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Industrialization for economic transformation

Economy-wide impacts of agro-processing development in Tanzania

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Abstract: Various policies are being implemented in Tanzania to expand the agro-processing sector. This study evaluates the role that agro-processing activities can play in the industrialization and economic transformation of the Tanzanian economy, and the impact of policies. The study employs a recursive dynamic computable general equilibrium model to assess the economy-wide impacts of increasing productivity in agro-processing activities as well as increasing the quantity of educated labour in Tanzania. Increasing productivity increases the exports of agro-processed products, and significantly decreases processed food imports and raw agricultural exports. Increasing the supply of educated labour has significant positive effects on economic growth and the incomes of rural households.

Keywords: Economic transformation, agro-processing, CGE, social accounting matrix, food processing, non-food agro-processing
JEL classification: C68, O14, O25, O55

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1 Introduction

Tanzania has been among the top 10 fastest growing economies, leading Africa's 'growth miracle' and averaging between five and seven per cent gross domestic product (GDP) growth per annum (Page 2016). However, as in most African countries (Kormawa and Jerome 2014), this high growth has not resulted in significant poverty reduction, the creation of high-quality jobs, or productivity increases (Page 2016; URT 2016a). The lack of economic transformation—which would entail structural change, the shifting of resources from low-productivity to high-productivity sectors, and interrelated processes (Breisinger and Diao 2008)—has been identified as the source of these economic problems (Page 2016). Agriculture, which is less productive, is still the largest contributor to employment and GDP, and has a significant role in exports. Despite the important role the agricultural sector plays in the economy, historical experience shows that virtually all successfully developed countries have managed to diversify away from agriculture, and industrialization[1] has been the means to achieve high income levels. The levels of manufacturing activity in Tanzania, however, are substantially lower than they should be based on per capita income (Dinh et al. 2012). The Tanzanian government has identified the need for 'nurturing industrialization for economic transformation and human development' (URT 2016a: 1).

The government is currently implementing several horizontal policies—such as attracting foreign direct investment (FDI), and investing in infrastructure and education, among others—to support the industrialization process. Various sector-specific investments are also being implemented to promote the subsectors with the highest potential for poverty-reducing growth that offers opportunities for employment and structural change (URT 2016a). The agro-processing sector has been identified among the priority sectors to meet the country's objectives (URT 2016a, 2017). This is because Tanzania has a comparative advantage in light manufacturing (AfDB 2014; Dinh and Monga 2013), and adding value by enhancing the processing of agricultural products can be a starting point for transforming the economy (Dinh and Monga 2013; Wangwe et al. 2014). Nevertheless, despite the greater share of agriculture in Tanzania's total output, the further value addition and processing of agricultural goods is still limited (Jahari et al. 2018). The demand for packaged and processed agricultural products is growing, signifying a need to move from minimal processing to higher-value-added products; but the country continues to export raw agricultural commodities, while the agro-processing industry cannot meet local demand (URT 2011). Paremoer (2018) indicates that the country's imports of processed agricultural products will grow far above exports if investments in the sector do not increase. This suggests the need for more investments to unleash the potential of the agro-processing sector. However, there is not much knowledge as to the extent to which developing this sector can achieve the economy's growth objectives.

This study aims to assess the role that agro-processing activities can play in the industrialization and economic transformation of the Tanzanian economy. A computable general equilibrium (CGE) model calibrated to a 2016 Tanzanian social accounting matrix (SAM) is used to evaluate alternative policies (increasing productivity, and increasing the supply of educated labour) that might expand the agro-processing sector. The rest of the paper is organized as follows. Section 2 reviews the role of agro-processing in the development process, and the previous studies conducted. Section 3 gives an overview of the agro-processing sector in Tanzania. The fourth section details the methodology and data used in this study. The policy simulations are also

[1] Industrialization is a process in which the importance of manufacturing increases and significant changes are observed in the composition of industrial output and production techniques.

discussed in this section. This is followed by a discussion of the results in section 5, while conclusions are drawn in section 6.

2 The role of agro-processing

2.1 Theoretical review

Agro-processing comprises manufacturing activities that transform raw materials and intermediate products from agriculture, forestry, and fisheries (FAO 1997). The sector thus includes the manufacturing of food, beverages, tobacco, textiles, clothing, leather, footwear, wood products, paper and paper products, rubber products, and furniture products. The sector can be divided into food and non-food industries. Agro-processing served as the entry point to industrialization for the majority of modern-day industrialized countries. The industry is important in the creation of employment and incomes, and as a strategy for pro-poor growth in rural economies. Expanding agro-processing has a positive impact on human development (Wilkinson and Rocha 2009).

The manufacturing sector in developing and transitioning countries is mainly dominated by agro-processing activities. These activities contribute 52 per cent, 36 per cent, and 32 per cent of the total value-added of manufacturing in low-, middle-, and upper-middle-income countries respectively. This can be even higher in agro-based countries. In addition, about four to five per cent of the total value-added in low- and middle-income countries is from agro-processing. Thus, agro-processing has a vital role in contributing to the output of the economy. Agro-processed products also make up a significant part of these countries' exports (Wilkinson and Rocha 2009). Processed products are of higher value than raw agricultural produce, and thus agro-processing adds value to agricultural exports. Exports are important in a developing country, as they create external demand, leading to an increase in the country's production (Fukase and Martin 2017).

Agro-processing industries, particularly small-scale processors in Africa (Woldemichael et al. 2017), are often located close to their source of raw materials (Henson and Cranfield 2008). Because of their labour-intensive nature, especially at early stages, the activities thus provide employment and incomes to a large rural population (Yumkella et al. 2011). This rural-based workforce often has low skills and tends to remain stuck in less productive subsistence agriculture (Briones and Felipe 2013; Figueroa et al. 2018) and informal sectors, limiting rapid growth and transformation (Collier and Dercon 2014; McMillan et al. 2014). However, the more productive processing activities (Wilkinson and Rocha 2009), which offer better wages and benefits (McMillan and Headey 2014), can absorb a significant quantity of unskilled and semi-skilled labour (Yumkella et al. 2011). For example, employment in the South African food industry comprises 46 per cent semi- and unskilled labour, 40.3 per cent labour with mid-level skills, and only 7.1 per cent with high-level skills (Gebrehiwet 2012). A lot of women are also gainfully employed in processing activities (Woldemichael et al. 2017). Expanding processing can thus generate better jobs and incomes, and can encourage productivity increases through the movement of labour out of agriculture. Although the agro-processing subsectors are heterogeneous in terms of productivity, generally labour productivity is higher in agro-processing than the manufacturing averages (Wilkinson and Rocha 2009). Specifically, productivity in food processing is very high (FAO 2017; Wilkinson and Rocha 2009). Combine all this with its labour-intensive nature (FAO 2017), and food processing presents a huge employment generation opportunity in the rural areas of low-income countries (FAO 2017; Wilkinson and Rocha 2009).

The rural population constitutes most of the poor. Pro-poor growth is enabled if economic growth and development is brought to rural areas (Henson and Cranfield 2008) and is led by labour-

intensive sectors (El-Enbaby et al. 2016; Loayza and Raddatz 2010), which is the case of the agro-industry. However, some industries producing high-value products locate themselves close to their markets (Henson and Cranfield 2008). They thus help low-skilled and poor migrants with wage employment, reducing urban poverty, which is increasing in Africa.

The Hirschman (1958) unbalanced growth strategy of choosing key sectors with strong interdependence with others is another argument in favour of the agro-industry. As summarized by Yotopoulos and Nugent (1973) and FAO (1997), the strategy entails focussing investments in 'non-primary' activities that utilize substantial quantities of raw materials and intermediate inputs from other sectors (backward linkages), and also in 'non-final' activities whose output will be utilized as inputs and induce production in other sectors (forward linkages). This will induce private investments in other sectors, and thus the expansion of various sectors. The development of agro-processing activities is driven by the need to capture the strong backward and forward production linkages between the sector and the rest of the economy (Da Silva et al. 2009; Ehui and Delgado 1999; FAO 1997). For example, backward linkages are formed with the primary agricultural activities which process activities with raw materials, as well as with other input suppliers such as machinery, electricity, and financial service providers. Examples of forward linkages include food service sectors that use processed products as intermediate inputs, and the retail and transport services, which can also be part of the rural activities of the poor. Agriculture can also benefit when activities such as milling provide feed for animals. Expansion of the processing industry thus supports the expansion of other industries: it induces investments, output, and employment growth in other sectors. For every single job created in agro-processing, about 2.8 jobs are created somewhere else in the economy (Infodev 2018).

The linkages between agriculture and processing are very important. Agro-processing industries expand the market and the demand for agricultural produce, and thus 'pull up' agricultural production (Nkechi and Lambon-Quayefio 2017; Watanabe et al. 2009; Wilkinson and Rocha 2009). This provides incentives for the commercialization of agriculture, which is important for economic transformation. The need to meet the increased demand results in the adoption of modern technologies, which in turn increases productivity and therefore farm incomes—the total effect of which is poverty alleviation among the rural poor (Wilkinson and Rocha 2009). On the other hand, commercialization is encouraged by transforming agriculture's non-tradable products into tradable products through processing (Ehui and Delgado 1999). Processing also reduces the post-harvest losses which are prevalent in Africa, creating value from what might have been lost to spoilage; it can also add nutritional value to food (Infodev 2018; Nkechi and Lambon-Quayefio 2017). Processed foods also have stable prices compared with primary agricultural products, which benefits those that depend on wage employment (Ehui and Delgado 1999; Nkechi and Lambon-Quayefio 2017).

2.2 Related studies

Ehui and Delgado (1999) implemented a static CGE Global Trade Analysis Project (GTAP) model to assess the impacts of technology in agriculture and related processing sectors in Africa. They analysed the impacts of different forms of technical change across the agro-processing sector. The study found that labour-using rather than labour-augmenting in processing activities offered superior domestic welfare gains. Technical change in processing activities was also found to reduce exports of raw agricultural products in favour of processed food exports. The study did not, however, account for the costs of increasing productivity.

Breisinger et al. (2009) modelled different growth options and structural changes for Ghana to reach middle-income status, using a recursive dynamic CGE model. A comparison was made between accelerated growth in the industry, services, and agriculture export sectors, and other

agricultural sectors. They found out that industrial-led growth would reduce raw material exports and improve the country's export structure. However, it would be constrained by its dependency on agricultural growth for inputs. The study concluded that Ghana's growth path would be one in which all sectors drove the transformation process.

A recent study by Fukase and Martin (2017), focussing on trade, employed a static GTAP model to evaluate the impact of increasing productivity in the food processing industries of African countries, including Tanzania. The study found that exports of processed food increased while imports decreased. Exports by other industries declined. However, the study understated the long-run impacts of productivity increases, and also the costs of bringing about the productivity gains (Fukase and Martin 2017).

Diao and Thurlow (2012) concluded from their study of the impacts of raising productivity in the agricultural sector that the growth of some primary activities in Tanzania may be limited due to the lack of downstream processing capacity. To this author's knowledge, however, there are no empirical studies that have evaluated the economy-wide impacts of developing the agro-processing sector in Tanzania to examine the impacts on growth, trade, incomes, and household welfare. In addition, the impacts of increasing the quality of labour as part of industrial development have not yet been exploited. Hence the purpose of this study is to fill that gap.

3 Agro-processing in Tanzania

The development of the agro-processing sector is accorded priority in various national development plans (URT 2017), highlighting its greater role in the Tanzanian economy. It is the largest subsector within manufacturing, characterized by a several small and medium-sized enterprises and a few large firms. In Agriculture Sector Development Programme 2, the sector is recognized for its potential to 'generate employment, raise productivity, transfer skills and technology, increase competitiveness, substitute imports and enhance exports, and contribute to the long-term national economic development' (URT 2016b: 6). According to URT (2011), agro-processing activities are an important part of agricultural commercialization and transformation. Dorosh and Thurlow (2014) highlight that agro-processing in Tanzania favours less-educated workers than is the case in Mozambique or Uganda, where the sector is more capital- and skills-intensive. Table 1 shows the number of employees in the various subsectors in 2013.

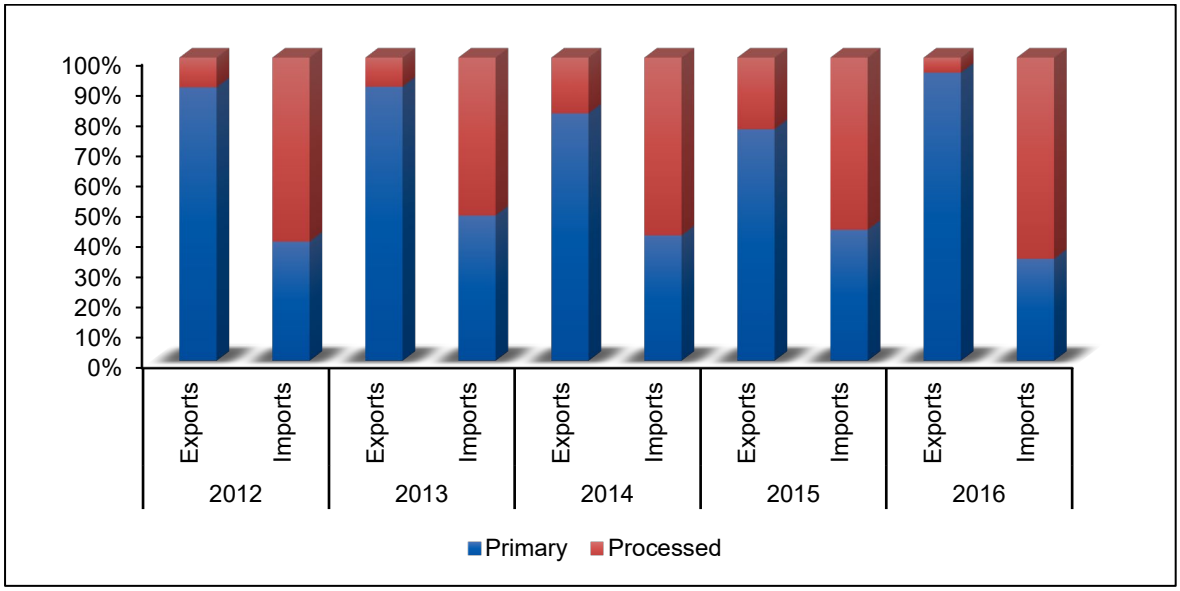
The food processing industry makes up about a quarter of formal manufacturing and more than half of manufacturing sector employment. The industry also has strong linkages with agriculture. For example, grain-milling offers an additional market for staple crop producers, and supplies feed to livestock producers. The agro-processing sector also contributes to total agricultural exports, especially processed foods. For example, palm oil is among the top 10 agricultural exports. Processed food exports grew at an annual rate of 4.6 per cent between 2012 and 2016, while imports grew at an annual rate of 3.9 per cent (Paremoer 2018). Tanzania has made progress in closing the food trade deficit. However, the trade is skewed towards palm oils (Paremoer 2018).

Table 1: Employment in agro-processing activities in Tanzania by establishment type, 2013

Industry	Employment size (number)								Total engaged
	1-4	5-9	10-19	20-49	50-99	100-499	500+	Total	
Food	18,565	6,437	1,938	2,991	2,424	9,168	22,340	63,863	85,330
Beverages	24	87	96	362	558	4,384	1,408	6,919	7,004
Tobacco	6	37	0	0	0	122	4939	5103	5,109
Textiles	546	138	43	159	244	3,214	12,305	16,649	17,714
Wearing apparel	6,235	2,500	52	140	86	137	1,302	10,453	30,538
Leather	117	164	43	192	413	480	0	1,410	1,726
Wood	1,764	1,775	514	375	353	147	2,281	7,209	9,418
Paper	3	18	12	149	305	248	1,507	2,242	2,253
Furniture	5,533	4,569	327	268	689	1,550	0	12,935	23,739
Total processing	32,793	15,725	3,025	4,636	5,072	19,450	46,082	126,783	182,831

Source: author's compilation based on data from NBS and MITI (2016).

Figure 1: Composition of agricultural trade in Tanzania (top 10 imports and exports)



Source: author's illustration based on data from ITC Trade Map (2018).

The composition of agricultural trade signifies the need to expand the processing of agricultural products (Figure 1). Agro-processing exports are limited, and most of them are in semi-processed form (UNIDO 2012). Tanzania continues to export most of its products in raw form, while the growing demand for agro-processed products is met through imports. By exporting these raw and semi-processed products, Tanzania loses opportunities for increased value addition that would result in more decent jobs and income. Thus, the country continues to export its economic value and jobs (Scholtes 2018).

4 Methodology and data

CGE models are explicit in recognizing the economy-wide effects of changes or shocks in one sector of the economy, and they capture direct and indirect effects of policy reform changes (Lofgren and El-Said 1999). They are thus preferable over econometric or partial equilibrium models, as they overcome the difficulty of isolating the effects of individual policies from other changes in policies and external factors.

4.1 Model

The model applied in this study is consistent with neoclassical structural theory and is based on the International Food Policy Research Institute (IFPRI) standard model developed by Lofgren et al. (2002). It is a recursive dynamic CGE, implying that decision-making by economic agents is based on past and prevailing market conditions—there are no future expectations involved in decision-making, as there are in intertemporal models (Diao and Thurlow 2012). The model is expressed as a system of simultaneous linear and non-linear equations, which are presented in Diao and Thurlow (2012). At any given time, these equations present the structure of the economy: they capture the circular flow of payments or the behaviour of economic agents with regard to production, consumption, investment, and trade, and they include government revenues and expenditures (Lofgren and Robinson 2008). The economic environment governing agents' behaviour is expressed in the form of equilibrium conditions, macroeconomic balances, and dynamic updating equations (Lofgren and Robinson 2008; Thurlow 2008). The recursive dynamic CGE model has two components, the 'within period' module and the 'between period' module, with the latter capturing the recursive dynamics of the model.

The model identifies various activities that produce their final output, using a combination of primary factors and intermediate inputs, to maximize profits subject to a production technology. The production technology is a two-step nested structure. At the bottom level of the nest, the aggregation of primary factors (labour, capital, and land) into value-added is governed by a constant elasticity of substitution (CES) function. Given the prevalence of high underemployment in Tanzania, the supplies of uneducated and primary-educated labour are assumed to be unlimited, and labour is assumed to be mobile across sectors. On the other hand, more educated labour, as well as land, is fully employed and mobile, while capital is activity-specific. Intermediate inputs are combined in fixed proportions into aggregated intermediate inputs. At the top level, the value-added and the intermediate inputs are combined into final output by a CES function. The decision on whether to export or sell domestically is governed by a constant elasticity of transformation function, while a CES function governs the decision between imports and domestic products.

The macroeconomic behaviour in the model is specified through three macro closure rules pertaining to the current account balance, the foreign account, and the savings-investment account. For the government balance, the revenue from taxes is based on fixed tax rates. Government savings therefore adjust to maintain the fiscal balance. The foreign inflows are held fixed and the exchange rate fluctuates to ensure equilibrium in the foreign account. A balanced closure for the savings-investment account is selected. Changes in absorption result in simultaneous adjustments in all three components of absorption. The savings rates of selected institutions are scaled to ensure enough savings for investments. The model's numeraire is the domestic producer price index.

For the recursive dynamics of the model, capital stocks are updated between periods by assuming that previous period investments are used as the basis for the stock of the current period. The new

capital stock is allocated between the different sectors based on their profitability. Population, productivity, government spending, and factor supplies are updated base on external trends.

4.2 Elasticities

Elasticities used in the CGE models are exogenously determined by means of econometric analysis. In this study, no econometric estimates were done. Due to the lack of econometric estimates, elasticities from another developing African country—Malawi, applied by Schuenemann et al. (2016)—were used in this study.

4.3 SAM

The SAM used in this analysis is an aggregation of the 204-account IFPRI Nexus Project SAM for Tanzania for the year 2016. The aggregated model SAM has 41 activities (of which 15 are agro-processing, 10 food, and five non-food activities), with an equal number of commodities. There are 13 factor accounts: eight labour accounts (grouped according to education level and location—rural or urban), four capital accounts, and one land account. Regarding institutions, there is one enterprise account, a core government account, and 15 household accounts. Households are divided into urban (hhd-u) households and rural households, which are further disaggregated by their primary activities into farm (hhd-f) and non-farm (hhd-n) households. All the households are further grouped into five per capita income quintiles. There are five tax collection accounts—one for each tax type (direct, export, factor, import, and sales taxes)—that are separated from the core government account. The SAM also includes savings and investments, changes in stocks, and foreign accounts.

Table 2 presents the structure of the Tanzanian economy in 2016 as portrayed by the SAM. The services sector has the highest share in GDP, value-added and total production (output). Agriculture has the lowest share in total output, despite a high share in GDP. However, its share in exports is significantly high, mainly dominated by the export of crops. Imports of agricultural produce, on the other hand, are very low. The industrial sector, particularly manufacturing and mining, has the highest shares in trade. Total imports of manufacturing are more than three quarters of total imports, mainly dominated by manufactures and a significant share of agro-processed imports. Agro-processed exports, however, make up the largest share of manufacturing exports.

Figure 2 presents the sources of income for households in 2016. The rural household income sources are more diversified, as well as those of the lower quintile urban households. Non-farm households, on the other hand, have less diversified sources. They derive their incomes predominantly from labour, and from enterprises with no rents from capital or land. Transfers from the government and the rest of the world constitute a very small percentage of all households' incomes. On aggregate, the highest source of income for total households is enterprises, 70 per cent of which is claimed by the urban households in the top two income quintiles. The amount derived from enterprises increases with income quintile level in both rural and urban households.

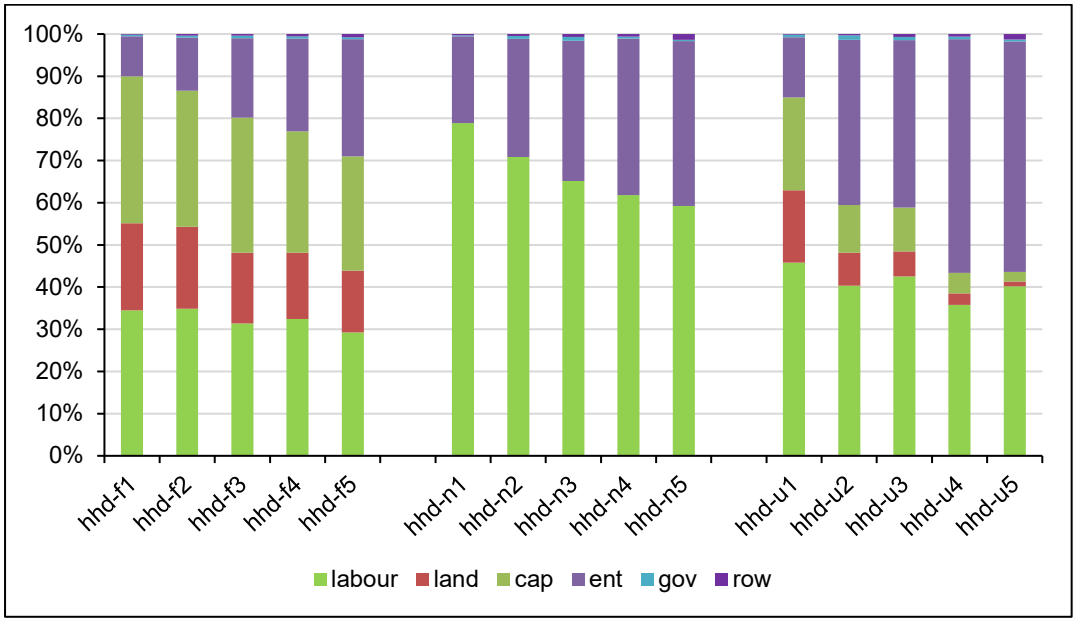
Table 2: Structural characteristics of the Tanzanian economy (% share)

	GDP	Value-added	Output	Imports	Exports
Agriculture	29.15	27.00	18.81	2.19	17.18
Crops	15.98	15.98	11.84	2.08	17.03
Livestock	7.12	6.40	4.01	0.04	0.08
Forestry	4.04	2.92	1.64	0.07	0.02
Fisheries	2.01	1.70	1.32	0.00	0.05
Industry	27.42	29.40	35.66	76.91	46.69
Mining	3.70	2.86	3.76	0.52	29.04
Manufacturing	5.56	8.37	12.46	76.17	17.65
Agro-processing	*3.76*	*4.48*	*7.90*	*11.09*	*10.35*
Food processing	*2.86*	*3.50*	*6.45*	*6.33*	*6.77*
Non-food processing	*0.90*	*0.98*	*1.45*	*4.76*	*3.58*
Other manufacturing	*1.79*	*3.89*	*4.56*	*65.08*	*7.30*
Other industries	18.17	18.17	19.44	0.22	0.00
Services	43.43	43.60	45.52	20.91	36.12
Trade and transport	17.56	16.37	17.09	9.36	11.07
Hotels and restaurants	1.11	1.11	4.19	8.27	20.72
Other services	24.76	26.12	24.24	3.28	4.33
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Source: author's compilation based on data from IFPRI Nexus Project SAM for Tanzania.

A closer inspection of the SAM shows that the majority of labour incomes in rural farm households are from primary-educated labour, followed by uneducated labour and then secondary-educated labour. Tertiary-educated labour makes a little contribution to only the top two income quintiles. For non-farm and urban households, uneducated labour incomes make up the least share of these households' labour incomes, higher shares being received from primary-educated labour incomes, followed by secondary- and then tertiary-educated labour. Both rural farm and urban households also receive incomes from capital (crops and livestock) and land.

Figure 2: Income sources of Tanzanian households, 2016



Note: A number in front of the household name denotes the quintile (e.g., hhd-f1=rural farm household, income quintile 1).

Source: author's illustration based on data from IFPRI Nexus Project SAM for Tanzania.

4.4 Simulations

A baseline scenario is first established in the model for the period 2017–2025. The alternative scenarios are benchmarked against this scenario. The base year is 2016, and exogenous trends are imposed on the model to replicate the current growth in the economy. The total population and the labour force are set to grow at three per cent annually, which is the observed trend (URT 2018). Land, however, grows at 0.5 per cent per annum (Dorosh and Thurlow 2014), which is lower than the observed trend. Productivity growth is imposed to target the observed growth in GDP, but is varied among broad sectors to closely resemble growth in these sectors. This results in total GDP growing at an average of 6.39 per cent. Agriculture grows more slowly than other sectors at an average of 5.04 per cent annually, while industry and services grow at 7.08 per cent and 6.79 per cent respectively.

Simulation 1: Total factor productivity increase in agro-processing

The Tanzanian manufacturing industry suffers from low productivity levels. In this scenario, total factor productivity (TFP) growth is accelerated for agro-processing activities, which is assumed to be driven by the increase in FDI inflows. The Tanzanian government aims to increase FDI inflows and thus has put in place several incentives to attract FDI (Tanzania Investment Centre 2018). Chuang and Lin (1999) found an increase in the investment ratio of FDI to produce a gain of between 1.40 per cent and 1.88 per cent in domestic firms' productivity. Based on their findings, Kinyondo and Mabugu (2009) applied a one per cent increase in productivity to evaluate the impact of FDI on South African industries. In this simulation, the growth rate in agro-processing firms' productivity is increased by one percentage point from the baseline level. This additional growth rate is assumed to be accounted for by a five per cent increase in foreign savings. In the CGE model, changes in productivity are captured by the efficiency parameter in the CES production function at the bottom-level production nest, that is, in the aggregation of primary factors (value-added).

Simulation 2: Increased secondary- and tertiary-educated labour

The level of educated and skilled labour is very low in Tanzania (Morisset and Haji 2014), and this is one of the limiting factors on industrial growth. This scenario aims to examine the impacts of increasing the quantity of educated labour (EDUC) in the Tanzanian economy as part of industrial policy (URT 2016a). This policy is not sector-specific and is implemented in the whole economy. In this scenario, the growth rate of secondary- and tertiary-educated labour is increased by an additional one per cent from the baseline value, to four per cent. To account for the increase in educated labour, government consumption in education is increased by 10 per cent. However, the government is devoting a relatively large share of the budget to education.

Education and training to increase knowledge and skills will result in more efficient workers, which in turn results in better-quality products and services (Jajri 2007). Thus, increasing education can improve productivity. However, the simulation does not consider the effects of educated labour on productivity.

5 Results

5.1 Impact on GDP growth

Table 3 presents the growth rates at the baseline and the simulations under consideration. Increasing the productivity of the agro-processing sector increases the sector's average GDP growth rate from 6.91 at the baseline to 7.65 per cent. Within the agro-processing sector, growth in food processing is 0.73 percentage points higher than at the baseline. The non-food processing sector gains 0.78 additional percentage points in growth compared with the base. The growth of agro-processing activities generates linkages with other sectors, spurring growth in these sectors. Additional growth in the agriculture, other manufacturing, and services sectors is recorded due to the expansion of the processing sector. Within the agricultural sector, growth in the GDP of crops in general remains unchanged. However, there are differences at crop subsector levels (not shown in the table). The additional growth in agro-processing results in an additional 0.06 percentage points in total GDP growth compared with the base. Generally, the productivity increase does not result in higher growth, probably reflecting the dependence of the agro-processing sector on primary activities with lower production (Breisinger et al. 2009; Diao 2010).

As depicted in the education scenario, labour-driven growth plays a large role in developing economies. Growth in GDP is 0.24 percentage points higher than at the baseline, which is higher than in the productivity scenario. Increasing the quantity of educated labour has a significant impact on the growth of all the broad sectors in the economy. The agricultural average growth rate under the education scenario is 0.14 percentage points higher than baseline growth. Industry, on the other hand, grows at 7.25 per cent, with an additional 0.17 per cent compared with the baseline level, while the service sector's growth rate of 7.15 per cent is 0.28 percentage points higher than baseline growth. Within industry, mining and other manufacturing industries are the major drivers of growth. The agro-processing sector does not achieve higher growth, because educated labour is not specifically targeted at agro-processing, and the sector has to compete with the other sectors when hiring additional labour. Compared with the TFP scenario, the agro-processing sector records lower growth in its GDP.

Table 3: Average annual real growth rates in GDP, 2017–25

	Base	TFP	EDUC
Agriculture	**5.04**	**5.07**	**5.18**
Crops	3.87	3.87	4.00
Livestock	7.08	7.14	7.25
Forestry	4.91	4.96	5.07
Fisheries	6.34	6.39	6.41
Industry	**7.08**	**7.19**	**7.25**
Mining	10.12	9.98	10.30
Agro-processing	6.91	7.65	7.04
Food	*6.75*	*7.48*	*6.85*
Non-food	*7.40*	*8.18*	*7.60*
Other manufacturing	8.73	8.76	8.92
Other industries	6.23	6.26	6.39
Services	**6.79**	**6.84**	**7.15**
Trade and transport	7.25	7.31	7.41
Hotel and restaurants	7.39	7.39	7.54
Other services	6.43	6.48	6.95
Total GDP	**6.39**	**6.45**	**6.63**

Source: author's model results.

5.2 Impact on trade

Consistent with the literature, the additional growth in the productivity of agro-processing activities makes Tanzanian processed agricultural products more competitive on the global market, expanding agriculture-related manufacturing exports. This is revealed in the model results (Table 4), which show an increase in the average annual growth rate of the sector's exports from 9.06 per cent at the baseline to 9.84 per cent, that is, additional growth of 0.78 per cent. At a broader level, the non-food processing industry, with a higher additional GDP growth rate, in turn has higher growth in exports: a 0.81 percentage-point increase compared with the baseline value. The food industry's export growth, on the other hand, increases by 0.76 percentage points from baseline growth.

The expansion of agriculture-related manufacturing exports also slightly increases the growth in exports of services. However, growth in other industrial and agricultural exports decreases. This decrease in the growth of other sectors' exports has a negative effect on total exports, which is consistent with the results of Fukase and Martin's (2017) static model. Raw agricultural exports decline significantly because of productivity-driven growth in the downstream sectors, which increases demand for intermediates in the processing sector, causing some agricultural products that were previously exported in raw form to be processed before exporting. However, some products, such as sugar, fish, and cotton, still increase (not shown in Table 4), probably due to processing still being limited. The expansion of agro-processing activities due to productivity gains increases not only exports but also the quantity of output available for the domestic market. The import substitution of agro-processed products takes place, indicating an increase in the competitiveness of agro-processing industries relative to foreign competitors. The average annual growth rate of imports in the sector falls from 5.77 per cent at the baseline to 5.62 per cent. However, there is a surge in raw agricultural imports to support the expanding processing sector,

and thus the growth of primary agricultural imports increases from 5.72 per cent at the baseline to 5.74 per cent.

Table 4: Average annual growth rate of real exports and imports, 2017–25

	Base	TFP	EDUC
Exports			
Agriculture	***4.36***	***3.99***	***4.59***
Crops	4.32	3.95	4.56
Livestock	8.45	8.24	8.42
Forestry	5.14	4.92	5.51
Fisheries	7.59	7.61	7.65
Industry	***9.90***	***9.95***	***10.12***
Mining	10.35	10.19	10.61
Agro-processing	9.06	9.84	9.15
Food	*8.05*	*8.82*	*8.03*
Non-food	*10.79*	*11.60*	*11.06*
Other manufacturing	9.23	9.14	9.45
Services	***6.76***	***6.77***	***7.06***
Trade and transport	7.49	7.51	7.70
Hotel and restaurant	6.42	6.42	6.73
Other services	6.43	6.44	6.94
Total exports	**7.98**	**7.96**	**8.22**
Imports			
Agriculture	**5.72**	***5.74***	***5.89***
Crops	5.63	5.64	5.80
Livestock	9.98	10.42	10.55
Forestry	5.18	5.44	5.17
Fisheries	5.50	5.67	5.71
Industry	**7.36**	***7.40***	***7.60***
Mining	5.59	5.79	5.82
Agro-processing	5.77	5.62	6.00
Food	*5.55*	*5.39*	*5.80*
Non-food	*6.06*	*5.93*	*6.27*
Other manufacturing	7.64	7.71	7.89
Other industries	2.44	2.66	2.50
Services	**6.31**	***6.42***	***6.48***
Trade and transport	6.30	6.42	6.50
Hotel and restaurant	6.06	6.16	6.23
Other services	6.92	7.02	7.07
Total imports	**7.12**	7.17	7.34

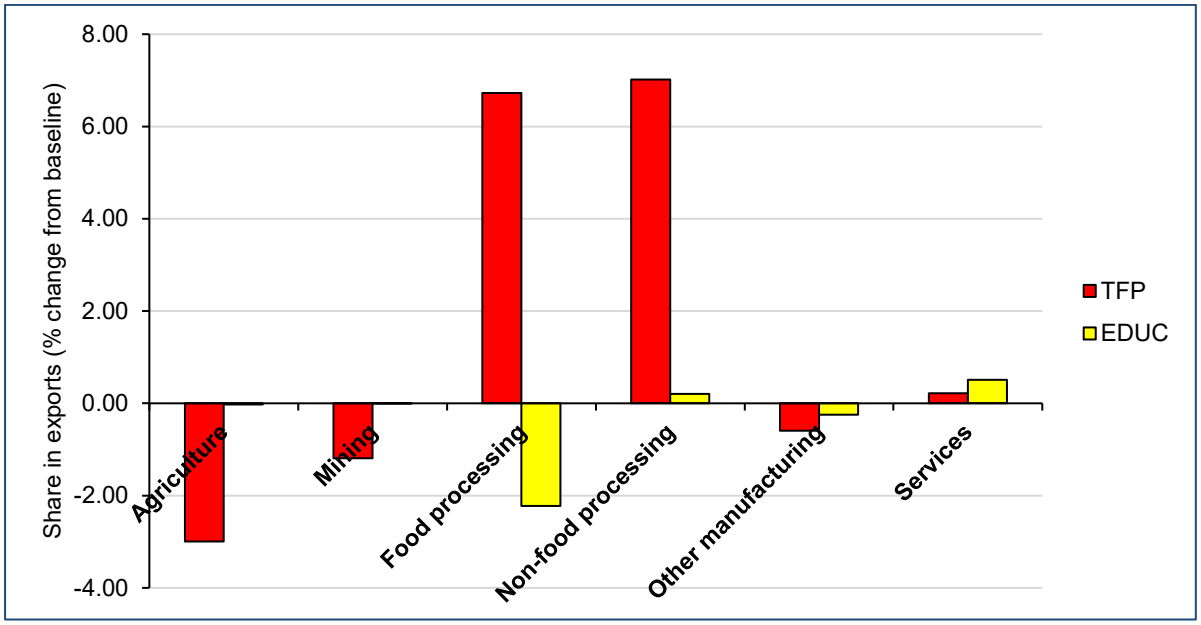
Source: author's model results.

Increasing the quantity of educated labour, on the other hand, is effective in pushing the total exports of all export products in the economy. Under the education scenario, total exports grow

at an annual rate of 8.22 per cent, which is 0.26 percentage points higher than baseline export growth. Growth in raw agricultural exports increases by 0.13 percentage points from the average annual growth rate at the baseline. A trade-off exists between the surge in these primary exports and processed product exports: the growth in agro-processed exports is only 0.09 per cent higher than baseline growth, which is lower compared with the effects of increased productivity. Exports from other industrial sectors, however, record higher growth rates.

The structure of exports changes under the two simulations, as shown in Figure 3. Under the productivity simulation, the share of agricultural exports significantly decreases. Mining and other manufacturing also lose their share in exports, while service exports increase, and manufacturing exports are dominated by agro-processing products. The education scenario yields similar results (but at low magnitude), except for food product exports, which decrease.

Figure 3: Changes in structure of exports under different scenarios



Source: author's model results.

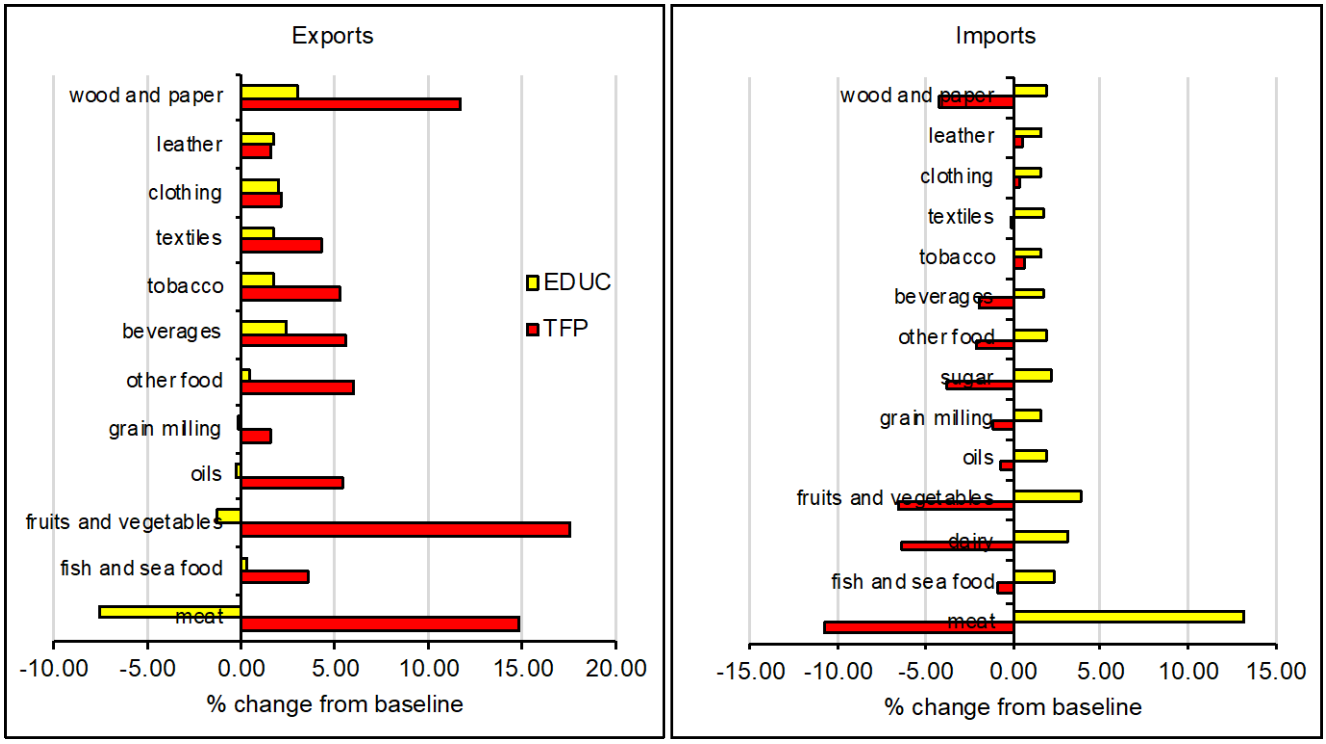
The decrease in both scenarios in exports from other industrial activities, especially manufacturing, is a setback, as development entails export sophistication and diversification (Page 2012; UNIDO 2009). On the other hand, the decline in imports of capital goods (other manufacturing) under the productivity scenario is another policy issue. Capital goods imports are a necessary ingredient in the industrialization process.

The changes in imports and exports within the agro-processing subsectors are presented in Figure 4. Productivity increases have the highest impact on exports for meat and for fruit and vegetable processing, whose exports increase by 14.76 and 17.48 per cent respectively from the baseline. In the non-food industry, major increases in exports are recorded for wood and paper activities. Slow expansion in grain-milling exports is probably a reflection of the impact of the slow growth in cereals on the processing sector. The inputs of this sector are mainly intermediates from primary agricultural activities, and thus significant growth in these sectors might be a necessary requirement for the downstream processing sector. The food sectors with higher increases in exports also have a significant reduction in imports. In the non-food sectors, imports of tobacco, clothing, and leather increase relative to the baseline outcomes. These sectors have limited processing capacity and are among the sectors targeted for industrial expansion. The income effect of the productivity increases might have increased the effective demand for the products of these industries, which

are less competitive than their foreign counterparts; hence the increase in imports to meet the demand.

Unlike the productivity simulation, the education scenario yields mixed results on exports from the agro-processing industries. Except for fish and seafood and other food product exports, which increase slightly, exports from the food sectors decrease because of the increased quantity of educated labour. All non-food agro-processed products increase, showing that the education scenario would benefit the relatively labour-intensive non-food processing sectors. However, imports increase for all agro-processed commodities. This is because of the high growth in other sectors of the economy, which require more inputs from the agro-processing sector, and the income effect, which causes increased demand for imports (Figure 4).

Figure 4: Changes in imports and exports in agro-processing industries

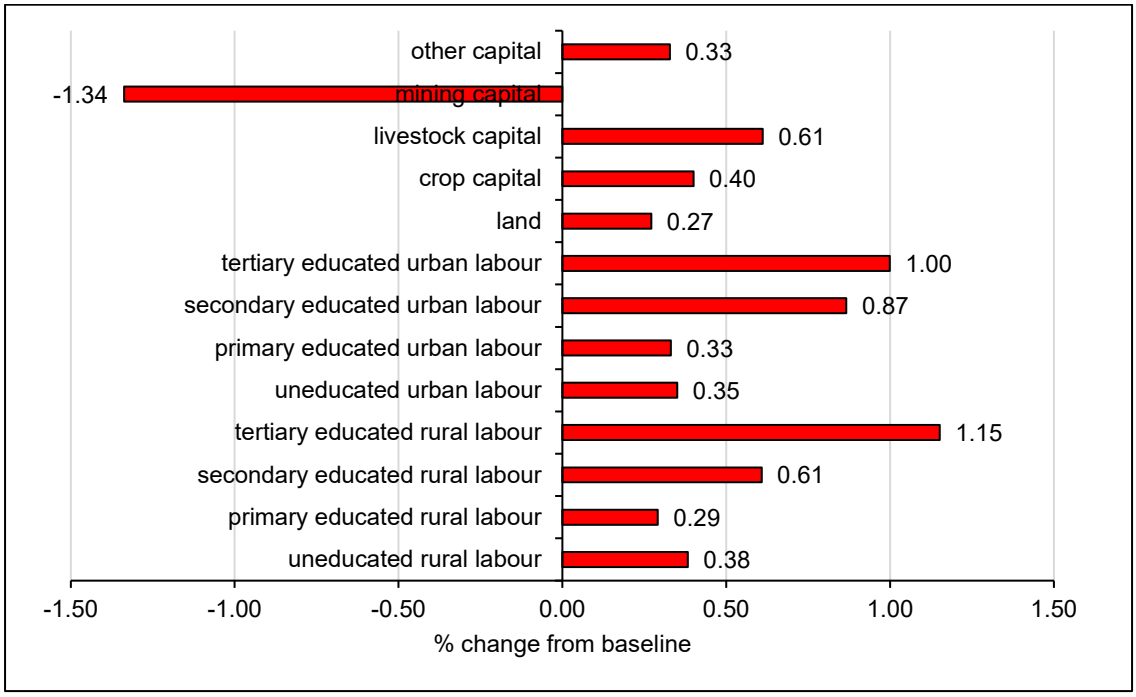


Source: author's model results.

5.3 Impact on factor outcomes

The impacts of productivity growth in agro-processing industries on factor incomes are presented in Figure 5.

Figure 5: Impact of productivity increase in agro-processing on factor incomes

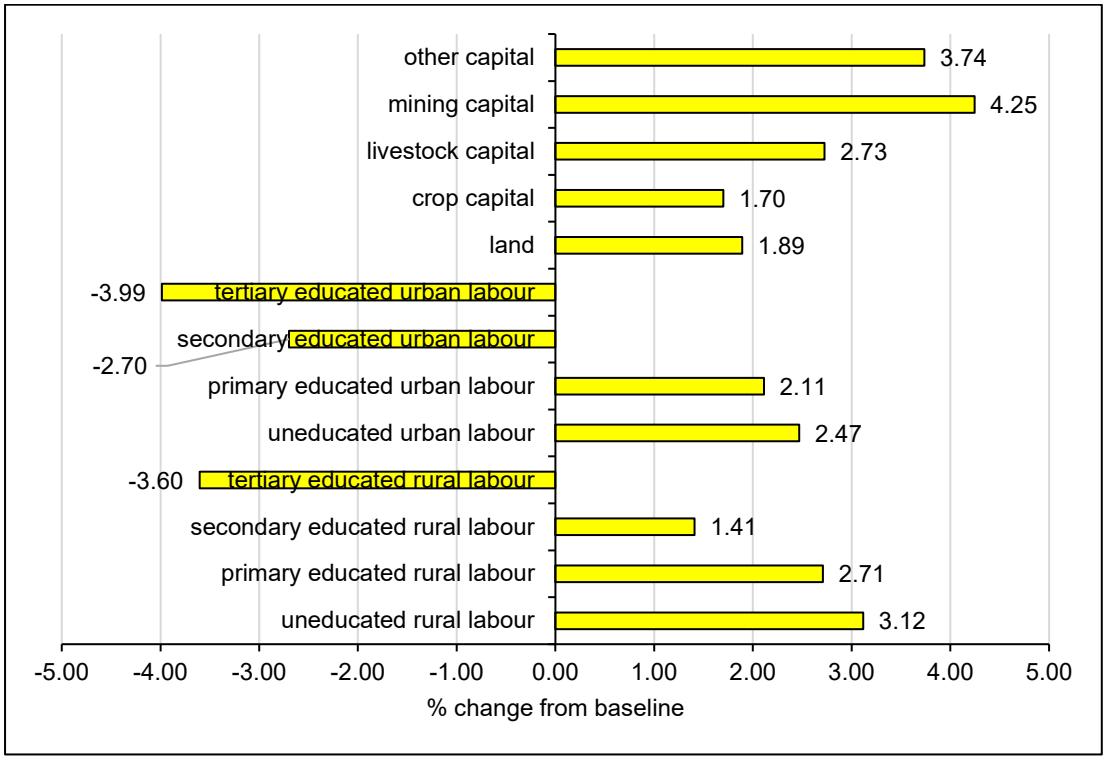


Source: author's model results.

Productivity-driven growth in the processing of agricultural products positively impacts on factor incomes, that is, shows additional increases compared with baseline values, except in the case of mining capital. Due to limited linkages between the two sectors, growth in agro-processing does not spur growth in the mining sector. The returns to capital which is only employed in the mining sector therefore decrease as the sector's growth decreases. The income from land as well as crop and livestock capital increases, reflecting the impact that the expansion of the processing sector has on primary agricultural production. The increased demand for intermediates from agriculture for the expanding processing sector drives the demand for production factors for raw agricultural products. The agricultural sector's activity-specific wage terms for capital and land therefore increase, and thus total income for these two types of factor increases. The income from other capital, which includes capital for agro-processing and other industrial and service sectors, also increases. Although the productivity increase results in a decrease in the capital-output ratio in the agro-processing sector, resulting in a decrease in demand for the factor in related industries, the expansion in the other sectors increases the demand for capital; hence the increase in the factor income. Labour is affected in the same way as capital. In both urban and rural areas, tertiary-educated labour records the highest income increases, followed by secondary-educated, then uneducated, and lastly primary-educated labour. The changes in the incomes of these labour categories are proportional to the initial average wages for each category.

Increasing secondary- and tertiary-educated labour has mixed results on factor incomes (Figure 6). Due to the increased supply of labour, the wages (not shown in the graph) of rural secondary- and tertiary-educated labour decrease by 10.2 and 22.44 percentage points respectively compared with baseline values, while the wages of urban secondary- and tertiary-educated labour decrease by 19.17 and 21.81 percentage points from baseline values.

Figure 6: Impact of increase in education on factor incomes



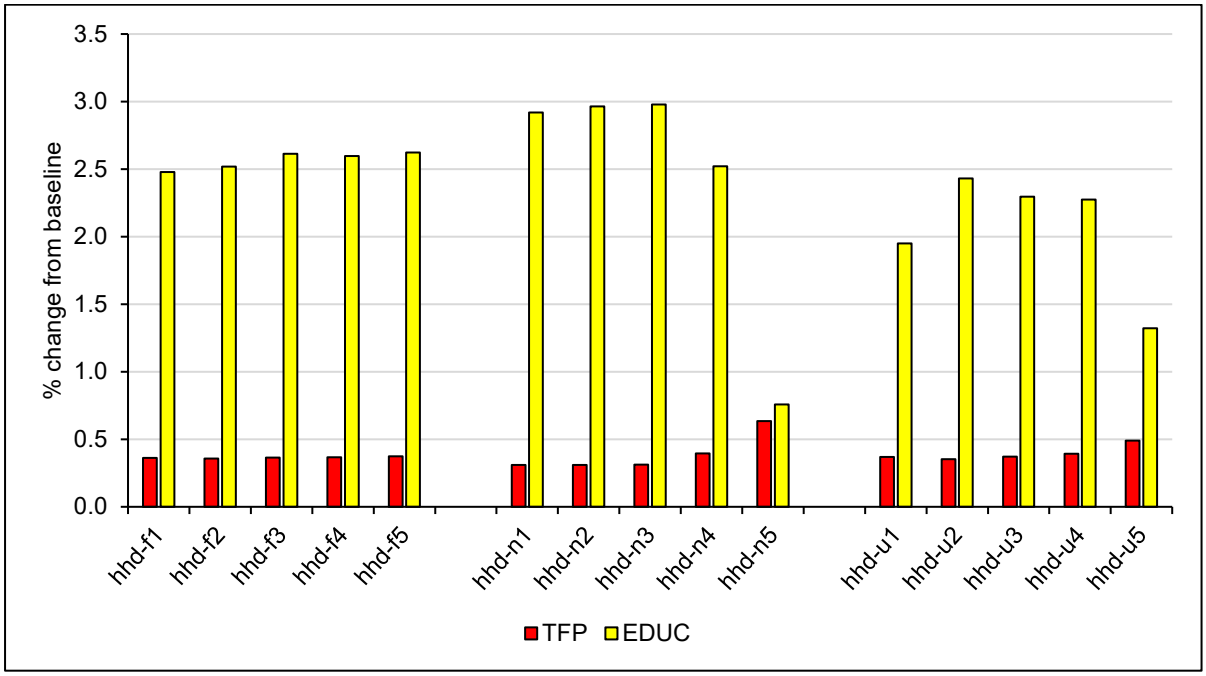
Source: author's model results.

The incomes of secondary-educated labour with relatively lower decreases in wages do not decline, while the other labour categories whose wages fall record negative impacts on incomes. Incomes for less-educated labour with unlimited supplies increase, due to increased demand for these factors in the expanding labour-intensive sectors. The expansion of the agricultural, industry, and service sectors results in increased incomes from the land and capital used in these industries, as the demand for these factors increases to meet production.

5.4 Impact on household incomes

Figure 7 presents the impacts of the two policy scenarios on household incomes. Under the productivity scenario, the general trend is that the higher the income quintile, the higher the additional household incomes compared with baseline incomes, in both rural and urban households. Higher income quintiles receive a significant share of their incomes from more highly educated labour, whose incomes significantly increase under the productivity scenario (shown in the previous subsection). At a broad level, compared with baseline incomes, productivity increases have the highest positive impacts on non-farm households (+0.52 per cent), followed by urban households (+0.46 per cent), and lastly rural households (+0.37 per cent). The highest returns to factors under the productivity scenario are from labour, which makes up the highest portion of rural non-farm households; land, which contributes a significant portion to farm households, has the lowest returns.

Figure 7: Impact of policies on household incomes



Source: author's model results.

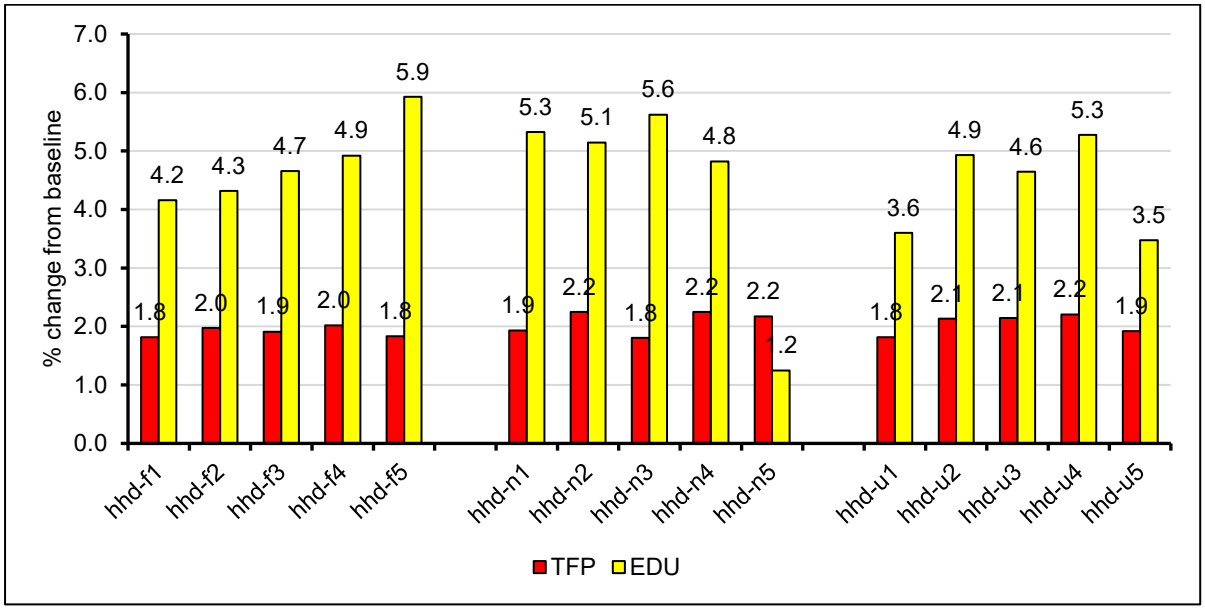
In the education scenario, the results are also a reflection of the changes in factor earnings from which households derive their incomes. Among rural farm households, the higher the income quintile, the higher the household income. For non-farm households too, income increases with quintile, but only for the lower quintiles; the top two quintiles' income changes are lower. The top income quintiles are lower due to the reduced income from highly educated labour, which constitutes a significant source of income for these households. Overall, compared with the baseline, the highest increases in income are observed in farm households (+2.58 per cent), followed by non-farm households (+1.59 per cent) and then urban households (+1.55 per cent).

5.5 Impact on household welfare

In this study, equivalent variation (EV) is used to evaluate household welfare. EV is an important measure widely used in CGE analysis to quantify—*ex ante* in this case—the welfare effects of policy shocks. This measure considers changes in household incomes and price changes given the consumption bundles (Pauw et al. 2007). It estimates at base price values the required change in income that would give the consumer the same satisfaction (utility) as would have been brought by the economic shock should it have taken place (Sennoga and Matovu 2016). Positive EV implies welfare gains, while negative EV implies welfare losses.

Increases in both productivity and the quantity of educated labour result in positive EV, implying that there are welfare gains from implementing such policies in the industrialization process. Increasing the quantity of educated labour, however, results in greater improvements in welfare (Figure 8). At an aggregated household level, an increasing quantity of educated labour shows higher welfare improvements among rural farm households (+4.91 per cent), followed by urban households (+3.85 per cent); rural non-farm households record the smallest improvement in welfare (+2.83 per cent). When the impacts on welfare are examined across income quintiles, the higher the quintile, the higher the welfare improvements for the first four quintiles. The fifth quintile has the lowest improvements.

Figure 8: Impact of policies on household welfare



Source: author's model results.

In the productivity scenario, the welfare impacts also do not necessarily resemble the changes in household incomes explained in the previous subsection at the broader household level: non-farm households have the highest welfare improvements (+2.15 per cent), followed by urban households, with farm households (+1.92 per cent) having the smallest welfare improvements (+1.98 per cent).

6 Conclusions

Economic transformation is a missing feature of the high growth in Tanzania, and thus progress towards significant poverty reduction and the creation of high-quality jobs has been slow. The government is therefore pushing towards the industrialization of the economy, and the development of the agro-processing sector is identified as crucial. The expansion of agro-processing activities presents opportunities for better jobs and higher incomes, and expands higher-value exports while reducing dependence on raw material exports. Despite the dominance of primary agricultural activities, the further processing and value addition of agricultural products is still limited. Various measures are being implemented to support agro-industrialization. This study has evaluated the impacts of increasing educated labour and productivity in agro-processing activities using an economy-wide model.

The results show that productivity gains in agro-processing will not have significant results for overall economic growth, but will enhance the competitiveness of the sector, expanding agro-processed product exports and effectively reducing low-value raw agricultural exports. In the food sector, exports of meat, fruit, and vegetables will expand significantly, with wood and paper product exports being the leaders in the non-food sector. Productivity increases will also be effective for the import substitution of food products, especially processed meat, dairy, and fruit and vegetable products. Capacity constraints in the majority of the non-food sectors, on the other hand, imply that huge productivity increases will be needed for import substitution. The horizontal policy to expand the educated labour force will result in high additional economic growth, and higher total exports and imports. However, its impact on the growth of agro-processing activities

will be less pronounced. Exports from the food industry will decrease significantly, while non-food sector exports will increase due to increased educated labour, and imports of all agro-processing activities will increase.

In relation to factor incomes, productivity-driven growth in agro-processing expands labour incomes as well as returns on capital and land in primary agriculture. Educated labour benefits more from productivity increases. Expanding educated labour may, however, reduce the returns to educated labour, due to a fall in wages. Household incomes generally reflect the changes in factor incomes. A broad analysis shows that non-farm households benefit more from productivity increases, while farm households benefit more from an increase in educated labour. The results, however, show variations among the income quintiles.

The findings suggest that agro-processing activities play an important role in the Tanzanian economy, and hence the government should continue to implement policies to encourage more investments in the sector. Sector-specific policies, such as attracting FDI to enhance the sector's productivity, are more important for trade outcomes and growth within the sector. Horizontal policies such as increasing education may not necessarily be effective for the sector's expansion, but they are crucial for expansion of the whole economy. The simulation analysis also highlights that policy outcomes among subsectors within the agro-processing sector may differ. Thus policies must be targeted at the subsector level. In addition, it is also important to note that different policies that can expand the agro-processing sector have different implications for factor and household incomes.

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