army worm spread; 2) a reduction in pig production due to African swine fever; and 3) a decline in sweet potato production due to an El Niño Southern Oscillation (ENSO) weather event.

The COVID-19 related scenarios are designed to estimate the impact on PNG's food economy and on household welfare of 1) changes in international prices for specific goods, 2) increased marketing costs in international and domestic trade, and 3) business closures and social distancing restrictions.

Specifically, we model:

1. A 30 percent rise in the imported rice price reflecting rice export restrictions and logistics complications in rice exporting countries.
2. A 60 percent decline in domestic poultry production due to restrictions on transportation that hamper distribution and sales of breeding stock.
3. A 30 percent decrease in the price of major PNG agricultural exports, including coffee, cocoa, tea, and other export crops.
4. A 30 percent increase in domestic trade margins for both the export and the import of agricultural and nonagricultural products

[3] These figures are based 2009/10 HIES data that were collected when per capita PNG's Gross National Income (GNI) was approximately USD 1,500.

due to COVID-19 related restrictions on the movement of traders.

5. A 30 percent increase in domestic trade margins for commodities traded within each region of PNG.

6. A 10 percent decrease in urban household income due to an economic recession that followed business closures domestically and abroad.

7. The combined effects of all these COVID-19 related shocks (simulations 1-6).

We first discuss the simulation results of the impacts of COVID-19-related shocks individually, and then discuss the combined effects of all of the COVID-19 related shocks.

Table 1: Baseline values of key indicators in simulation model

Key indicators	Base
Production (metric ton)	
Maize/sorghum	18,478
Sweet potato	705,116
Poultry	12,006
Swine	78,357
Total Agriculture (million Kina)	47,149
Price, 2018 Kina/kg	
Maize/sorghum	6.6
Sweet potato	4.0
Poultry	44.9
Swine	14.6
Household Incomes (2018 Kina / person / year)	
Rural Poor	4,504
Rural Nonpoor	11,829
Urban Poor	9,617
Urban Nonpoor	25,532
Total (average)	9,937
Consumption (Kilocalories / person / day)	
Rural Poor	1,666
Rural Nonpoor	2,693
Urban Poor	2,104
Urban Nonpoor	3,323
Total (average)	2,310

Source: Authors' calculations

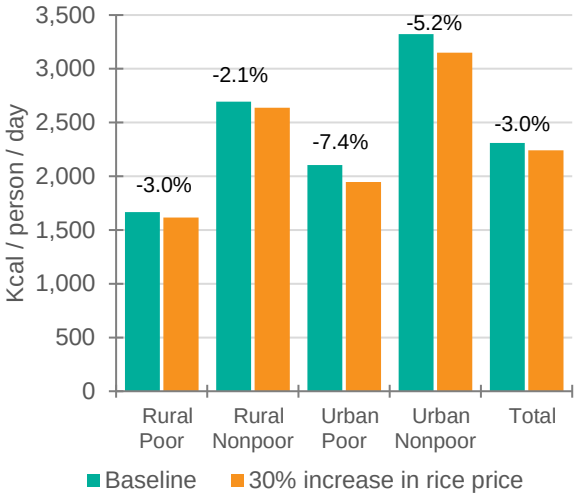
Table 1 summarizes the baseline values of the key indicators in the simulation model. These include: 1) total production by crop type, 2) price (PGK / kg) by crop type, 3) household income by household type, and 4) consumption in total kilocalories per person per day. Each of the indicators as used in the model considers differences across regions and household type (poor / non-poor).

Simulation 1: 30 percent rise in price of imported rice

Since more than 95 percent of rice consumed in PNG is imported, the domestic rice price also rises by 30 percent under this scenario.[4] Higher rice prices lead to reduced consumption of rice and, because consumers have less income available for consumption of other goods, consumption of other food falls as well.

Thus, total consumption of calories falls by between 2.1 to 3.0 percent for rural households and by between 5.2 and 7.4 percent for urban households. However, it is important to note that even at the baseline some households are not meeting the minimum calorie consumption threshold (2,250 kcal/person/day), demonstrating that these households are already food insecure regardless of the COVID-19 related rice price increase (Figure 3).

Figure 3: Decrease in calories consumed due to imported rice price increase



Source: PNG economywide multimarket model simulation results.

Simulation 2: 60 percent decline in poultry production

It is important to note that the impacts of each modeled shock vary across each of the

[4] See Schmidt et al. (2020) for a detailed description of PNG's international rice trade.

model's 20 household groups (4 regions x rural/urban/metro x poor/non-poor). For example, given a 60 percent decrease in poultry production, the reduction in poultry consumption among non-poor households is larger than it is among poor households.

This is due to lost income from poultry production and a sharp increase in poultry prices. Non-poor households consume more poultry compared to poor households and a greater share of non-poor households are poultry producers, given the capital requirements for intensive poultry rearing (enclosures, feed, etc.).

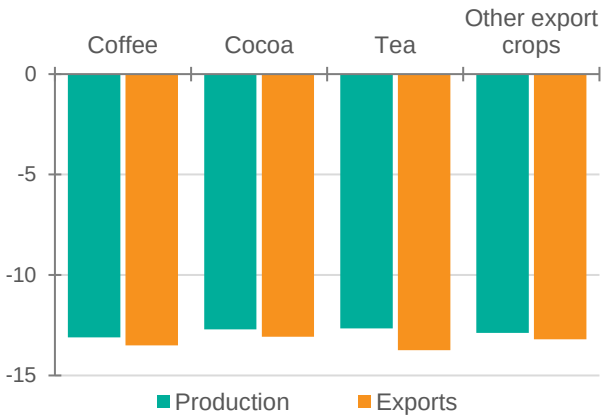
While total calorie consumption declines are not substantial under this simulation, decreasing between 0.4 and 0.6 percent, reductions in poultry consumption may have significant nutritional effects given the already low protein intake among both rural and urban households in PNG (Schmidt et al. 2020).

Simulation 3: 30 percent decrease in price of major PNG agricultural exports

Between February and July 2020, the international cocoa price fell by almost 23 percent, from USD 2.72/kg to USD 2.10/kg due to COVID-19, influenced by falling global demand for luxury goods, such as processed chocolate.[5] This fall in demand is seen across other agricultural export crops as well.

Since almost all of PNG's coffee, cocoa, and tea production is sold on world markets, the simulated fall in world prices translates to similar decreases in domestic production (between 12 and 14 percent) (Figure 4). However, export crops make up a small share of overall household incomes in PNG, thus average household incomes only fall by 0.5 percent under this scenario and household calorie consumption is minimally affected, falling on average by 0.12 percent for all households nationwide.

Figure 4: Percent change in production and exports due to 30 percent decrease in major agricultural exports



Source: PNG economywide multimarket model simulation results.

Simulation 4: 30 percent increase in domestic trade margins for both export and import of agricultural and nonagricultural products

A 30 percent increase in domestic trade margins for PNG's exports and imports simulates the potential impact from restrictions on movement of people (traders) and goods due to COVID-19. For exported goods, the increase in the cost of transportation between producers and the port has an effect of lowering the producer price relative to the international border price. For imported goods, such as rice, the increase in trade margins raises the consumer price relative to the PNG port/border price.

As a result, the producer price for coffee falls by 4.0 percent, while that for rice rises by 3.8 percent. Given these changes in price incentives, production of coffee falls by 13.1 percent and production of rice increases by 1.0 percent.[6] Producer and consumer prices of the three non-tradable commodities, sweet potato, poultry, and swine, fall slightly. This is due to the higher margins resulting in reduced incomes for producers of export crops and reduced purchasing power for consumers of imported goods. National average calorie consumption falls by only 1.9 percent. However, in urban households,

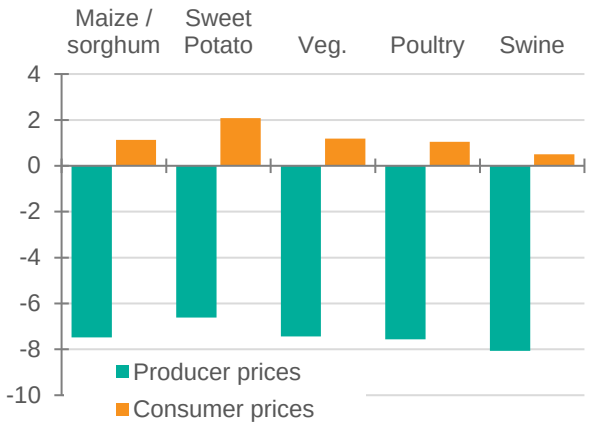
[5] The international cocoa price has recently recovered somewhat to USD 2.46 in September 2020, a decline of only 9.5 percent relative to February 2020 (calculated from World Bank 2020).
[6] See previous work on rice production in Papua New Guinea and the limited incentives for expanding rice production in the country (McKillop et al. 2009; Gibson 2001)

which on average consume more rice, consumption falls by 3.3 and 2.9 percent in poor and non-poor households, respectively.

Simulation 5: 30 percent increase in domestic trade margins

Given that most domestic agri-food trade flows from rural to urban areas in PNG, this simulation highlights the possible impact on rural producer prices due to transportation and food marketing bottlenecks associated with COVID-19 restrictions. Because consumer demand decreases due to increased prices from higher trade margins, consumer prices rise by slightly less than the amount of the marketing cost increase.

Figure 5. Percent changes in producer and consumer prices for non-tradable commodities



Source: PNG economywide multimarket model simulation results.

Although the consumer price of a good at the market increases, the producer price of the respective good decreases considerably more due to the high cost (or inability) of producers transporting their produce to market (Figure 5). Household incomes decrease between 1.2 and 3.9 percent and consumption of these domestically produced foods decreases by between 1.6 and 3.3 percent.

Simulation 6: 10 percent decrease in urban household income

To simulate the effect on decreases in urban economic activity, we exogenously impose a 10 percent decrease in the productivity of tradable non-agriculture, i.e., local manufacturing, and a 13 percent fall in productivity of non-tradable non-agriculture, i.e., services. Given these shocks, non-agricultural production declines by about 10 percent.

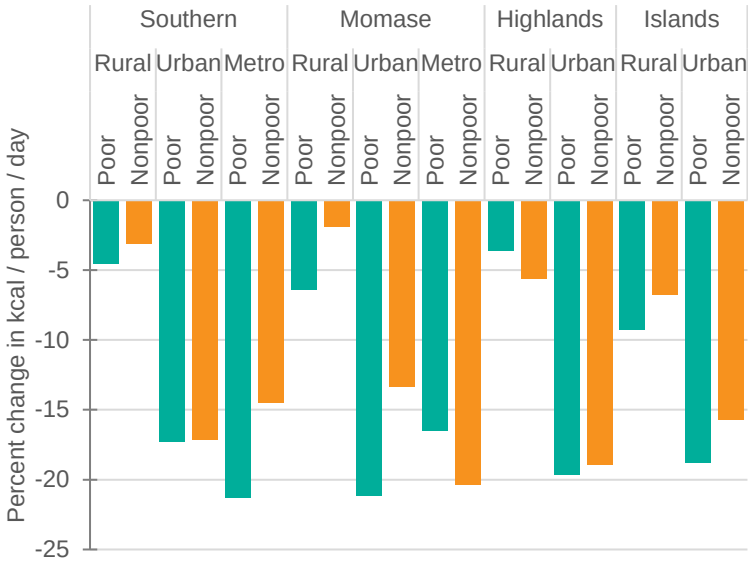
Incomes of urban poor and urban non-poor households fall by 10.4 and 10.6 percent, respectively, while incomes of rural households decline by only between 0.9 and 1.0 percent. Calorie consumption falls by 8.5 percent for urban poor households and by 7.4 percent for urban non-poor households, whereas rural calorie consumption decreases by less than 1 percent.

Simulation 7: Combined effects of COVID-19 related shocks (simulations 1 to 6)

Combining the potential effects of COVID-19 that were simulated, including a fall in urban production (manufacturing); an increase in domestic and international trade margins; ongoing fluctuations in global demand; a decrease in domestic poultry production; and an increase in the imported rice price, suggests that the overall impact of COVID-19 on PNG households may be quite large.

Household incomes fall steeply, particularly in urban areas where the decline ranges

Figure 6: Percentage changes in total calorie intake per person per day due to combined COVID-19 related shocks



Source: PNG economywide multimarket model simulation results.

between 12 and 15 percent in various regions. Food consumption declines even more sharply, due to both higher prices and lower incomes (Figure 6). Calorie consumption of urban poor households falls almost 20 percent nationwide and by over 21 percent for poor Southern metro and poor Momase urban households. Households in which members have suffered a permanent job loss are likely to have an even larger drop in income and calorie consumption.

Conclusions and Policy Implications

This analysis strongly suggests that the urban poor are particularly vulnerable to food insecurity due to the impact of COVID-19 on PNG's agriculture and trade. Lower economic activity in urban areas, increases in marketing costs due to domestic trade disruptions, and 30 percent higher imported rice prices combine to lower urban incomes by almost 15 percent for both poor and non-poor urban households. Urban poor households, however, suffer the largest drop in calorie consumption at 19.8 percent, compared to a 15.8 percent decline for urban non-poor households.

Rural households are much less affected by the COVID-19 related shocks modeled in these simulations. Rural household incomes, affected mainly by reduced urban demand and market disruptions, fall by only about 4 percent. Nonetheless, calorie consumption for the rural poor and non-poor falls by 5.5 and 4.2 percent, respectively. About half of these declines are because of the adverse impact of higher rice prices on average rice consumption. Given that higher rice prices reduce the power of households to purchase other commodities, households are forced to reduce consumption of other food products as well.

PNG has an opportunity to learn from its experience with the COVID-19 pandemic and build more resilient food systems that can support more timely and efficient responses to a variety of unexpected shocks. Based on other country experience, safety net programs that are targeted at vulnerable households, as well as those which offer support to pregnant and lactating women and young children have demonstrated success in safeguarding the welfare of families in need. PNG could roll out a portfolio of pilot safety net programs that include a robust evaluation element in order to learn which mechanisms work best for a targeted population and environment. Successful pilot programs would then be expanded as and where needed, while still maintaining a strong evaluation component in their designs.

In addition, investments in market infrastructure, including roads, ports, and marketplaces, could lower marketing costs and benefit both producers and consumers. Lowering the costs of trade and, thereby, increasing the efficiency of markets will also enhance food security by minimizing the effects of local production shortfalls and reducing the frequency and severity of shocks to household incomes and food consumption.

Finally, PNG lacks important and up-to-date data on household production and consumption, market structure and performance, and current food prices across the country. More data collection and analysis is needed to better understand market inter-connections between regions and across agricultural products, including how these linkages affect household welfare. Given uncertainty in the data available and in the behavioral parameters of the multimarket model employed, the results of this exercise must be treated with caution. Nonetheless, the broad magnitudes of the simulation results, since they are determined largely by the structure of the PNG food economy reflected in the model, point to the key policy issues highlighted, as well as areas for further investigation.

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ACKNOWLEDGMENTS

We thank the Department of Foreign Affairs and Trade (DFAT) of the government of Australia, the Regional Strategic Analysis and Knowledge Support System for Asia (ReSAKSS-Asia) funded by United States Agency for International Development (USAID), and the CGIAR Research Program on Policies, Institutions, and Markets (PIM) for funding and facilitating the work undertaken to produce this note.

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Funding for this work was provided by the Department of Foreign Affairs and Trade (DFAT) of the government of Australia and the CGIAR Research Program on Policies, Institutions and Markets (PIM). This document has not been independently peer reviewed. Any opinions expressed here belong to the author(s) and are not necessarily representative of or endorsed by IFPRI, DFAT, USAID, PIM, or CGIAR.