PAPUA NEW GUINEA PROJECT NOTE 10 AUGUST 2022

Synopsis: Implications of Public Investments and External Shocks on Agriculture, Economic Growth and Poverty in Papua New Guinea

An Economywide Analysis

Paul A. Dorosh and Angga Pradesha

Key Policy Messages

- Policy simulations utilizing an economy-wide model based on PNG national accounts and survey data highlight the importance of linkages between the agricultural and non-agricultural sectors of the PNG economy.
- There are potentially major benefits of increased agricultural productivity for national income and urban households. To reduce rural poverty, however, transport and processing costs must be lowered, as well.
- Even if only half of the increase in foreign exchange earnings from the 2022 world energy price shock is absorbed into the PNG economy, the real exchange rate appreciates by 13 percent, reducing incomes from export crops. However, increased domestic demand for non-tradable crops contributes to a 10 percent income gain for the rural poor.
- Using a portion of increased oil and natural gas revenues to finance new investments in crop agriculture, processing and transport, provides even greater benefits by spurring real GDP growth and raising real household incomes by an additional 2 to 4 percentage points.
- A hypothetical carbon credit arrangement in which PNG reduces deforestation in exchange for funds used to finance cash transfers to the poorest 20 percent of both urban and rural households could raise the incomes of these groups by about 13 percent.

Overview

Policymakers in Papua New Guinea face difficult choices as to how best to promote economic growth and reduce poverty in the context of vast differences in technology and infrastructure across the country. Fluctuations in world prices of petroleum, minerals, and export crops complicate the management of the economy because of their large impacts on export earnings and government revenues, as well as on household welfare.

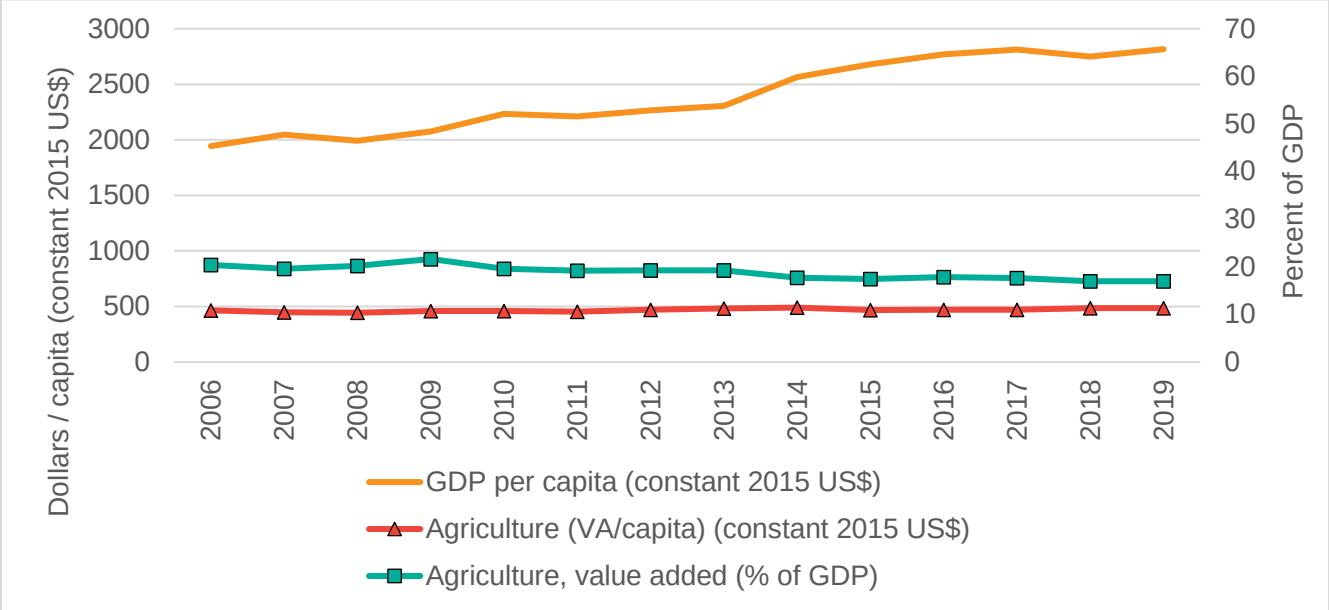
This project note summarizes the results of an economywide modeling analysis on the effects of different investment options in the agricultural sector, as well as the effects of recent major economic shocks and potential benefits from carbon credits linked to forest management. The simulations suggest that there are potentially major benefits of increased agricultural productivity of both domestic and export-oriented crops, especially when these investments are coupled with a reduction in domestic transport and processing costs (Simulation 1-3).

Changes in the prices of crude petroleum and natural gas have especially large effects on the PNG economy and household incomes. Simulation 4 shows that even if only half of the increase in oil and natural gas revenues resulting from the 65 to 70 percent increase in real international prices in early 2022 is absorbed into the PNG economy, the real exchange rate may appreciate by 13 percent. All households enjoy sizeable gains in real incomes. Rural households can gain even more from the oil price shock if a portion of the increased oil and natural gas revenues is used to finance new investments in crop agriculture, processing, and transport (Simulation 5). Finally, a potential carbon credit arrangement in which PNG reduces deforestation in exchange for a cash transfer to the poorest 20 percent of both urban and rural households could raise the incomes of these groups by an estimated 13 percent (Simulation 7).

Agriculture, Economic Growth and Macroeconomic drivers in PNG

Economic growth is often accompanied by structural transformation, whereby a country transitions from lower-productivity agriculture labor and output to higher-value manufacturing and services output, displacing agricultural GDP as the primary economic driver. However, this transformation may only be just beginning in PNG. This may reflect the high capital and relatively low labor intensity of the extractive resources sector that employs relatively few people given the value of its output, limiting its direct effect on a shift in employment across sectors. Nonetheless, the share of agriculture in total GDP fell from 23.9 percent in 2006 to 17 percent in 2019, as the share of the service sector expanded (World Bank, 2022a; Figure 1).

Figure 1: Agriculture contribution to GDP and Agricultural GDP per capita (2006-2019)



Source: Authors' calculations using World Development Indicators (WB, 2022a)

At the macro level, the real exchange rate, which measures the relative price of tradable to non-tradable goods and services, plays a crucial role in determining broad economic incentives in PNG. In PNG, the real exchange rate is heavily influenced by natural resource (oil and gas) exports, which account for nearly 90 percent of export earnings.[1] These export earnings, while providing government revenues and foreign exchange to finance imports, can also distort prices. As the earnings are spent in the local economy, prices of local (non-tradable) goods and services (such as domestically produced and sold crops, housing rents, transport, etc.) tend to rise. However, prices of non-oil and gas export goods (such as coffee, cocoa, palm oil, etc.) and import substitutes (including domestically produced rice), which are determined by world prices, nominal exchange rates and trade policies (e.g. import tariffs and export taxes), tend to remain stable. As a result, incentives for producing non-tradable goods and services improve while incentives for producing non-oil and export goods decline.[2] These negative effects could be reduced, however, by saving part of the foreign exchange earnings in government accounts abroad and / or using the foreign exchange earnings to finance productive investments.

To a large extent, PNG has avoided sharp changes in nominal and real exchange rates through careful management of macro-economic policy. The annual average nominal exchange rates appreciated by 31.8 percent from 3.06 kina/USD in 2006 to 2.08 kina/USD in 2012 but has since depreciated by 68.4 percent to 3.51 kina/USD in 2021 (Table 1).[3]

[1] IMF estimates for resource exports in 2019 were 9.65 billion US dollars, 89.5 percent of total exports. The current account balance of 6.1 billion US dollars was 24.2 percent of GDP (IMF, 2020).

[2] The resulting stagnation is known as the "Dutch Disease", named after a stagnation of the Netherlands' economy following the discovery development of oil and natural gas in the North Sea in the 1970s

[3] The 2021 figure is a ten-month average through October.

Table 1: Nominal exchange rate and CPI (2006-2021)

	2006	2012	2021	2006-12	2012-21	2006-21
Nominal Exchange Rate (kina/USD)	3.06	2.08	3.51	-31.8%	68.4%	14.8%
Nominal ExRate Index (2006=100)	100.0	68.2	114.8	-31.8%	68.4%	14.8%
PNG CPI	100.0	138.3	214.7	38.3%	55.2%	114.7%
RER Index (USD) = ER/CPI	3.06	1.51	1.63	-50.7%	8.5%	-46.5%
US CPI = PW*	100.0	113.9	134.4	13.9%	18.0%	34.4%
RER Index = ER*PW/CPI	100.0	56.1	71.9	-43.9%	28.1%	-28.1%
IMF RER**	100.0	49.3	53.5	-50.7%	8.5%	-46.5%

Source: Authors' calculations and IMF International Financial Statistics data (downloaded April, 2022).

Over these periods, there has been steady domestic inflation, however, averaging 5.6 percent per year from 2006 to 2012 and 5.0 percent per year from 2012 to 2021, so that consumer prices in PNG rose by a total of 114.7 percent between 2002 and 2021. Thus, the real exchange rate (a measure of the average relative price of tradable goods to non-tradable goods) appreciated by 53.5 percent between 2006 and 2012 sharply reducing the profitability of production of export crops and other tradables (including rice). Thus, changes in the macro-economic incentives for production of tradable goods in PNG over the past decade have reduced the profitability of agricultural exports (e.g. cocoa, coffee, palm oil, etc.) and of production of import-substitutes (e.g. domestically produced rice).

Appropriate non-price distorting PNG government interventions such as investments in roads, power and ports can help address the disincentives faced by the agricultural tradable sectors by decreasing transactions costs of farmers and traders. This is further discussed in the analysis below. Despite relatively weak economic incentives, however, PNG has experienced growth in its agri-food trade, with agri-food exports increasing by 8 percent, and agri-food imports increasing by 13 percent between 2001-2016. **Maintaining high levels of trade in agriculture products will require policies and investments to support domestic logistics and reduced transactions costs, thereby benefitting export-oriented smallholder farmers and household's dependent on staple food imports.**

MODEL STRUCTURE

In this study, we use the Rural Investment and Policy Analysis (RIAPA) model, a neo-classical Computable General Equilibrium (CGE) model calibrated to data from the 2019 Social Accounting Matrix (SAM) of Papua New Guinea (Pradesha and Dorosh, 2022) and other parameters describing responsiveness of demand and supply across different sectors. RIAPA measures how impacts of policies and external shocks are mediated through prices and resource reallocations and ensures that resource and macroeconomic constraints are respected. The model consists of both behavioral equations that describe the economic decisions related to production, marketing, consumption, etc. of economic agents (firms, households, and institutions) and structural equations that specify accounting relationships between the incomes and expenditures of individual agents and within the macroeconomy.[4] These relationships are

[4] Model equations are presented in Annex A of the original paper (Dorosh and Pradesha 2022). Please refer to Diao and Thurlow (2013) for more detailed explanation about the model. Benfica et al. (2019) provides application of the model.

estimated using the publicly available national accounts data of PNG, household survey data and other sources.

The model divides the economy into sectors and household groups that act as individual economic agents. Producers maximize profits given the technology available and the costs of intermediate inputs, land, labor and capital. Household demand is determined by (linear expenditure system) demand equations that implicitly maximize utility given budget constraints.[5] Market prices adjust to balance supply and demand for all goods, services and factors of production.

SIMULATION RESULTS

There are seven simulations covered in the analyses. Simulations 1-3 explore the effects of increased total factor productivity in agriculture and related sectors. Simulations 4 and 5 evaluate the implications of recent changes in world oil and natural gas prices with and without additional public investments in agriculture. Simulation 6 models the effects of increases in the prices of agricultural exports. Finally, Simulation 7 explores the potential effects of carbon credits for reducing deforestation together with a safety net.

In Simulation 1, the 20 percent increase in total factor productivity of food crops raises production of the sector, but real incomes from agriculture change little because food crop prices fall for most cereals and roots because the supply of these crops increases faster than demand. Overall, total real GDP rises by 1 percent while total real consumption rises by 4.3 percent (Figure 2a). Incomes of the rural poor are essentially unchanged and incomes of the rural non-poor rise by only 0.5 percent (Figure 2b). Urban households actually gain more than rural households (by 1.2 percent for the poor and 1.4 percent for the nonpoor), in large part because of an increase in urban wage rates and returns to capital.

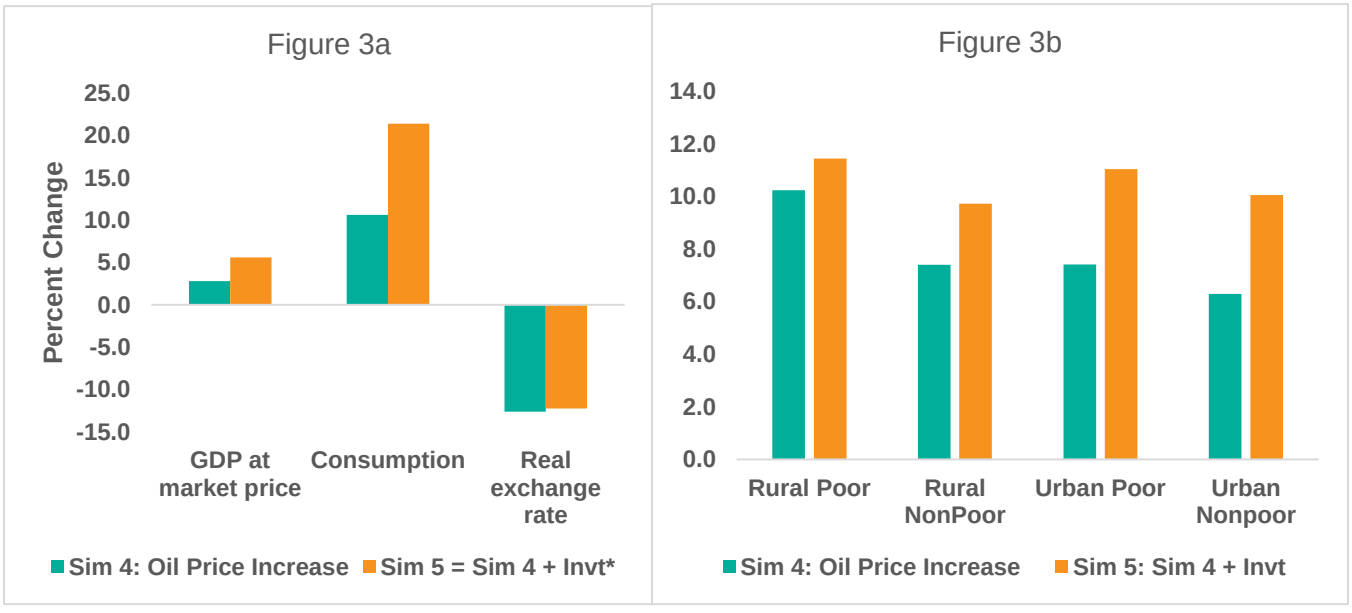
If increases in food crop productivity are accompanied by increases in productivity of processing and transport (Simulation 2), the declines in food crop prices are less than in Simulation 1 because demand for food crops by the food processing sector also increases. Output of the food processing sector rises and total real GDP increases by 2.6 percent (Figure 2a). With reduced transport costs, imports also become cheaper and since the total value of imports is greater than the total value of exports, the reduced price of imports results in an increase in demand for foreign exchange and a 1.0 percent appreciation of the real exchange rate (Figure 2a). As a result of the increase in overall economy activity, incomes of both rural and urban rise, including the incomes of the poor (Figure 2b). Increases in total factor productivity of export crops (Simulation 3) also raise GDP and household incomes, but given the small size of the sector, the effects are smaller for food crops (as in Simulation 1). Thus, the gains in real GDP and household incomes are only slightly larger in Simulation 3 than in Simulation 2 (Figure 2a and 2b).

5 Income (expenditure) elasticities for various food commodities used in this study follows Diao et al. (2012).

Figure 2: Macro-economic and Distributional Impacts of Agricultural Productivity Shocks

Source: CGE Model simulations.

Figure 3: Macro-economic and Distributional Impacts of Oil Price Shocks

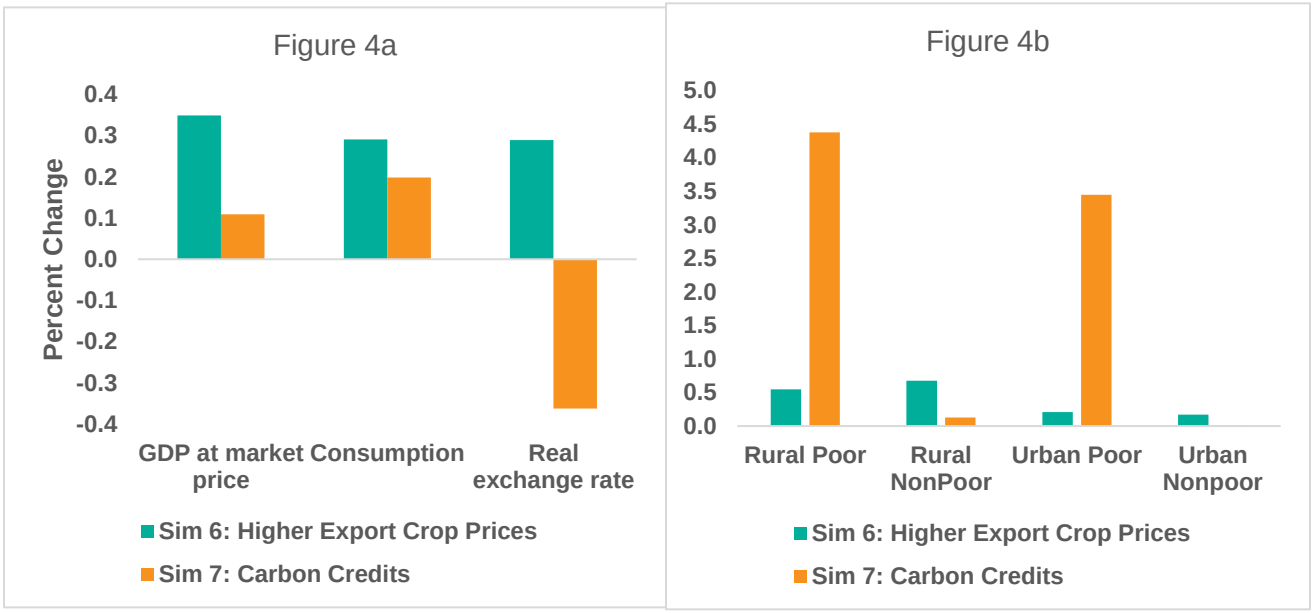


Source: CGE Model simulations.

In Simulation 4, we model the effects of sharp increases in real international prices of crude petroleum and natural gas between the 2019 average and March 2022 of 64.9 percent and 70.5 percent, respectively.[6] In this simulation, the real exchange rate appreciates by 12.6 percent due to the foreign exchange inflow (Figure 3a) reducing incentives for non-petroleum exports while encouraging more imports. As a result, consumption rises, in large part because of cheaper imports, proving sizeable gains in real incomes to all households, including the rural poor, who benefit from increased demand for agricultural products they sell. Their incomes rise by 10.2 percent, compared to gains of 7.4 percent for both the rural nonpoor and the urban poor, and 6.3 percent for the urban nonpoor (Figure 3b).

In Simulation 5, we assume that five percent of the increase in total savings generated from the increase in petroleum revenues (364 bn kina) is used to finance new investments in agriculture and another five percent is used to finance new investments in roads. Given this large increase in investment and TFP, real GDP surges by 5.6 percent and consumption rises by 21.4 percent (Figure 3a). As in Simulation 2, increased agricultural investments result in additional gains for all household groups, with total incomes rising from 9.7 percent for the rural nonpoor to 11.4 percent for the rural poor (Figure 3b).

Figure 4: Macro-economic and Distributional Impacts of Higher Export Crop Prices and Carbon Credits



Source: CGE Model simulations.

In simulation 6, we model the effects of recent shocks to world prices on PNG's agricultural exports between the 2019 average price and March 2022, raising the real prices of coffee (mild arabica) by 78.3 percent and the price of rubber (TSR20) by 11.5 percent, while lowering the price of logs (Malaysia) by 17.2 percent and the price of cocoa by 5.3 percent. We also simulate the increase in the world

[6] Price data for Simulations 3 and 6 are from the World Bank (2022) "Pink Sheet" data base. The consumer price index is from IMF (2022) International Financial Statistics. We obtain real price estimates by adjusting the nominal price changes by the 11.0 percent inflation in the US CPI (a measure of overall inflation) in this period.

price of rice (using the Vietnam price as a benchmark) by 0.3%. These shocks have relatively small effects on PNG's economy given the relatively small size of these sectors compared to the extractive resources sector. Real GDP and consumption increase by only 0.35 and 0.3 percent, respectively, and the real exchange rate depreciates by only 0.3 percent (Figure 4a). Effects on household incomes are likewise small, ranging between about 0.2 and 0.7 percent for all groups (Figure 4b).

Simulation 7 models a hypothetical reduction in forestry output in exchange for a carbon credit for protecting 117,400 hectares of forest per year (the average annual rate of forest loss in 2016-2020). Assuming an absorption rate of 10 kgs of carbon dioxide per tree per year and an average planting density of 1,000 trees per hectare (=10 tons CO2 / hectare / year), each hectare of forest absorbs 20 tons of CO2 per year.[7] At a carbon price of $20 / ton of C02, the potential value of the carbon credit is $46.96 million or 159.2 million kina at the 2019 average exchange rate of 3.39 Kina/USD. These carbon credit revenues are then assumed to be used to finance cash transfers to the poorest 20% of rural and urban households. In the simulation, we also introduce a negative productivity shock of 16 percent to the forestry sector, equal to the size of the annual carbon credit divided by the total value added of the sector.

The 47 USD million foreign exchange inflow from receiving the simulated carbon credit results in small exchange rate appreciation (Figure 4a) that contributes to a decline in exports and an increase in imports. The cash transfers raise incomes of the rural and urban poorest households by about 13 percent, though the average income of the bottom 40 percent of households rises by around 4 percent (Figure 4b). Total consumption in the economy, however, only rises by about 0.2 percent and real GDP is essentially unchanged (Figure 4a). Thus, this relatively small hypothetical carbon credit transfer, if accurately targeted, is sufficient to make a significant difference for the poorest households in PNG.

POSSIBLE NEXT STEPS

The above simulations show the importance of economic linkages between agriculture and the overall economy in PNG in determining policy outcomes. Further analysis is needed to refine the simulations described above, particularly by improving the household data used to create the Social Accounting Matrix and for refinement of model parameters. Other scenarios could also be analyzed, including policies related to greater use of fertilizer, alternative world price shocks to key commodities and productivity shocks to various sectors. A dynamic version of the model also could be used for scenarios in multi-year development plans. For all of this work, more capacity strengthening would be important to enhance the usefulness of the model and simulations to PNG analysts and decision-makers.

[7] Bernet (2021) uses a conservative estimate of the carbon absorption rate of 10 tons CO2 / hectare / year, assuming a tree density of 1,000 trees per hectare and an average absorption rate per tree of 10 kgs of carbon dioxide per year for the first twenty years. He notes, however, that a figure of 48 pounds (about 22 kgs) per tree is commonly cited. Our calculations assume a relatively high carbon absorption rate of 20 tons per hectare per year.

REFERENCES

Diao, X., and J. Thurlow. 2012. “A Recursive Dynamic Computable General Equilibrium Model.” In Strategies and Priorities for African Agriculture: Economywide Perspectives from Country Studies, edited by X. Diao,J. Thurlow, S. Benin, and S. Fan, 17-50. Washington, D.C: IFPRI.

International Monetary Fund. 2022. “International Financial Statistics”, Washington, DC: International Monetary Fund. https://data.imf.org/regular.aspx?key=61545849.

International Monetary Fund. 2020. “Papua New Guinea: 2019 Article IV Consultation and Request for Staff Monitored Program”, Washington, DC: International Monetary Fund.

NSO. 2011. Household Income and Expenditure Survey 2009-2019, Papua New Guinea. Port Moresby: NSO.

Pradesha, Angga and Paul A. Dorosh. 2022. 2019 Social Accounting Matrix for Papua New Guinea: A Nexus Project SAM. Data Paper. Washington, DC: International Food Policy Research Institute (IFPRI).

World Bank. 2022a. World Bank Development Indicators Database. (accessed August, 2021)

World Bank. 2022b. “World Bank Commodity Price Data (The Pink Sheet)”, Washington, D.C.: World Bank: https://www.worldbank.org/en/research/commodity-markets (accessed August, 2021).

ABOUT THE AUTHORS

Paul Dorosh (p.dorosh@cgiar.org) is a Director in the Development Strategy and Governance Division of IFPRI based in Washington, DC, USA.

Angga Pradesha (a.pradesha@cgiar.org) is a Senior Research Analyst in the Development Strategy and Governance Division of IFPRI based in Washington, DC, USA.

ACKNOWLEDGMENTS

We are grateful to our Papua New Guinea research partners at the National Agriculture Research Institute (NARI) and the National Research Institute (NRI), who collaborated with IFPRI to build the Social Accounting Matrix (SAM). In addition, we are thankful for the dynamic participation of representatives from the PNG Prime Minister National Executive Council (PMNEC), the PNG Department of Agriculture and Livestock (DAL), the PNG Department of National Planning and Monitoring (DNPM), NARI and NRI during a 2-week SAM and Computable General Equilibrium (CGE) modelling workshop in Washington DC in April – May, 2022. Namely, we would like to thank: Mark Ivekolia (NARI), Raywin Ovah (NARI), Dickson Benny (NARI), Francis Odongo Odhuno (NRI), Diana Gora (PMNEC), Joycelyn Guina (PMNEC), Merie Dada Unagi (DAL), and Sanja Pepae (DNPM). We would also like to thank Emily Schmidt, Karl Pauw and James Thurlow of IFPRI for their insights on the PNG economy and inputs on the CGE analysis.

Funding for this work was provided by the Australia Department of Foreign Affairs and Trade (DFAT) through the Australia High Commission (AHC) in Port Moresby, and the Regional Strategic Analysis and Knowledge Support System for Asia (ReSAKSS-Asia) funded by United States Agency for International Development (USAID). This publication has been prepared as an output of the Papua New Guinea Food Policy Strengthening Project and 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.