Empowered lives.
Resilient nations.

MAKING THE CASE FOR INVESTMENT IN CASSAVA

ESTIMATING ECONOMIC AND SOCIAL RETURNS THROUGH GENERAL EQUILIBRIUM MODELLING

NOVEMBER 2019

BAZLUL HAQUE KHONDKER, PHD
Consultant Economist for UNDP Cambodia

September 2019

CONTENTS

LIST OF FIGURES, TABLES, CHARTS AND BOXES

ACRONYMS

APS	Average Propensity to Spend
BAU	Business as Usual
BCR	Benefit Cost Ratio
CEDEP2	Cambodia Export Diversification and Expansion Programme 2
CES	Constant Elasticity of Substitution
CET	Constant Elasticity of Transformation
CGE	Computable General Equilibrium
CSES	Cambodia Socio Economic Survey
DCGE	Dynamic Computable General Equilibrium
DE	Degree of Endogeneity
DGT	Director General of Taxes
ESAM	Environmental Social Accounting Matrix
ESM	Employment Satellite Matrix
FOB	Free on Board
FP	Factors of Production
GDP	Gross Domestic Product
GFCF	Gross Fixed Capital Formation
HH	Household
IOM	Input-Output Matrix
IOT	Input-Output Table
LES	Linear Expenditure System
LPF	Livestock and processed food
LFS	Labour Force Survey
MAFF	Ministry of Agriculture, Forestry and Fisheries
MOC	Ministry of Commerce
N.E.C.	Not Elsewhere Classified
NIS	National Institute of Statistics
RGC	Royal Government of Cambodia
SAM	Social Accounting Matrix

EXECUTIVE SUMMARY

KEY FINDINGS AND CONCLUSIONS

This report finds that the potential returns to public investments in cassava are substantial, with the economic benefits outstripping costs by a factor of up to three to one over a ten-year period. Taking wider socioeconomic impacts (in employment and poverty reduction) into account, it finds that cassava also out-performs alternative investments in rice production, livestock and food, and tourism sectors.

Cassava is the second largest agricultural crop in Cambodia, it is both an important export commodity and an input to several industrial processes. Its development offers both output gains, and structural benefits to the Cambodian economy. Its possible future role in promoting higher value-added and greater productivity has gained recognition from the Royal Government of Cambodia (RGC) under the Industrial Development Policy 2015-2025.

However, cassava's potential is under-realized. Much of the sector is focused on growing and exporting raw product, while in-country processing remains unexplored. Realization of these potentials requires public sector intervention: the provision of resources to support growing, processing and marketing; and implementation of supportive infrastructure projects. UNDP's established cassava project has separately estimated that a public investment package of some US$296 million is needed to kick-start the sector's transformation. Nevertheless, policymakers remain reticent as they are uncertain of the likely economic and social returns.

This study provides robust estimates of impacts, including: strictly economic variables, income/ GDP gains and Benefit Cost Ratios (BCR); fiscal impacts (tax revenues); and the socioeconomic impacts, given by changes in employment, poverty rates and wage levels. Using macroeconomic general equilibrium modelling techniques, this report compares an investment in the cassava sector to a business as usual (BAU) scenario, and investments (of the same size) in three alternative sectors (rice, livestock and food, and tourism) over a 10-year period. Two models are applied: a basic multiplier model, which relies on static interactions; and a dynamic Computable General Equilibrium (CGE) model, which allows for market responses.

Construction of an updated Social Accounting Matrix (SAM) for Cambodia, which is a key data input for these techniques, and the specification of the multiplier and CGE models rank as significant outputs in their own right. These have the potential to facilitate research into other economic topics and are an important contribution to analytical toolkit available the Government.

The economic return to investment in cassava, versus the BAU case, and the alternative scenarios, is strong, delivering a BCR of 2.50 for the multiplier model and 3.11 for the CGE model over a 10- year period. Cassava clearly outpaces livestock and food (BCRs of 1.50 and 3.06 respectively), and the tourism sector (BCRs 1.90 and 2.51 respectively), but delivers a closer result compared to rice production (BCRs of 2.20 and 3.13 respectively). While on the CGE results rice production edges ahead, the nominal GDP gains are similar at US$949 for rice versus US$942 million for cassava.

The CGE results also suggest that all of the sectors modelled return a sizable portion (45 to 50 percent) of the initial investment to the Government budget within the 10-yaer period. The direct fiscal gain for cassava, rice and livestock and food are similar at around US$130 million. Nevertheless, the tourism sector performs strongest with a contribution of US$151 million.

The case for cassava over other investment choices is fully vindicated when the likely socio-economic impacts are considered. Under the multiplier model, employment generation and poverty reduction outcomes are markedly better under the cassava scenario compared to the BAU case and all of the alternatives. The CGE model results show that wage and income gains to cassava investment are the most progressive– with results favouring low and medium skilled workers, and landless and smaller farmers, over all other scenarios. Cassava therefore offers a means of maximizing inclusive growth, in line with the Royal Government's long-term Vision 2050 commitments.

Although analytically sound, our results are somewhat provisional due to some shortcomings in the source data. In particular, the SAM is based on 2014 data and includes a restricted set of activities. The embedded production technologies may also be dated therefore, and not fully reflect the level of structural change in the economy. Nevertheless, construction of the SAM marks very considerable improvement over the pre-existing position.

Data and time constraints meant that it was not possible to include assessment of the environmental impacts of expanded production in cassava versus alternative sectors. All activities may have negative externalities to varying extents, and such an appraisal would help to resolve ongoing debates about the desirability of alternatives.

POLICY RECOMMENDATIONS

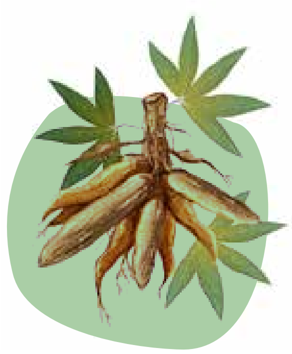
- **Given the strong economic and socioeconomic rationale, the Government should prioritize the proposed investment package in the cassava sector.** Realizing the estimated gains requires that Government move forward with the full package of US$296 million in supporting activities and key facilitating projects.

- **Cassava sector has growth and development advantages beyond the scope of our analysis as a spur to industrial activities, and in time this will deliver higher value-added output, augmenting the gains cited in this report.** This suggests that investments to support the establishment of processing activities, such as infrastructure improvements, rank as the highest priority.

- **To overcome data challenges, the National Institute of Statistics (NIS) is urged to construct an updated core dataset for economic modelling purposes.** These efforts should include a new Supply and Use Table (SUT) with an appropriate representation of the current economic structure; a new Input-Output Table (IOT) to provide up to date activity and commodity data; and a Social Accounting Matrix (SAM) using these two updated inputs.

- **A comparative assessment of environmental impacts should be considered as part of any follow-on analyses.** Noting also that UN STAT (UN, 1993) recommends that an Environment Satellite Matrix (ESAM) should be constructed for all major activities (in Cambodia) to assess environment costs and natural resource degradation impacts.

01 INTRODUCTION AND BACKGROUND



2[rd] largest
agricultural crop
in Cambodia

Cassava is Cambodia's second largest agricultural crop, a major export and an input to several industrial processes. Its development offers both short-term and long-term structural benefits to the Cambodian economy. Its potential role in promoting higher value-added and greater productivity has gained special attention from the Royal Government of Cambodia (RGC) under its Industrial Development Policy 2015-2025. However, its potential is under-realized, with much of sector focused on growing and exporting raw product, and in-country processing remains unexplored.

Cassava potential needs support from the Royal Government in terms of investment in key areas that would promote exports as well as higher valued use in other sectors of the economy. UNDP, supported by the Enhance Integrated Facility (EIF), via the Cambodia Export Diversification and Expansion Programme 2 (CEDEP2) has sought to build on favourable global conditions to open up opportunities for Cambodia to strengthen its agricultural production, processing and export capacities. The medium-term objectives of the RGC are to enable access to higher value markets (such as starch, bio-ethanol, and animal feed) by building productive capacity. These aims can be levered by targeted public investments in research and development, agricultural extension and support services, market information and trading systems, and relevant infrastructure. Unlocking these benefits will require the development of an investment case that can then be made to senior policymakers.

The purpose of this assignment, therefore, is to provide rapid but authoritative estimates on the impact of public investment to address market failures facing the Cassava sector. This would include estimated changes in:

ESTIMATED CHANGES IN

(a) cassava output, value and exports

(b) the effects on key macro-economic aggregates including output (economic growth), value-added and investment

(c) employment situation; and

(d) household incomes and the poverty rate

Moreover, this should also enable and include estimation of the total (social and private) rates of return to an optimal investment package, to be compared against a counterfactual investment in general infrastructure.

The rest of the report is composed of seven more sections. Section 2 discusses the methodology, Section 3 reviews the cassava sector in Cambodia, and Section 4 informs on the creation of Social Accounting Matrix (SAM) 2014. Key features of the SAM 2014 are presented in section 5, while Sections 6 and 7 assess the economic returns of public investment in cassava using SAM and Dynamic Computable General Equilibrium (DCGE) models respectively. Concluding observations are provided in section 8.

02 METHODOLOGY AND DATA

Three sets of methodologies/approaches have been used to study the economic returns to public investment in cassava sector. The first approach is a review of the situation and future prospect of cassava using secondary published and unpublished information. The second approach is a general equilibrium method to assess the economy wide impacts of cassava investment as well as investments in competing sectors. Finally, the third approach invokes the well-known Benefit Cost ratio (BCR) method to assess and compare the economic return of public investment in cassava and competing sectors. The various components, and the insights they provide, are summarised below.

Methodology	*Insights*
Desk Review	• *Analysing current situation* • *Understanding future prospects*
Social Accounting Matrix	• *Contribution to "upstream" sectors* • *Contribution to "downstream" sectors* • *Impacts on sectoral GDP* • *Impacts on sectoral domestic output* • *Impacts of household consumption* • *Split between direct, indirect and induced impacts*
Dynamic CGE Model	• *Employment structures by location, gender and skill levels* • *Impacts on sectoral employment* • *Impacts on urban and rural employment* • *Impacts on male and female employment* • *Split between direct, indirect and induced employment impacts*
Poverty Model	• *Poverty situation by location* • *Impacts on urban and rural poverty* • *Impacts on household level poverty*
BCR	• *Discounted public investment* • *Discounted benefit* • *Discounted benefit-Cost Ratio*

2.1. ECONOMY WIDE APPROACH

The economy wide impact is based on four inter-related frameworks:

(i) a Social Accounting Matrix (SAM) based multiplier model to capture the effects on domestic output, value added, and household consumption. It also captures direct, indirect and induced impacts using the interdependence or linkages of activities and commodities.

(ii) an Employment Satellite Matrix (ESM) to assess employment implications by activities, location (urban and rural) and gender (male and female). Moreover, it also assesses direct, indirect and induced employment impacts.

(iii) a Dynamic Computable General Equilibrium (DCGE) model to describe the accumulation of factors and their influence on the process of growth in each year of the intervention period.

(iv) a poverty model to assess poverty impacts. It examines poverty situations by location.

Economy wide Impact Assessment

SAM Model	*Impact on GDP and Output*
	Direct Impact (Cassava)
	Indirect Impact (Linked sectors)
	Induced Impact (Rest sectors)
SAM Model & Employment Matrix	*Impact on Employment*
	Direct Impact (Cassava)
	Indirect Impact (Linked sectors)
	Induced Impact (Rest sectors)
DCGE Model	*Impact on Prices and Markets*
	Direct Impact (Cassava)
	Indirect Impact (Linked sectors)
	Induced Impact (Rest sectors)
Poverty Model	*Impact on Poverty*
	Direct Impact (Cassava)
	Indirect Impact (Linked sectors)
	Induced Impact (Rest sectors)

Input-output tables (IOTs) provide a detailed picture of an economy through which mutual interrelationships among the producers and consumers in that economy can be systematically quantified. IOTs have become a widely used tool for national accounting, economic planning, and policy analysis.

BOX 1: DATA SOURCES

- *An updated Input-output Table for Cambodia for 2014. It provides a detailed picture of the economy by highlighting the mutual interdependence between the producers and consumers. It is also used to systematically quantify these interrelationships among the producers and consumers.*
- *An updated Social Accounting Matrix for Cambodia for 2014. It is a generalization of the IOT table for 2014 and captures the interdependence between producers, factors, consumers and institutions.*
- *Labour Force Survey 2012 produced by NIS. This is used to develop an Employment Satellite Matrix for 2014.*
- *Cambodia Socio Economic Survey (CSES) 2014 by NIS. This is used to prepare household income and consumption profiles for the SAM model which are linked with the poverty model to assess the poverty situation.*
- *Macro-economic framework for Cambodia (2009 to 2021) by Ministry of Finance and Economic Planning.*
- *A note on public sector investment provided by the UNDP project on Cassava. It provides detailed description of projects with aims and required funds and has as many as 33 budget lines.*
- *Ugandan SAM for 2016/17 which delineates the Cassava activity.*
- *Philippines SAM 2016/17 which delineate the Cassava activity.*
- *Myanmar SAM 2014 which incorporate Cassava as an activity.*

2.1.1. SAM and SAM Model

In a narrower sense, a SAM is a systematic data and classification system. As a data framework, it is a snapshot of a country at a point in time.[2] A particular innovation of the SAM approach is to bring together macroeconomic data (such as national accounts) and microeconomic data (such as household surveys) within a consistent framework. This aims to provide as comprehensive a picture of the structure of an economy as possible. A SAM is a generalization of production relations, and extends this information beyond the structure of production to include: i) the distribution of value-added to institutions generated by production activities; ii) the formation of household and institutional income; iii) the pattern of consumption, savings and investment; iv) government revenue collection and associated expenditures and transactions; and v) the role of the foreign sector in the formation of additional incomes for household and institutions. SAMs usually serve two basic purposes: a) as a comprehensive and consistent data system for descriptive analysis of the structure of the economy and b) as a basis for macroeconomic modeling[3].

The move from a SAM data framework to a SAM model[4] (also known as a multiplier framework) requires decomposing the SAM accounts as **'exogenous'** and **'endogenous'**.

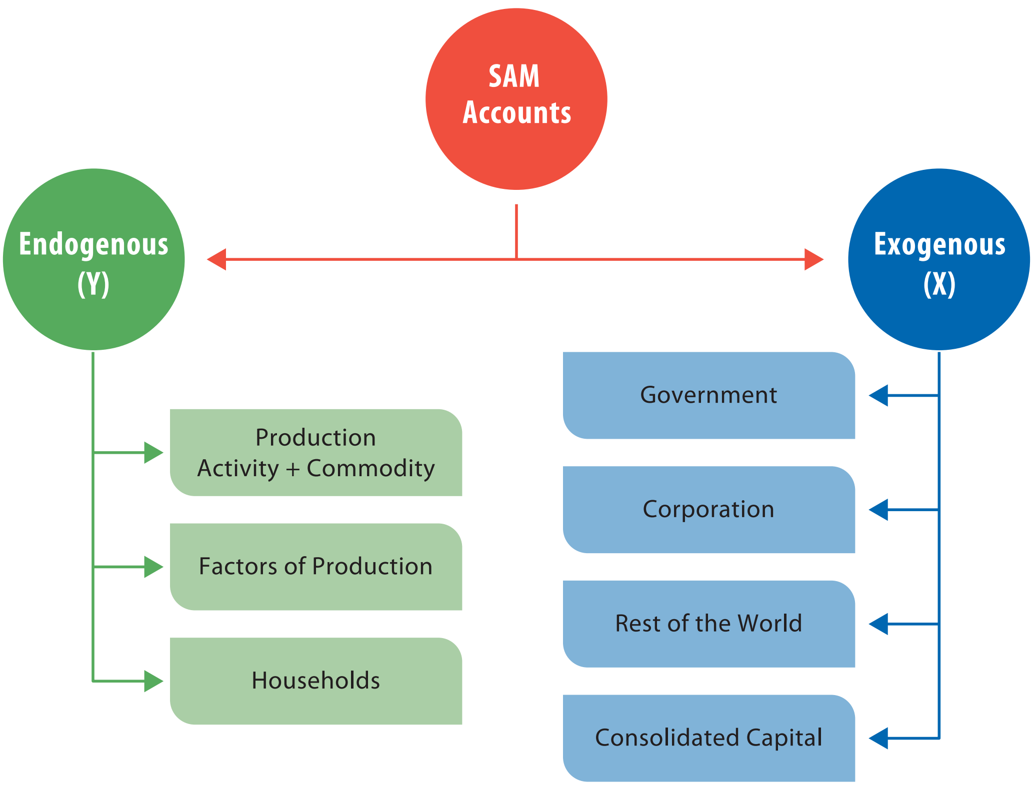
Exogenous Accounts: generally, accounts intended to be used as policy instruments are made exogenous. They usually include:

- *Government expenditure (including social protection)*
- *Investment*
- *Exports*
- *Foreign Remittances*

Endogenous Accounts: accounts specified as objectives or targets must be made endogenous. They are:

- *Gross Domestic output*
- *Commodity demand*
- *Factor return or GDP*
- *Household income or expenditure*

Chart 1: Separation of SAM Accounts



[2] *Pyatt G and Thorbecke E, Planning Techniques for a Better Future, Geneva, ILO, 1976.*

[3] *There are three widely used approaches to capture economy wide impacts: (i) fixed price multiplier model based on an input-output table or matrix ; (ii) fixed price multiplier model using a social accounting matrix– which is a super set of IOM encompassing activities, commodities, factors of production along with institution; and (iii) flex price computable general equilibrium model – invoking markets (e.g. product market and labour market etc.), behavioral specifications of all agents (e.g. producers and consumers etc.) and closure rules (e.g. defining how the accounts are balanced).*

[4] *Economic models specify a dependent (Y) [or endogenous] variable as function of an independent (X) [or exogenous] variable. This may be simbolised as: Y = f (X). Analogous to this specification, a SAM framework is converted into SAM model by specifying SAM accounts as endogenous and exogenous.*

For any given injection into the exogenous accounts of the SAM, influence is transmitted through the interdependent SAM system among the endogenous accounts. The interwoven nature of the system implies that the incomes of factors, households and production are all derived from exogenous injections into the economy via a multiplier process. The multiplier process is developed here on the assumption that when an endogenous income account receives an exogenous expenditure injection, it spends it in the same proportions as shown in the matrix of average propensities to spend (APS). The elements of an APS matrix are calculated by dividing each cell by the sum total of its corresponding column (please see Annex 2 for details on SAM based modeling).

Table 1: Description of the endogenous and exogenous accounts and multiplier effects

Endogenous (y)	Exogenous (x)
The activity (gross output multipliers), indicates the total effect on the sectoral gross output of a unit-income increase in a given account, i in the SAM, and is obtained via the association with the commodity production activity account i.	
The consumption commodity multipliers, which indicate the total effect on the sectoral commodity output of a unit-income increase in a given account i in the SAM, is obtained by adding the associated commodity elements in the matrix along the column for account i.	Intervention into activities (x = i + g + e), where i= GFC + ST (GFCF) Exports (e) Government Expenditure (g) *Investment Demand (i): Increased construction sector investment will be injected into the SAM model via capital account.* Inventory Demand (i)
The value-added, or GDP multiplier, giving the total increase in GDP resulting from the same unit-income injection, is derived by summing up the factor-payment elements along account i’s column.	
Household income multiplier shows the total effect on household and enterprise income, and is obtained by adding the elements for the household groups along the account i column.	Intervention via Households (x = r + gt), where Remittance (r) *Government Transfers (gt)*

The multiplier analysis using the SAM framework helps to understand further the linkages between different sectors and institutional agents at work within the economy. Accounting multipliers have been calculated according to the standard formula for accounting (impact) multipliers, as follows:

$$y = A\,y + x = (I - A)^{-1} x = M_a\, x$$

Where:

y is a vector of endogenous variables <u>*(68 accounts with non-zero values according to SAM 2014)*</u>

x is a vector of exogenous variables <u>*(which is also 68 accounts with lots of zero values suggesting that policy options are not large)*</u>

A is the matrix of average expenditure propensities for endogenous accounts, and

$M_a = (I - A)^{-1}$ is a matrix of aggregate accounting multipliers (the generalized Leontief inverse).

The present multiplier framework has four endogenous accounts, and hence for each account in the SAM we can calculate four types of multiplier measures due to changes in any one of the exogenous accounts.

The economy-wide impacts of the investment or export shocks have been examined by changing the total exogenous injection vector, especially rest of the world account. More specifically, the total exogenous account is manipulated to estimate their effects on output (through an output multiplier), value-added or GDP (through the GDP multiplier), and household income (through household income multiplier) and commodity demand (via commodity multipliers).

2.1.2. Dynamic Computable General Equilibrium Model

In addition to the fixed price demand driven SAM model, a dynamic computable general equilibrium (DCGE) model, based on the 2014 Cambodian SAM, has been used to estimate macro and sectoral implications of the Cassava investment discussed above. The reason for employing a DCGE model is that it is capable of capturing the growth effects of policy reforms. The inability of the static CGE model to account for growth effects make them inadequate for long-run analysis of the economic policies. They exclude accumulation effects and do not allow the study of transition path of an economy where short-run policy impacts are likely to be different from those of the long-run. To overcome this limitation, we use a sequential DCGE model. This kind of dynamics will not be the result of inter-temporal optimisation by economic agents. Instead, these agents have myopic behaviour. It is a series of static CGE models that are linked between periods by updating procedures for exogenous and endogenous variables. Capital stock is updated endogenously with a capital accumulation equation, whereas population (and total labour supply) is updated exogenously between periods. Other variables such as public expenditure, transfers, technological change or debt accumulation are also updated over time. The sequential DCGE model has two major modules: static module and dynamic module. It consists of the following five blocks.

Table 2: DCGE Blocks

Main Model Blocks	***Key Features***
1. **Production and Supply:** production arrangements through the use of factors of production (i.e. labour and capital) and intermediate inputs are specified here.	A nested structure for production has been adopted. Sectoral output is a Leontief function of value added and total intermediate consumption. Value added is in turn represented by a constant elasticity of substitution (CES) function of capital and composite labour. The latter is also represented by a CES function of two labour categories: skilled labour and unskilled labour. Both labour categories are assumed to be fully mobile in the model.
2. **Income and Expenditure:** income generation of various institutions (household and government) and their expenditure patterns are specified in this block.	Households earn their income from production factors – labour and capital. They also receive dividends, intra-household transfers, government transfers and remittances. Household demand is represented by a linear expenditure system (LES) derived from the maximisation of a Stone-Geary utility function. Minimal consumption levels are calibrated by using guess-estimates of the income elasticity and the Frisch parameters. Households also pay direct income tax to the government. Household savings are a fixed proportion of total disposal income. The government receives direct tax revenue from households and firms and indirect tax revenue on domestic and imported goods. Its expenditure is allocated between the consumption of goods and services (including public wages) and transfers.
3. **International Trade:** international trade with Rest of the World in the form of import from and export to is captured in this block.	Foreign and domestic goods are imperfect substitutes. This geographical differentiation is invoked by the standard Armington assumption with a CES function between imports and domestic goods. On the supply side, producers make an optimal distribution of their production between exports and domestic sales according to a constant elasticity of transformation (CET) function. Furthermore, a finitely elastic export demand function that expresses the limited power of local producers on the world market has also been assumed. In order to increase their exports, local producers may decrease their free on board (FOB) prices.

Main Model Blocks	Key Features
4. **Prices:** all types of prices including wages and returns to capital are defined in this block.	Prices are formed through the interaction of supply and demand. The nominal exchange rate is the numéraire in each period.
5. **Equilibrium Condition:** equilibrium conditions of the various markets; factors as well as institutions are specified here.	General equilibrium is defined by the equality (in each period) between supply and demand of goods and factors and the investment-saving identity.

STATIC TO DYNAMIC TRANSFORMATION

The DCGE model is formulated as a static model that is solved sequentially over a certain period of time horizon. The model is homogenous in prices and calibrated in a way to generate a 'steady state' path. At baseline, all the variables are increasing in level, at the same rate and the prices remain constant. The homogeneity test[5] generates the same shock on prices, and unchanged real values along the counterfactual path. This method is used to facilitate welfare and poverty analysis since all prices remain constant along the business as usual (BAU) path.

It is, however, important to note that, in contrast to the static CGE models, which make counterfactual analysis with respect to the base run (generally the initial SAM); a DCGE model allows the economy to grow even in the absence of a shock. This scenario of the economy (without a shock) is termed the BAU scenario. The counterfactual analysis of any simulation under the dynamic CGE model is, therefore, done with respect to this growth path. One of the salient features of the dynamic model is that it considers not only efficiency effects, as also present in static models, but also accumulation effects. Sectoral accumulation effects are linked to the ratio between the rate of return to the capital stock and the cost of investment goods.

KEY DRIVERS FOR THE DYNAMIC MODEL

Accumulation of Capital: In every period, capital stock is updated with a capital accumulation equation. It is assumed that stocks are measured at the beginning of the period and that their flows are measured at the end of the period. An investment demand function to determine how new investments will be distributed between the different sectors is also used. Investment here is not by origin (product) but rather by sector of destination. The investment demand function used here is similar to those proposed by Bourguignon et al. (1989), and Jung and Thorbecke (2003). The capital accumulation rate (ratio of investment to capital stock) is increasing with respect to the ratio of the rate of return to capital and its user cost. The latter is equal to the dual price of investment times the sum of the depreciation rate and the exogenous real interest rate. The elasticity of the accumulation rate with respect to the ratio of return to capital and its user cost is assumed to be equal to case specific values (i.e. it may be any number such as 1.5; 2 or 3). By introducing investment by destination, we respect the equality condition with total investment by origin in the SAM. Besides this, investment by destination is used to calibrate the sectoral capital stock in base run.

Endogenous Labour Supply: total labour supply is an endogenous variable, although it is assumed to simply increase at the exogenous population growth rate[6]. Note that the minimal level of consumption in the LES function also increases (as do other nominal variables, like transfers) at the same rate. The exogenous dynamic updating of the model includes nominal variables (that are indexed), government savings and the current account balance. The equilibrium between total savings and total investment is reached by means of an adjustment variable introduced in the investment demand function. Moreover, the government budget equilibrium is met by a neutral tax adjustment.

Descriptions of the static and dynamic modules of the model are presented in Annex 4.

[5] For example, a shock on the numéraire – the nominal exchange rate – with the "steady state" characteristics.

[6] *In static CGE model, labour supply is fixed and exogenous. But in a dynamic CGE model since the labour supply varies with population growth, it is made endogenous.*

2.1.3. Employment Satellite Matrix

An Employment satellite matrix (ESM) is developed for 2014 using the sectoral employment characteristics reported in the 2012 Labour Force Survey (LFS). LFS 2012 provides detailed information on employment by location (urban and rural), gender (male and female) and skill categories by LFS activity classifications. The activity classification adopted in LFS is more aggregated than the classification used in the national accounts and in SAM 2014, as LFS 2012 used 16 activities to record the employment situation while SAM 2014 adopted a 26 activity-classification to delineate economic structure and performances. A mapping scheme has been developed between the LFS 16 activity classification and 2014 SAM classification to assess employment impacts of simulations.

2.1.4. Poverty Model

A Poverty Model has been developed using the information from Cambodia Socio Economic Survey (CSES) 2014. Household income and consumption generated in the SAM model are linked with this model to assess the poverty situation.

2.1.5. Benefit-Cost Ratio

The benefit-cost ratio (BCR) compares the estimated present value of all benefits against the present value of all costs to assess feasibility of a project from both financial and economic perspectives. A project is feasible if the BCR is greater than one. Thus, BCR requires present value of all cost and benefits to be discounted using a discount rate. Project feasibility criterion is shown below.

BCR = (Present value of benefits) / (Present value of costs); Project viable if BCR > 1

BOX 2: LIMITATIONS OF THE STUDY

- *One key limitation of the study is to rely on dated (i.e. 2014) data to construct the Cassava inclusive SAM due to non-availability of data for a recent year such as 2017 or 2018. Moreover, technology vectors of primary and processed Cassava have been based on the observed technologies from other comparable countries. Furthermore, due to data limitations, processed Cassava activity has been represented as one activity – whereas it would have been appropriate to include more than one processed Cassava activity in the SAM for better representation on the Cassava value chain and their associated outcomes in the simulation exercise.*
- *Construction of SAM for 2014 incorporating some key agricultural sectors such as livestock, forestry, cassava in addition to crop agriculture is a huge improvement over SAM 2011 with regards to national accounts, supply and use tables, and macro-economic framework. Still some important shortcomings include use of aged production accounts (i.e. limited numbers of activities and commodities according to national accounts of NIS) and dated production technologies for most the representative activities. Due to non-availability of data of emerging sectors such as ICT, e-commerce, banking, various types of transport services, and tourism etc. could not be included to represent the production accounts of the SAM 2014. As a result, structural change (that may have already taken place in Cambodia) of the Cambodian economy could not be satisfactorily reflected in the SAM 2014. Similarly, like many economies, the Cambodian economy must have also experienced changes in technology structures. Again, due to non-availability of relevant data, production technology structures could not be updated in the SAM 2014. Omission of key emerging sectors and use of dated technology data may have implications on the outcomes of this exercise.*
- *Some issues such as finding the impact of modernization of Cassava and Cassava related disease control are better studied using micro-economic methodologies and hence not included in the scope of this study.*
- *Being a demand driven multiplier model, the SAM model has some limitations. One aspect is that it would always ensure supply when there is a demand injection – suggesting that there are no supply side constraints in the economy. SAM model simulations assume no effects on prices which remain one throughout and thus, all impacts are on quantity. There is no in-built resource allocation featured in the SAM model. However, the DCGE model is more flexible and hence use of the DCGE model addresses some of the limitation of the SAM multiplier model.*
- *Finally, the current study does not include an environmental impact assessment of Cassava investment as it is beyond the scope of the study. However, this is an important aspect not only for Cassava but also for other activities. It may be argued that all activities may be associated with negative externalities albeit to varying extents. Following UN STAT (UN, 1993) recommendations, an 'Environment' satellite matrix (ESAM) may be constructed for all major activities in Cambodia to assess the environmental and natural resource degradation impacts associated with output expansion. This may also be an important tool to assess 'sustainable' development.*

03 REVIEW OF THE CASSAVA SECTOR IN CAMBODIA

3.1. ORIGIN AND CURRENT SITUATION

While cassava came to South East Asia somewhere between the 16th and 17th centuries, until the last few decades, it was mostly grown in Cambodia for domestic purposes. Households produced Cassava for personal consumption. In the last 20 years however, cassava has developed from being produced primarily for household consumption to a commercial crop. Due to increased demand from Thailand and Vietnam, cassava is now grown in farms in Cambodia, with production skyrocketing in the last few years. Cassava is now the second largest agricultural crop in Cambodia[7], and is estimated to contribute between 2-3% of the country's GDP.

Over the last 10 years, approximately US$300 million has been invested by the RGC each year to grow cassava over a planting area of 0.5 million ha.[8] More than 90,000 rural households in 13 provinces have been involved in cassava farming, thus creating many seasonal jobs for local labourers.[9]

Table 3: Performance of major agricultural crop

	2012			2018			Annual average growth rate (%)		
	Production (ton)	Cultivated Area (ha)	Yield (ton/ha)	Production (ton)	Cultivated Area (ha)	Yield (ton/ha)	Production	Area	Yield
Rice	9,290,940	2,980,297	3.1	10,891,735	3,248,061	3.4	2.9	1.5	1.4
Maize	950,909	215,442	4.4	1,303,751	227,978	5.7	6.2	1.0	5.0
Cassava	7,613,697	337,800	22.5	13,750,076	650,510	21.1	13.4	15.4	-1.0
Vegetables	411,435	54,155	7.6	639,513	56,228	11.4	9.2	0.6	8.3
Soybean	120,165	70,972	1.7	91,766	45,754	2.0	-3.9	-5.9	3.0
Sugarcane	1,220,255	36,722	33.2	691,907	20,015	34.6	-7.2	-7.6	0.7

Source: World Bank (2015) and Ministry of Agriculture.

In some rural areas of Cambodia, cassava plays significant roles in households' food consumption, providing employment, and generating income, as well as reducing the need to work as migrant labour. Cassava plays a vital role in improving the family economic income of farmers. Investing in Cassava can promote local production growth, job creation, and contribute to poverty alleviation.

In Cambodia, cassava farms are limited to sandy upland areas, close to the alluvial plains.[10] Most cassava is grown close to the Thai border in Battambang, Pailin and Banteay Meanchey, and close to the Vietnamese border in Kampong Cham and Kratie. As a result, the main cassava farms are much closer to the Thai ports than Sihanoukville ports.

Cambodia's cassava exports are dominated by fresh tubers and dried chips. While fresh tubers are mostly imported by Viet Nam, dried chips are primarily exported to Thailand, Viet Nam and China, with the first two re-exporting some of the chips they buy from Cambodia to China.[11] The total value of cassava exports in 2016 was estimated at approximately $550 million.

7 *UNDP 2017, Cassava's Cassava Market Export Strategy.*

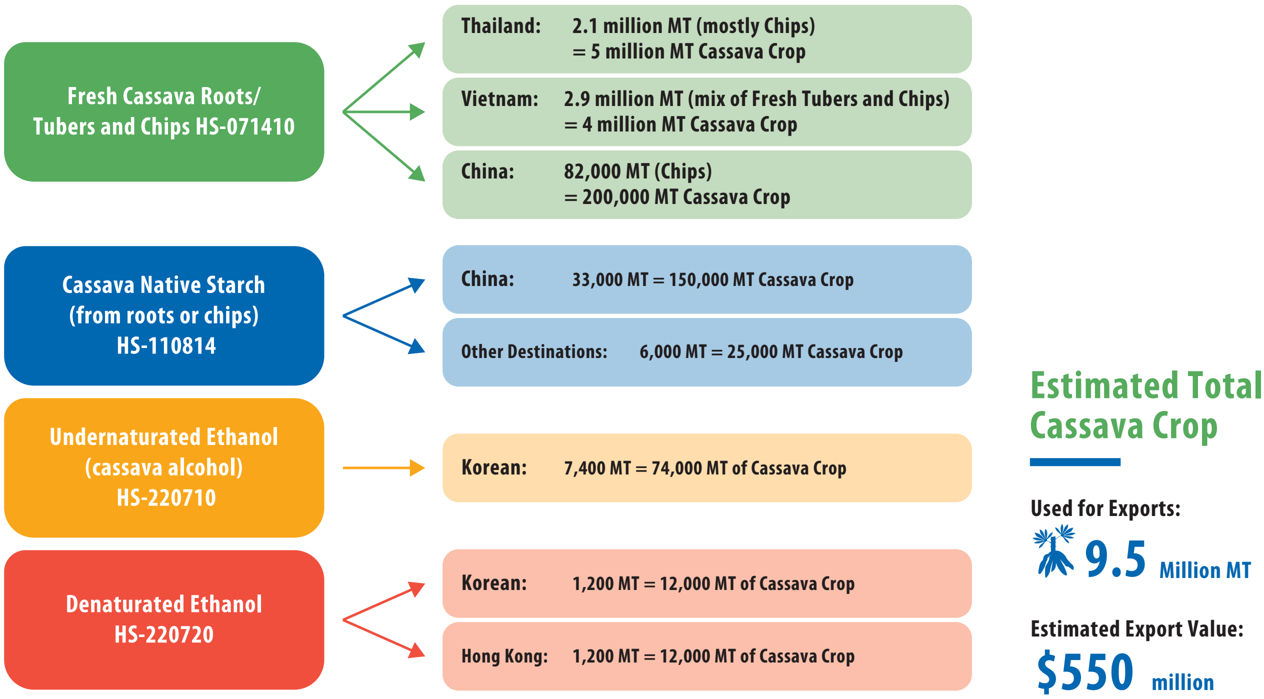
8 *Cassava Industry Analysis Report (2017), ASCS-Radius for its client, Green Leader Co. Ltd.*

9 *Building Sustainable Cassava Production for Export of Processed products to Market, 2018.*

10 *Commoditia, "A Study of the Value Chains for Cassava in Cambodia", 2016.*

11 *UNDP 2017, Cassava's Cassava Market Export Strategy.*

2016 Estimated Cambodia Cassava Export: Derivatives and Destinations (Qualities Based on Trade Map Data)



3.2. PROSPECT OF HIGHER VALUE-ADDED CASSAVA IN CAMBODIA

This section is based on studies and reports prepared to assess the prospects of the cassava sector in Cambodia as well as highlight the current interest in moving from exporting raw cassava to higher value cassava products[12]. It has been argued that, due to increasing demand in Asia for dried cassava and starch for livestock feed, and industrial application in Africa for food products, cassava production has increased around 100 million tons every year since 2000. The current world average yield of cassava is about 12.8 tons per hectare, so there is great potential for further production increase to attain a yield of 80 tons/ha under optimal conditions.[13]

The following table discusses the opportunities to enhance cassava value chain based on the underlying strengths of cassava production in Cambodia.

Table 4: Cassava sector in Cambodia: strengths and opportunities

Strengths	*Opportunities*
• Cassava is adaptable to diverse climates and soil varieties-offering potential income source to farmers on marginal land. • Cambodia has some of the highest yields for cassava roots in the world-average 22 MT/ha. • Cassava can be grown as a single crop or inter cropped-offering an additional income source. • Rising prices have encouraged increased planting and improved returns to farmers. • Cassava offers farmers the flexibility of time to harvest with suitable market conditions. • Cassava is a very easy plant to grow and requires very little labour input. • Cassava has many uses and is widely used in the global food, animal feed, bio-fuel, and semi-industrial sectors.	• Cassava farming can provide higher returns than other crops and produce significant welfare enhancing benefits. • Cambodian farmers tend to plant only one yearly crop. Other countries plant as many as three crops per year. • Mechanization of on-farm cassava chipping would significantly lower seasonal Labour costs, reduce wastage from perished stock and improve farmer's' margins. • Development of local processing capacity near main production areas would increase competition for cassava crop and improve farm-gate prices. • Increase in local processing capacity would significantly boost Cassava sector's overall prospects and parallelly support the agro-processing sector.

[12] *Srey, Sinath "The Need Assessment of Cassava Production, Processing, and Marketing in Cambodia", 2014*

[13] *Ibid*

Strengths	Opportunities
• Substitution of cassava for corn in the Chinese bio-fuel industry has opened up a new market offering attractive returns for dried cassava. • The cassava sector in Cambodia is increasingly attracting FDI from South Korea and China to establish large commercial plantations and dedicated processing facilities (for bio-fuels). • Cambodia's cassava exports enjoy tariff preference advantages in ASEAN, EU, and China.	• Scope to diversify export destinations of semi-processed cassava to other Asian markets-especially China, Korea, Indonesia and Malaysia. • The Cambodia-China Memorandum of Under-standing offers an important platform to facilitate technical exchanges and exports of up to million MT of dried cassava per year. • Recently there has been an agreement between Thailand and Cambodia to establish special trade zones for cassava and corn.

Source: MoC, 2013[14]

In Cambodia, there are high prospects for cassava production in the future. Given that the demand of cassava roots has been rapidly rising both locally and internationally, this is a very good opportunity for smallholder famers to produce more cassava.[15] From 2019 to 2023, the RGC's target is to successfully export 0.5 million metric tons of cassava starch (native and modified) to diverse markets, and 1,000 metric tons of high premium cassava products (organic starch and flour) for niche markets.[16] The RGC also plans to promote the use of cassava by-products and residues for animal feed and fertilizers as cheap inputs for Cambodian farmers.

Furthermore, the following table describes the cassava main derivatives based on 2017 data. Among others it reveals some attempts in Cambodia to move to higher value chains. Analysis further suggests that output at the higher value-added stages (i.e. animal feed, starch, and biofuel ethanol) are still low and require strategic interventions by public sector to attract private investment to realize the potential.

Table 5: Cambodia's Cassava Main Derivatives Producers 2017

Producers	Location (Province)	Nominal Annual Production Capacity	Months Operating	Actual 2017 Production
Fresh Tubers and Chips				
Fresh tubers are produced by hundreds of thousands of farmers. Small local traders buy these fresh tubers or dried chips from farmers and local processors and, in turn, sell them to larger consolidators/traders that process fresh tubers and store dried chips. They then sell these chips to large Cambodia-based producers of starch or animal feed and/or export tubers and chips to Viet Nam, Thailand, and China. There are between 50 and 60 large dried-chip silos with an annual storing capacity of approximately 40,000 MT each in the Battambang/Pailin area (equivalent to about 5 million MT in fresh tubers). Because most of the exports to Viet Nam are fresh tubers, the number of large dried-chips silos in the Kampong Cham/Kratie area is likely to be far smaller than the Battambang/Pailin area. Fresh cassava production in 2017 was estimated at 12 million to 13 million MT.				
Native Starch				
BAI (Khmer)	Battambang	40,000 MT 300 MT/day	6/7 months	Approximately 40,000MT (70% export market)
Hunan ER-Kang (China)	Battambang	30,000 MT 150 MT/day	6/7 months	10,000 MT
HLH Agriculture (Singapore)	Kampong Speu	30,000 MT 120MT/day	9 months	25,000 MT (70% export market)
Sing Song (Korea)	Kratie	35,000 MT 240 MT/day	6/7 months 9 months target	New construction. At testing stage.
TTY (China)	Kampong Cham	30,000 MT 200/250 MT/day	6/7 months	20,000-25,000 MT (80% export market)

14 *MoC, Cambodia Trade Integration Strategy 2013-2018 and Trade SWAp Road Map 2013-2018, 2013*

15 *Srey, Sinath "The Need Assessment of Cassava Production, Processing, and Marketing in Cambodia", 2014*

16 *Ibid.*

Producers	Location (Province)	Nominal Annual Production Capacity	Months Operating	Actual 2017 Production
Green Leader (HK)	Pursat Tbong Khmum	2 plants @ 100,000MT native starch per plant. First plant to open March 2019	9 months	Current investment: 2 plants. Each plant to consume 500,000MT of tubers and to produce 100,000MT native starch and 30,000MT modified starch. Also, 100,000MT of biomass pellet and 50,000MT of feed
Quite likely a few smaller plants (e.g. annual capacity below 20,000 MT.). Current nominal export supply capacity is approximately 135,000/150,000MT to rise to 180,000/200,000 MT once Sing Song is operational. Much larger once Green Leader is operational. Commoditia's 2016 Report estimates *domestic consumption of starch at between 60,000 and 80,000 MT per year?* originating mostly from small plants and some of the production from larger plants.				
Thai Meng	Battambang	15,000 MT 80 MT/day	6/7 months	8,000
Seang Phong	Kampong Cham	20,000 MT 100 MT/day	6/7 months	Not producing in 2016
Sun Ath	Kampong Cham	20,000 MT 100 MT/day	6/7 months	Not producing in 2016
Kim Heng	Kampong Cham	15,000 MT 80 MT/day	6/7 months	8,000
Ly Hong Leng	Tbong Khmum	15,000 MT 80 MT/day	6/7 months	8,000
Specialty Starch: Organic Native Starch				
AMRU	Kampong Chhnang	2020 target: 50,000 MT of organic tubers. Initially, organic tubers will be processed to organic starch in Thailand		Production to be based on output from 1500ha by contract farmers in Social Land Concessions (SLC). At trial stage. To meet USDA and EU Organic standards. Component in gluten-free and organic processed foods
Specialty Starch: Modified Starch				
Sing Song (Korea)	Kratie	18,000 MT 120 MT/day	6/7 months but to target 9 months	Planned as part of new starch factory. Target markets: Japan and Korea
Green Leader (HK)	Pursat Tbong Khmum	2 plants @ 30,000MT	9 months	See above. Within the 2 planned starch plants
Starch Residues				
There is no evidence of a structured sector for starch residues yet, partly because the production of starch remains limited. For now, starch producers seem to focus on using residues as an energy source to produce electricity to run plants and generate heat to dry starch. In the future, Green Leader plants in Pursat. Tbong Khmum will have capacity to process residues.				
Biofuel – Ethanol				
MH-BioEnergy Ethanol/ Seo Won Distribu-tion Co., Ltd. (Korea)	Kandal	60,000 MT		Approximately 10,000MT in 2016
IDEMITSU (Japan)		May build an ethanol plant. Trial phase working with contract farmers to produce tubers to assess reliability of supply.		
Green Leader (HK)		Might look into building new ethanol producing plant		
Undenatured Ethyl Alcohol				
Not researched				

Producers	Location (Province)	Nominal Annual Production Capacity	Months Operating	Actual 2017 Production
Animal Feed				
CP (Thailand)	Kandal and Pailin	360,000 MT/year 100/150 MT/day in Kandal 180,000 MT/year 80 MT/day in Pailin	12 months	Approximately 500,000 MT year. All domestic sales: 70% for Charoen Pokphand Co.Ltd (CP) own pig and chicken farms; balance to other Cambodian producers
CJ (Korea)	Kampong Speu	100,000 MT/year 8,000 MT/month	12 months	Current production about 50,000 MT/year. Planning a pig farm in Cambodia. Some limited export of finished product to Vietnamese markets.
Betagro (Thailand)	Kandal (PP Special Economic Zone)	120,000 MT/year 10,000 MT/month	12 months	Consumes 35% of production for its own chicken and pig farms in Cambodia; balance sold to other Cambodian producers
Green Feed				Unable to secure interview – no information available.
Possibly 2 other small plants				

Source: UNDP 2017, Cassava's Cassava Market Export Strategy

It must be noted that in dealing with derivatives destined for animal and human consumption, Cambodia must meet the same SPS regulations and requirements as those applying to any other exporting country for the same derivatives in the same market.

"A report prepared by an SPS expert for UNDP-Cambodia in December 2017 observes that[17]:

1. Very few (if any) processors in the sector are certified for GMP, HACCP, or GHP.
2. The use of GAP-compliant farming methods is extremely limited, although countries that have implemented those in cassava production have been able to improve land productivity and better control the spread of plant diseases. The Ministry of Agriculture, Forestry and Fisheries (MAFF) is attempting to introduce GAP-compliant farming methods in the country, but thus far, it has been mostly NGOs that have introduced such schemes in limited areas.
3. RGC's monitoring and surveillance capacity at the farm level is very weak. Cambodia lacks the ability to control risks associated with plant diseases (a significant number of seedlings come from Viet Nam or Thailand) and the capacity for surveillance of risks associated with sale of herbicides, pesticides, and chemical fertilizers (including dangerous or banned products.)

3.3. ROLE OF PUBLIC INVESTMENT

Prospects of the Cassava sector in terms of enhancing production; export root and chip; and move to higher stages in Cassava value chain appear bright. However, a critical pre-requisite to realize these potentials is public sector support through allocating funds as well as implementing key public sector projects. UNDP's cassava project provides a detailed breakdown of public sector investment requirements by 33 budget items. The public investment needed has been estimated at $ 296 million to be implemented over a 5-year period (i.e. 2019-2023).

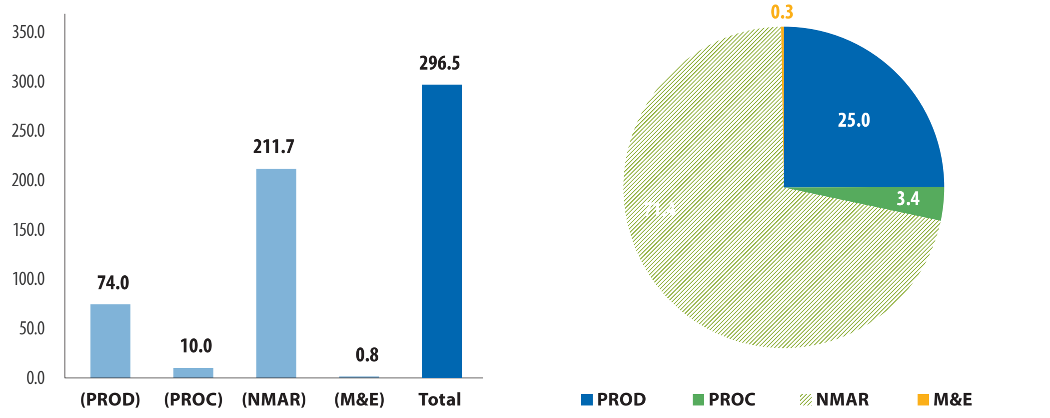
For a better understanding of the investment requirements, the 33- line items have been mapped into two broad categories: (i) activity category; and (ii) functional category.

The distribution of public investment by four activity categories, namely – 1. Cassava production (PROD); 2. Cassava processing (PROC); 3. Cassava export market diversification (NMAR); and 4. Implementing and monitoring (M&E) – has been shown in the figure below. The major emphasis is on exploring new markets and supporting enhanced production.

[17] *UNDP, Cassava SPS Technical Report, December 2018*

Figure 1: Distribution of public investment by activity category

Panel A: Public Investment (Million $) *Panel B: Public Investment (%)*

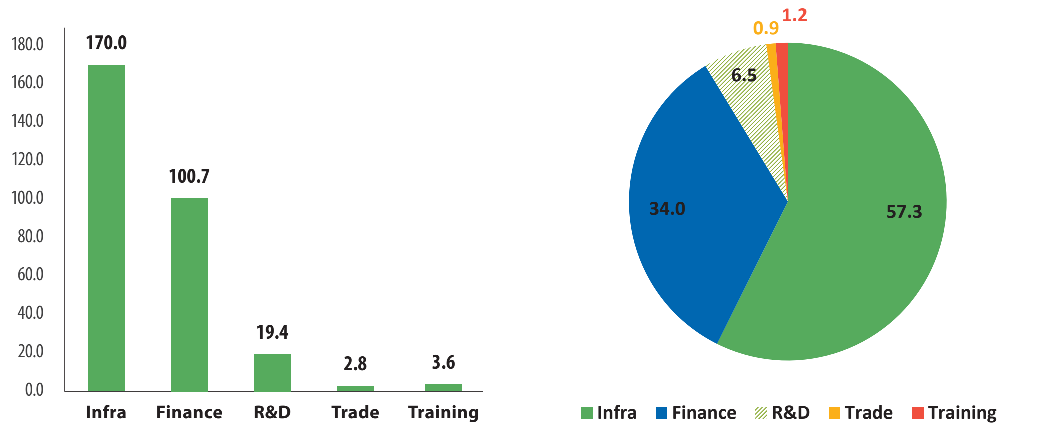


Source: Note on Public Investment

The distribution of public investment by five categories, namely – 1. Infrastructure development (Infra); 2. Financing (Finance); 3. Research and development (R&D); 4. Trade facilitation (Trade); and 5. Training and capacity building (Training); – has been shown in figure below. The main emphasis is on infrastructure development and ensuring credit.

Figure 2: Distribution of public investment by activity category

Panel A: Public Investment (Million $) *Panel B: Public Investment (%)*



Source: Note on public investment

04 AN UPDATED SAM FOR CAMBODIA

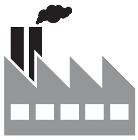
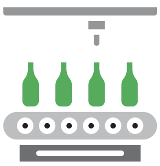
The latest social accounting matrix (SAM) available for Cambodia is for 2011. It is composed of 21 activities; 27 commodities; four factors of production; and three current institutions – such as government, households, and rest of the world. Household, which is a key institution representing 80 percent of the institutional account, is represented by 20 households classified regions. One of the main shortcomings of the 2011 SAM is the lack of representation of agricultural activity. Agriculture activity, which accounts for more than 30 percent of the GDP, has been represented by two highly aggregated activities– (i) Agriculture, Hunting, Forestry, and Related Service Activities; and (ii) Fishing, Aquaculture, and Service Activities Incidental to Fishing. There is no separate representation of livestock and poultry, whose technology structure is quite different than crop or fisheries activities. Moreover, in the context of the current study to measure economic return of cassava investment, cassava activity is contained within the crop agriculture classification. Thus, it has been agreed to update 2011 SAM to represent following features:

1. The base year for updating SAM has been chosen as 2014 since most of the data needed for the updating exercise such as the production account, factor account and the institution account (including CSES 2014) were available for the year 2014.
2. Better representation of agriculture activity with five agriculture activities – namely crop agriculture; cassava; livestock and poultry; forestry and fisheries.
3. Household accounts include a revised classification based on location, landownership, and education level of the head of the household head.

4.1. SAM ACCOUNTS

The SAM 2014 identifies the economic relations through *four types of account:* (i) production activity for 26 activities and commodity accounts or 31 products and services; (ii) 4 factors of production with 3 different types of labour and1 type of capital (including land); (iii) current account transactions among the 3 main institutional agents; household-members and unincorporated capital, government, and rest of the world; and (iv) one consolidated capital account capturing the flows of savings and investment. The disaggregation of activities, commodities, factors and institutions in the SAM is given below.

Table 6: Description of Cambodia SAM 2014

SAM Accounts	Detailed sector classification
Activities (26)	
	Crop agriculture; Cassava; Livestock; Forestry; Fishing, Aquaculture, and Service Activities Incidental to Fishing (05)
	Mining and Quarrying; Manufacture of Food Products, Beverages, and Tobacco; Manufacture of Textiles, Wearing Apparel, and Footwear; Manufacturing of Wood, Wood Products, Paper, and Paper Products; Manufacture of Rubber and Plastic Products; Manufacture of Basic Metals; Manufacture of Fabricated Metal Products; and Office and Computing Machinery; Manufacture of Motor Vehicles and Other Transport Equipment; Other Manufacturing; Electricity, Gas, and Water Supply; and Construction (11)
	Wholesale, Retail Trade; Hotels and Restaurants; Transportation services; Post and Telecommunications; Financial Intermediation and Insurance; Real Estate, Renting, and Business Services; Public Administration and Defense; Education; Health and Social Work; and Other Community Service Activities (10)
Commodities (31)	
	Crop agriculture Products; Cassava Products; Livestock and poultry Products; Forestry, and Logging Products; and Fish and Other Fishing Products (05)
	Coal and Lignite; Peat, Crude Petroleum, and Natural Gas; Other Minerals, not elsewhere classified (N.E.C.); Food, Beverages, and Tobacco; Clothing and Wearing Apparel; and Leather and Leather Products; Products of Wood, Paper, and Paper Products; Basic Chemicals and Other Chemicals; Rubber and Plastics Products; Furniture and Other Transportable Goods, N.E.C.; Basic Metals; Fabricated Metal Products, Except Machinery and Equipment; General and Special Purpose Machinery; Office, Accounting, and Computing Machinery; Transport Equipment; Other Manufacturing; Electricity, Gas, and Water; and Construction Services (16)
	Wholesale & Retail Trade; Lodging, Food, & Beverage Serving; Transportation services; Postal, & Courier & Telecommunications services; Financial Intermediation, Insurance, & Auxiliary Services; Real Estate, Leasing services, & Other Business services; Public Administration & Compulsory Social Security services; Education services; Health and Social Services; & Other Services, N.E.C. (10)
Factors of Production (04)	
	Labour factor (03): Low Skilled; Medium Skilled; and (iii) High Skilled
	Capital factor
Institutions (04)	
	Household
	Government
	Rest of the World
	Savings or Gross fixed capital (consolidated capital)

Source: SAM 2014

The updating/construction of the SAM proceeded in two steps. ***First***, a 'proto-SAM' was constructed |using the data collected from diverse sources. Since the data came from different sources as well as for different years, in line with the expectation, the estimated 'proto-SAM' is unbalanced. In ***the second step***, the SAM is balanced by adjusting the activity and commodity (i.e. private consumption, intermediate demand vectors) accounts as explained below.

Updating a SAM is not only an exercise in putting together a complete data set, but also an estimation process on the basis of insufficient and partly inconsistent data. In this current exercise, the first step to generate a consistent and balanced SAM is to build a macroeconomic SAM (i.e. the Macro SAM). The main objective of the Macro SAM is to summarize and show the circular flow in the economy in general and inter-dependence between commodity, activity, consumption, and flow-of-fund accounts without sectoral or institutional details. Thus, in the second step a preliminary disaggregated SAM (which is also referred to as the Micro SAM) is constructed using available disaggregated information drawn from various data producing agencies. Subject to data availability, the disaggregated SAM segregates most of the Macro SAM accounts to desired sectoral and institutional breakdowns. While ensuring balance between the receipts and outlays for all accounts, the disaggregated or micro SAM must reproduce the control totals of the macro SAM. The correspondence between accounts of the aggregated micro and macro SAM thus ensure its desired consistency with national accounts data.

Overview of the Cambodia SAM for 2014

The complete Macro SAM for 2014 containing national accounts and other data including transfers, taxes and foreign transactions is shown in Table 7. The Cambodia macro SAM is anchored primarily to the production accounts 2014 or Input-Output Table 2014, National Accounts data and their macro aggregates. Savings of households and enterprises have been adjusted to fulfil the macroeconomic balance of the SAM. Government savings are computed as the difference between total government receipts and total government spending.

Table 7: Cambodian Macro SAM 2014

(Million $)

SAM Accounts	SNA Accounts	Code		ACT	COM	Factors				Domestic Institutions		Capital		RoW	Total Income
				1	2	3				4	5			6	
						Labour	*Capital*	*Indirect Tax*	*M duty*	*House-hold*	*Govern-ment*	*Capital*	*Inven-tory*		
Activity A/C	**Activities**	1		0	30,983										30,983
Production A/C	**Commodities**	2		15,233						14,559	867	3,246	150	11,218	45,263
Distribution of Primary Income	**Income Generation by Institutions**	3	**Compensation To Employees**	7,101											7,101
			Operating Surplus	8,659											8,659
			Indirect Tax		1,342										1,342
			Import Duty		442										442
Use of Income	**Primary Income of Institutions**	4	**Household**			7,101	8,659				285			593	16,637
			Government					1,342	442	488					2,272
Consolidated Capital AC	**Capital Account**	5	**Capital**							1,591	1,121			685	3,396
			Inventory									150			150
Rest of World	**Rest of the World-Imports (current)**	6			12,496										12,496
Total Expenditure A/C				30,983	45,263	7,101	8,659	1,342	442	16,638	2,272	3,396	150	12,496	

Note: Based on the SNA-SAM Relationship

Production Accounts

The SAM 2014 identifies production relations through **three accounts**: (1) total supply of 26 activities and demand for 26 activities; (2) total supply of 31 commodities and demand for 31 commodities; (3) 4 factors of productions-3 labour types and 1 capital category.

The construction/updating of 2014 production account is based on several data sets drawn from diverse sources. They are listed below.

- Activity wise value-added data for 2014 supplied by the National Institute of Statistics (NIS)
- Export of commodities by 4-digit level, ITC comtrade and Ministry of Commerce
- Import of commodities by 4-Digit level, ITC comtrade and Ministry of Commerce
- General government consumption expenditure at 2014 prices
- Final consumption expenditure at 2014 prices, NIS
- Gross fixed capital formation in Cambodia, at current prices, NIS
- Tax data supplied by directorate general of taxes
- Macro-economic framework for Cambodia (2009 to 2021)

The construction/updating procedure proceeded in two steps. First, a 'proto-production account' has been constructed using data collected from diverse sources. Since the data came from different sources as well as for different years, in line with the expectation, the estimated 'proto-production accounts' are unbalanced. Second, the production accounts are balanced by adjusting the activity and commodity (i.e. private consumption, and intermediate demand and input use vectors) accounts as explained below.

More specifically, in this current exercise, the first step to generate a consistent and balanced production account is to build a macroeconomic production account (i.e. Macro PA). The main objective of the Macro PA is to summarize and show the circular flow in the economy in general and inter-dependence between commodities and activities in particular. Thus, in the second step, preliminary disaggregated production accounts are constructed using available disaggregated information drawn from various data producing agencies. Subject to data availability, the disaggregated production accounts segregate most of the Macro PA accounts to desired sectoral (i.e. activity and commodity) breakdowns. While ensuring balance between the demand and supply for all accounts, the disaggregated production accounts must reproduce the control totals of the Macro PA. The correspondence between the aggregated production accounts and the Macro PA thus ensure its desired consistency with the national account data.

Overview of the Cambodia Macro PA for 2014

The Cambodia Macro PA is anchored primarily to the National Accounts data and other macro aggregates provided by the NIS. The table below shows the macro totals for the Cambodian economy based on information obtained from the above sources.

Table 8: Macro aggregates for 2014

(Million $)

Components	NA 2014	Adjusted Values	NA 2014 Share (%)	Adjusted share (%)
1. Consumption (C)	19,144	15,426	121	98
Private	18,277	14,559	116	92
Public	867	867	6	6
2. Investment (I)	3,396	3,396	22	22
GFCF	3,246	3,246	21	21
Stock changes	150	150	1	1
3. Exports of goods and services (E)	11,218	11,218	71	71
Total demand (C + I + E)	**33,758**	**30,040**		
4. GDP at factor cost/prices (Y)	15760	15760		
5. Net Taxes (T)	1,784	1784		
6. Imports of goods and services (M)	12,496	12,496		
Total Supply (Y + T + M)	**30,040**	**30,040**		
Discrepancy	**-3,718**	**0**		
As % of GDP	**-23.6**	**0**		

The compilation of macro aggregates for 2014 reveals a computational discrepancy of \$ 3,718 million (i.e. 23.6 % of GDP at producer's price) between supply and final use. This is a huge discrepancy since SAM is a deterministic framework, and it must equate supply to demand (or use). In order to remove this discrepancy, following three adjustments have been made:

- The observed discrepancy of \$ 3,718 million has been absorbed in the private consumption as it seems unrealistically large (i.e. private consumption is 121% of 2014 GDP at producer's price) and this is the largest component of the final demand vector.
- Due to this adjustment, private consumption as a proportion of GDP decreased to 98 percent of GDP or by 19 percent of its original NA value (i.e. \$ 18,277 million).

The complete Macro PA for 2014 containing national accounts and other data is shown in Table 9. The table also contains a national accounts matrix which reveals discrepancy of 23.6 percent of GDP (or \$ 3,718 million) between supply and final use.

Table 9: National Account Matrix and Macro Accounts, 2014

(Million \$)

Components	***MACRO STRUCTURE (BALANCED)***							
		CP	***CG***	***Exports***	***GFC***	***Stock change***	***Total use***	***Difference***
Intermediate flows	15,223	14,559	867	11,218	3,246	150	45,263	0
GDP at producer's price	15760							
Gross output	30,983							
Net tax	1784							
Imports	12,496							
Total Supply	45,263							
	NATIONAL ACCOUNT MATRIX (UNBALANCED)							
		CP	***CG***	***Exports***	***GFC***	***Stock change***	***Total use***	***Difference***
Intermediate flows	0	18,277	867	11,218	3,246	150	33,758	3,718
GDP at producer's price	15760							
Gross output	15,760							
Net tax	1784							
Imports	12496							
Total Supply	30,040							
	DIFFERENCE: MACRO AND NA MATRIX							
		CP	***CG***	***Exports***	***GFC***	***Stock change***	***Total use***	***Difference***
Intermediate flows	15,223	-3,718	0	0	0	0	11,505	3,718
GDP at producer's price	0							
Gross output	15,223							
Net tax	0							
Imports	0							
Total Supply	15,223							

Source: Author's compilation based on National Accounts Data

4.2. DERIVATION OF MICRO-SAM 2014

Once a balanced macro SAM for 2014 for Cambodia has been derived, the next step involved production of the disaggregated micro SAM for 2014. Derivation of a macro SAM for 2014 has been discussed above. Thus, in the second step, preliminary disaggregated production accounts are constructed using available disaggregated information drawn from various data producing agencies (discussed above). Disaggregated information for 26 activities and 31 commodities have been generated for 2014. More specifically, data on all elements of supply and use (or demand) components of the production account have been generated. In the next step, data on all components of the factor accounts and institutional accounts have been generated to complete the data requirements for the micro SAM. Sectoral values of production accounts; factor accounts and institutional accounts are then put together in the SAM matrix format to produce the micro SAM for 2014.

05 KEY FEATURES OF SAM 2014 AND ESAM

5.1. PRODUCTION STRUCTURE – SAM 2014

Production structure of Cambodia's SAM for 2014 are provided in table below. Structures are divided into three broad categories and activity classification has been adopted in SAM 2014.

Table 10: Production Structure - Cambodian SAM 2014

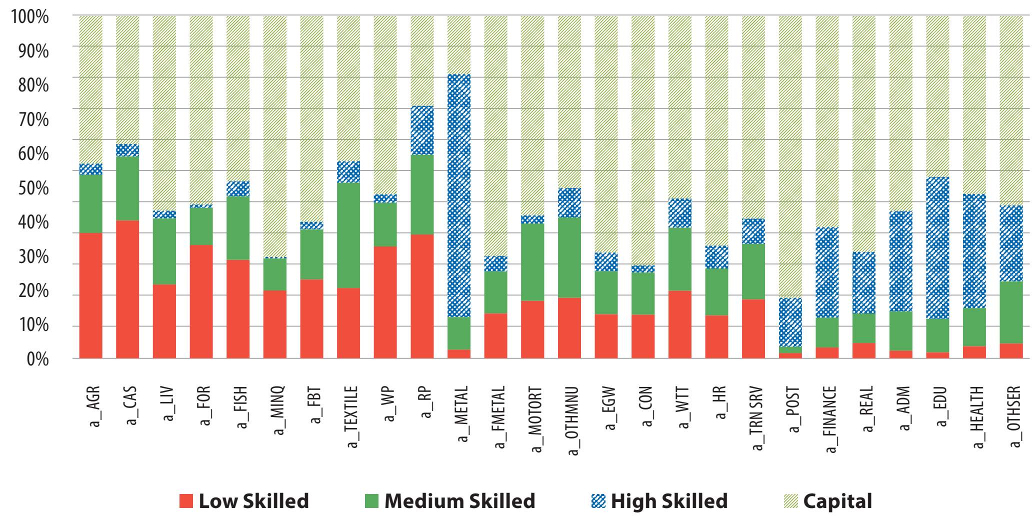
Activity Classification	*Gross Output*	*Input Use*	*GDP/Value added*
Broad Activity Classification (Share in total)	100.00	100.00	100.00
Agriculture	**24.17**	**17.39**	**30.65**
Industry	**39.41**	**52.17**	**27.19**
Services	**36.42**	**30.44**	**42.16**
SAM Activity Classification (share in total)	100.00	100.00	100.00
Crop Agriculture	11.29	6.69	15.70
Cassava	1.63	0.71	2.52
Livestock and poultry	3.13	2.78	3.47
Forestry	1.44	0.69	2.16
Fish and Other Fishing Activity	6.67	6.52	6.82
Coal and Lignite; Peat, Crude Petroleum, and Natural Gas	0.97	0.71	1.22
Food, Beverages, and Tobacco	3.31	4.26	2.41
Clothing and Wearing Apparel; and Leather and Leather	17.82	25.26	10.70
Products of Wood, Paper, and Paper	0.69	0.81	0.57
Rubber and Plastics	1.18	1.82	0.56
Basic Metals	0.44	0.60	0.29
Fabricated Metal, Except Machinery and Equipment	0.04	0.06	0.03
Transport Equipment	0.28	0.38	0.18
Other Manufacturing	3.89	6.27	1.61
Electricity, Gas, and Water	2.63	4.78	0.57
Construction Services	8.16	7.22	9.05
Wholesale, Retail Trade, and Transport Service	5.89	1.64	9.95
Lodging, Food, and Beverage Serving Services	8.51	11.74	5.41
Transportation services	4.26	2.88	5.58
Postal, and Courier and Telecommunications Services	1.79	0.67	2.87
Financial Intermediation, Insurance, and Auxiliary Services	1.69	1.40	1.97
Real Estate, Leasing Services, and Other Business Services	5.35	4.21	6.45
Public Administration and Compulsory Social Security Services	2.00	2.51	1.50
Education Services	1.29	0.94	1.62
Health and Social Services	2.94	2.77	3.11
Other Services, N.E.C.	2.71	1.67	3.71
Total in Million USD at current prices	**30,852**	**15,092**	**15,760**
Share (%)		**48.9**	**51.1**

Source: Cambodia SAM 2014

- The largest income (i.e. GDP or Value added) generating activity in Cambodia is services, contributing about 42.2 per cent of total income in 2014. This is followed by agricultural activity with a contribution of about 30.1 percent of total income. Contribution of industrial activity is lowest with a 27.2 percent share of total income.
- Agriculture is composed of five activities – crop agriculture, livestock and poultry, forestry, fish and other fishing activities, and cassava. Crop activities account for more than 50 % of the total agriculture GDP and 15.7 % of total GDP in 2014. Contributions of fish and other fishing activities; and livestock and poultry in total agriculture GDP are respectively 22% and 11%. Cassava accounts for 8 % of total agriculture GDP in 2014.
- Industrial activities are composed of manufacturing, utilities and construction. The contribution of manufacturing in total income generation in 2014 was 16.4 percent. This suggests that more than 60 percent of the industrial sector's income (or GDP) has been due to the performance of manufacturing activities.

In the 2014 SAM, the factor market has been represented by three types of labour – classified by skill levels – low skilled labour; medium skilled labour and high skilled labour. The capital factor which is represented by one category includes land as well as mixed factors (i.e. mostly self-employed groups who combined capital and their own labour in their production). The factor intensities across 26 activities and 4 types of factors are shown in the figure below.

Figure 3: Primary Income Distribution Structure



Source: Cambodia SAM 2014

- Factor intensity patterns are diverse. Capital intensities are relatively high in heavy industries. This include mining; fabricated metal industries; utility; and construction. All of them have capital intensity of 70 percent or more. A Few services also have high capital intensity. It is high in hotel; post and communications and real estate services.
- Low capital intensity (or relatively high labour intensity) has been found for activities such as crop agriculture, fishing, rubber, basic metal and textiles. Capital intensity is less than 50 percent in these activities.
- In particular, capital intensities are between 40 and 50 percent in the agricultural activity envisaging that combined labour intensities are between 50 and 60 percent. Among agricultural activities, relatively higher capital intensities are observed for livestock and poultry, and fish and fishing activities. Cassava on the other hand is relatively less capital intensive. The underlying factor intensity pattern of the agriculture (in particular cassava) suggests that expansion of agriculture activities would likely benefit workers more compared to the holders of capital. Furthermore, expansion on agriculture would have greater beneficial impact on the low and medium skilled labourers enhancing their welfare.

One key advantage of the IOT or SAM data base is that it captures important element of inter-dependence of activities and commodities in the production system. There are three measures of interdependence: (i) degree of endogeneity; (ii) backward linkages and (iii) forward linkages. Review of the activity level input structure (or which is more widely known as the technology structure) identifies the level of linkages[18]. An activity with larger number of inputs would have higher linkages compared to an activity that uses a smaller number of inputs in production. These linkages can be differentiated into backward and forward linkages. Stronger forward and backward production linkages lead to larger multipliers.

The ***'endogeneity'*** of an activity captures the relationship between input shares and activity level output. In simple terms, it describes the extent to which an activity is self-contained or, conversely, relies on other activities. The formula for degree endogeneity (DE) for an activity (i) is the ratio of raw materials (RM) (or intermediate inputs) to gross output (GQ):

$$DEi = \frac{RMi}{GQi} \times 100$$

By definition this must be less than 1 or 100%. A higher endogeneity value suggests that either the activity is highly integrated in terms of input structure or that the contribution to the value of that activity's output of raw materials and input costs from within the activity is relatively high compared to remuneration and capital payments. For practical purposes, a high level of endogeneity indicates that the activity is more 'self-contained', that is, it does not require significant inputs from other activities.

Backward production linkages are the demand for additional inputs used by producers to supply additional goods or services. For example, when Cassava production expands, it demands intermediate goods and services like seed, fertilizer, electricity, irrigation (water), machine parts, and extension services. This demand then stimulates production in other sectors to supply these intermediate goods and services. The more input intensive a sector's production technology is, the stronger its backward linkages are. The backward linkages provide valuable information about the degree of integration of an activity with the rest of the economy. Using this measure, it is possible to determine which activities contribute most to economic growth as a result of an exogenous increase in final demand, for instance exports demand.

Forward production linkages account for the increased supply of inputs to upstream industries. For example, when electricity production expands, it can supply more power to the economy, which stimulates production in all the sectors which use power. Thus, the more important a sector is for upstream industries, the stronger its forward linkages will be. Forward linkages are particularly important for activities (such as trade, transportation, energy etc.) that provide key inputs into majority of other activities in the economy. In other words, forward linkages help us to understand the importance of a commodity for the rest of the economy in terms of intermediate demand. Therefore, a commodity that exhibits high forward linkages is said to be important to growth since growth in that activity will have knock-on effects in other sectors.

Table 11: Linked Activities of the Ready-Made Garment Activity

Activity Classification	***Degree of Endogeneity***	***Backward Linkages***	***Forward Linkages***
Crop Agriculture	28.97	1.64	2.14
Cassava	21.26	1.49	2.97
Livestock and poultry	43.41	1.95	2.45
Forestry	23.48	1.51	2.93
Fish and Other Fishing Products	47.83	2.20	2.61
Coal and Lignite; Peat, Crude Petroleum, and Natural Gas	35.89	1.69	2.13
Food, Beverages, and Tobacco	63.42	2.45	1.92

[18] *To proceed with the analysis of multipliers and backward and forward linkages it is necessary to calculate the matrix of technology coefficients. Backward linkages are measured by the total column sum of the multiplier matrix.*

Activity Classification	*Degree of Endogeneity*	*Backward Linkages*	*Forward Linkages*
Clothing and Wearing Apparel; and Leather and Leather Products	69.34	2.68	3.41
Products of Wood, Paper, and Paper Products	57.74	2.29	1.67
Rubber and Plastics Products	75.56	2.57	2.36
Basic Metals	66.28	1.96	1.68
Fabricated Metal Products, Except Machinery and Equipment	66.28	1.97	1.04
Transport Equipment	67.30	2.20	1.11
Other Manufacturing	78.83	2.57	2.93
Electricity, Gas, and Water	88.97	2.85	2.15
Construction Services	43.30	1.80	3.02
Wholesale, Retail Trade Service	13.65	1.28	5.01
Lodging, Food, and Beverage Serving Services	67.50	2.58	1.97
Transportation services	33.08	1.64	2.25
Postal, and Courier and Telecommunications Services	18.28	1.39	2.23
Financial Intermediation, Insurance, and Auxiliary Services	40.46	1.92	3.22
Real Estate, Leasing Services, and Other Business Services	38.47	1.88	2.46
Public Administration and Compulsory Social Security Services	61.56	2.29	2.04
Education Services	35.78	1.80	2.08
Health and Social Services	46.11	1.84	2.16
Other Services, N.E.C.	30.13	1.64	2.14

Source: Cambodia 2014 SAM Model

The table above presents the DE ratio, backward and forward linkages for each activity. Several manufacturing activities have values of over 60%, with other manufacturing highest at 78%. By comparison, DE ratios among the agricultural activities are on the lower side ranging between 21 and 48. Low DE ratio suggests higher content of value added or factor share.

In line with trend of the DE ratios higher backward linkages have also been found for manufacturing activities. Among the manufacturing activities, high backward linkages are found for apparel (2.68) and food processing activity (2.45). Due to a low DE ratio, backward linkages are also low among agricultural activities.

As expected, the highest forward linkage has been reported for trade services. Apparel also has high forward linkages of more than 3. However, this value is a manifestation of the aggregation of textile with apparel in activity classification. Otherwise, apparel is a high backward linkage activity with low to moderate forward linkages. A moderate forward linkage value of more than 2 found for most of the agriculture activities suggests that a significant part of these products is demanded by other activities as raw material for processing activities.

5.2. DEMAND STRUCTURE – SAM 2014

Total demand is composed of intermediate and final demand. The distribution of demand structure by the 31 SAM commodity classification is shown in the table below.

Table 12: Demand Structure - Cambodia SAM 2014

Commodity Classification	Inter demand	Consumption		Export	Investment	
		Private	Public		GFC	Stock change
SAM Commodity Classification	100.00	100.00	100.00	100.00	100.00	100.00
Crop Agriculture	1.28	20.98	0.00	2.31	0.00	10.01
Cassava	2.29	0.86	0.00	0.21	0.00	6.67
Livestock and poultry	3.01	3.41	0.00	0.14	0.55	26.68
Forestry	2.71	0.25	0.00	0.00	0.00	0.00
Fish and Other Fishing Products	3.44	10.59	0.00	0.01	0.00	0.00
Coal and Lignite; Peat, Crude Petroleum, and Natural Gas	0.09	0.04	0.00	0.00	0.00	8.67
Other Minerals, N.E.C.	4.28	0.00	0.00	0.00	0.00	0.00
Food, Beverages, and Tobacco	5.14	9.11	0.00	0.90	0.00	0.00
Clothing and Wearing Apparel; and Leather and Leather Products	24.83	2.71	0.00	51.58	0.00	0.00
Products of Wood, Paper, and Paper Products	2.87	0.05	0.00	1.49	0.00	0.00
Basic Chemicals and Other Chemicals	3.65	0.70	0.00	0.04	0.00	0.00
Rubber and Plastics Products	3.86	0.05	0.00	1.51	0.00	10.01
Furniture and Other Transportable Goods, N.E.C.	0.33	1.06	0.00	0.10	0.00	7.34
Basic Metals	3.73	0.03	0.00	0.25	0.00	0.00
Fabricated Metal Products, Except Machinery and Equipment	1.99	0.33	0.00	0.02	4.99	0.00
General and Special Purpose Machinery	0.42	1.42	0.00	0.29	8.48	0.00
Office, Accounting, and Computing Machinery	1.85	0.17	0.00	0.50	10.00	14.68
Transport Equipment	1.04	5.50	0.00	0.35	2.31	15.95
Other Manufacturing	4.77	4.11	0.00	1.53	15.06	0.00
Electricity, Gas, and Water	0.53	5.13	0.00	0.00	0.00	0.00
Construction Services	3.52	0.62	0.00	0.00	58.60	0.00
Wholesale, Retail Trade, and Transport Service	11.80	0.00	0.00	4.82	0.00	0.00
Lodging, Food, and Beverage Serving Services	0.41	0.11	0.00	26.33	0.00	0.00
Transportation services	3.07	8.96	0.00	2.96	0.00	0.00
Postal, and Courier and Telecommunications Services	0.66	3.14	0.00	0.00	0.00	0.00
Financial Intermediation, Insurance, and Auxiliary Services	3.22	0.28	0.00	0.00	0.00	0.00
Real Estate, Leasing Services, and Other Business Services	1.58	9.77	0.00	0.00	0.00	0.00
Public Administration and Compulsory Social Security Services	0.09	0.05	68.69	0.00	0.00	0.00
Education Services	0.16	1.35	20.31	0.00	0.00	0.00
Health and Social Services	0.43	5.14	11.00	0.00	0.00	0.00
Other Services, N.E.C.	2.94	4.09	0.00	4.68	0.00	0.00
Total (Million $)	**15,092**	**14,559**	**867**	**11,217**	**3,246**	**150**
Share in Total Demand (%)	**33.4**	**32.3**	**1.9**	**24.9**	**7.2**	**0.3**

Source: Cambodia SAM 2014

Three noticeable demand components in terms of values are intermediate demands – accounting for about 33% of total demand; private consumption with a 32 % share, and exports of goods with almost 25% of total demand.

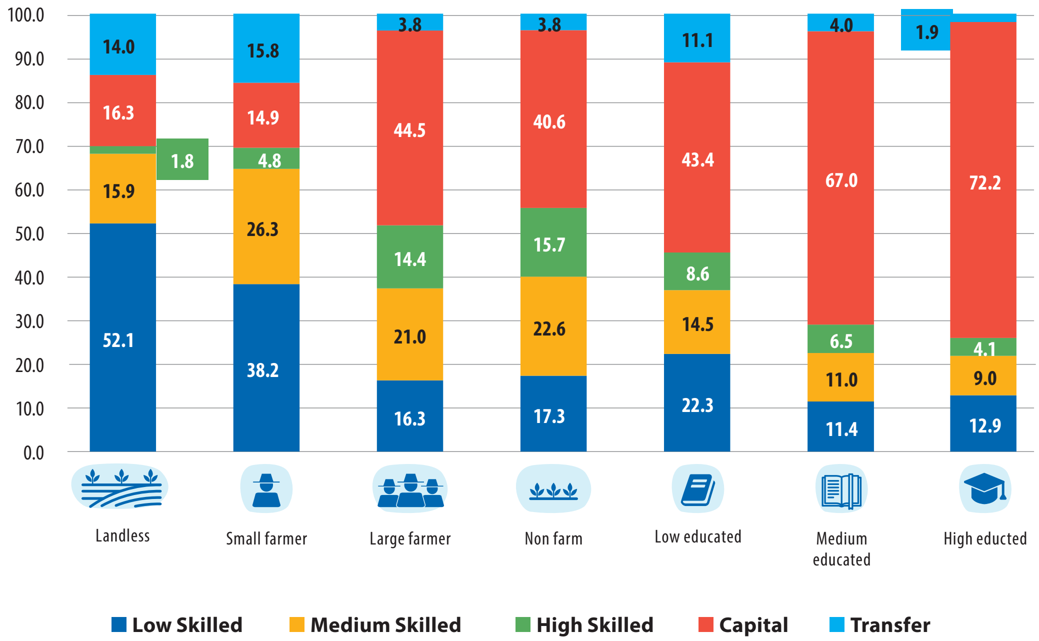
In 2014, households in Cambodia spent about 36% of their income on agricultural products. The contribution of services in total private consumption is around 32%. Thus, industrial products account for rest (31%) of the total private consumption. Public consumption spending is dominated by three services – such as public administration (i.e. 69%); education services (20%); and health services (11%). Merchandise exports are predominantly apparel exports (i.e. accounting for about 85% of total merchandise exports). While service exports are mainly led by tourism (i.e. accounting for 68% of total services exports), capital goods are originated in 8 commodity categories. Construction alone accounted for 58% of the capital goods in 2014. Other important capital goods producing sectors are machinery (i.e. together accounting for about 34% of total capital goods), and other manufacturing (accounting for about 15% of total capital goods).

5.3. HOUSEHOLD ACCOUNT – SAM 2014

Household accounts in the SAM 2014 have been represented by the 7 representative household groups. According to SAM 2014, sources of household income are either returns from factors (i.e. labour, and capital) or transfers from other institutions (government and rest of the world). Figure 4 shows the distribution of income by the representative household groups. Returns from factors are the main income source. Albeit varying across households, average contributions of factor income in household total income are more than 80%. Following from the value-added structure where capital dominated, the main source of household income is the return from capital.

Transfer constitutes another source of income for household groups with its contribution varying from 2 percent to around 14 percent. Major beneficiaries of the transfers are poorer household groups.

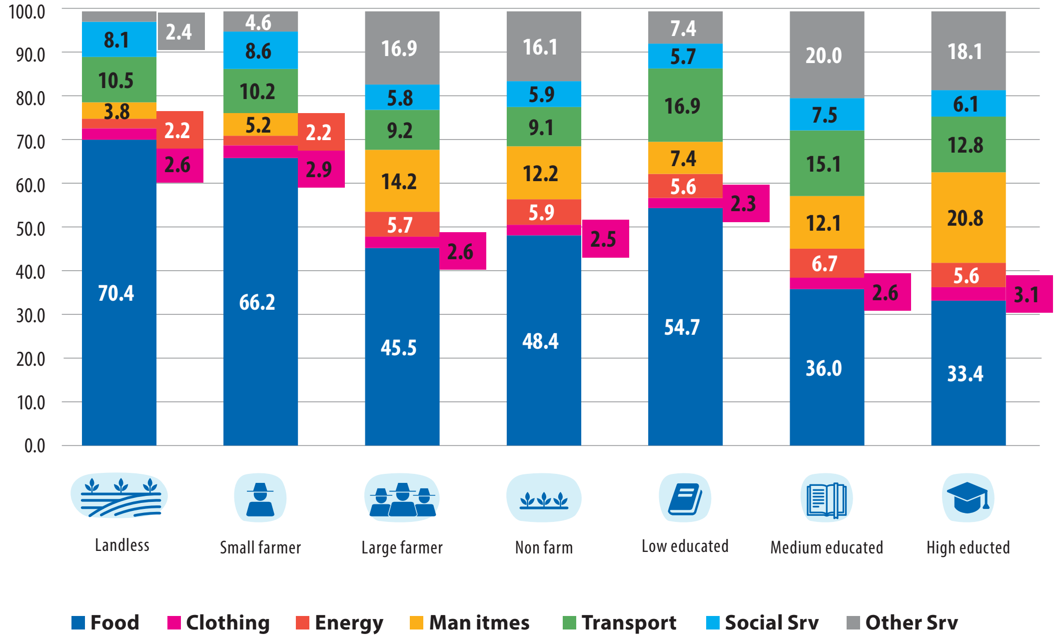
Figure 4: Sources of income by household groups



Source: Cambodia SAM 2014

Distribution of consumption expenditure by main expenditure items and the 7 household groups is shown in the figure below. Although, households spend more than 40 % of their budget on food items – it varies quite considerably across household groups. For instance, food expenditure accounts for 70 percent of 'landless' a household's total budget while it is only 33 percent for a 'high educated' household. Other important expenditure categories are 'other services', 'transport services', and 'other manufacturing' items. Households spent around 7 to 20 percent of their budget on 'other services'. Households' expenditure on 'transport services' ranges between 9 and 15 percent.

Figure 5: Household consumption patterns



Source: Cambodia SAM 2014

5.4. EMPLOYMENT STRUCTURE – ESM 2014

The employment structure of Cambodia has been presented from the perspective of activity, location and gender for a deeper insight to understand implications for employment for a contraction or expansion of a particular activity.

Table 6 shows the employment structure by activities. Employment structure from location (urban vs and rural) and gender (male vs female) perspectives have been presented in table below.

Table 13: Cambodia Employment Structure by Activities (%)

	Cambodia			Urban			Rural		
	Both	Male	Female	Both	Male	Female	Both	Male	Female
Agriculture	33.25	33.75	32.70	3.76	4.02	3.49	42.97	43.43	42.44
Industry	25.24	24.62	25.92	19.63	20.66	18.51	27.08	25.92	28.40
Mining	0.40	0.66	0.10	0.22	0.43	0.00	0.45	0.73	0.14
Manufacturing	17.42	11.54	23.99	13.09	9.49	17.03	18.85	12.21	26.31
Utility	0.65	1.03	0.22	1.06	1.81	0.25	0.51	0.78	0.22
Construction	6.77	11.39	1.61	5.26	8.93	1.23	7.26	12.19	1.73
Services	**41.51**	**41.63**	**41.38**	**76.60**	**75.33**	**78.00**	**29.95**	**30.65**	**29.16**
Trading services	17.49	12.40	23.19	31.85	22.95	41.61	12.77	8.96	17.05
Transport services	5.34	9.23	1.00	7.62	12.79	1.95	4.59	8.07	0.68
Hotel and Restaurants	4.52	3.12	6.08	8.17	5.44	11.17	3.32	2.36	4.39
Communication	0.31	0.39	0.23	0.90	1.03	0.76	0.12	0.18	0.06
Financial services	0.66	0.67	0.64	1.96	1.79	2.14	0.23	0.30	0.15
Business services	0.30	0.23	0.37	1.16	0.86	1.49	0.01	0.02	0.00
Public administration	4.11	6.97	0.91	9.20	15.44	2.35	2.43	4.21	0.43
Education	2.46	2.41	2.53	4.34	3.94	4.79	1.85	1.91	1.78
Health	0.94	1.06	0.81	1.96	2.43	1.45	0.60	0.61	0.60
Other services	5.37	5.17	5.60	9.44	8.66	10.30	4.03	4.04	4.03
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Source: ESM 2014

- The largest employer in Cambodia is the services activity. It accounts for around 42 percent of the total work force. The second largest employer is agriculture activity absorbing about 33 percent of the total work force. Industry is providing employment to about 25 percent of total job seekers. The employment structure is very different for urban activities. More than 75 percent of urban workers are employed in the services sector. Industry emerged as the second largest employer for the urban work force, as almost 20 percent of the urban work force finds jobs in industrial activities. Understandably, only about 4 percent of the urban work force is employed in agriculture. In the case of rural work force, the largest employer is agriculture. It provides employment to about 43 percent of the rural work force. The second largest employer is service sector employing almost 30 percent of the rural work force, and the contribution of industrial activities in rural employment is surprisingly high at around 27 percent.
- Manufacturing activity which employ about 17.4 percent the total work force is a highly female dominated activity. Almost 24 percent of the total female work force of the country is employed in the manufacturing activity whereas only about 11.5 percent of total male work force works in the manufacturing activity. These patterns seem to hold in Cambodia, for both urban and rural areas. On the other hand, construction – another subsector of industry – is a highly male dominated activity. Only about 2 percent of the total female work force is employed in construction activity while about 11.5 percent of total male work force works in this activity.

Table 14: Distribution of Cambodia Employment by Location and Gender (%)

	Cambodia			Urban				Rural			
	Both	Male	Female	Urban	Male	Female	Total	Rural	Male	Female	Total
All	100	52.8	47.2	24.8	52.33	47.67	100.00	75.22	52.9	47.1	100.0
Agriculture	100	53.6	46.4	2.8	55.84	44.16	100.00	97.20	53.5	46.5	100.0
Industry	100	51.5	48.5	19.3	55.05	44.95	100.00	80.72	50.6	49.4	100.0
Mining	100	87.8	12.2	14.0	100.00	0.00	100.00	85.95	85.7	14.3	100.0
Manufacturing	100	35.0	65.0	18.6	37.94	62.06	100.00	81.39	34.3	65.7	100.0
Utility	100	83.8	16.2	40.5	88.97	11.03	100.00	59.46	80.3	19.7	100.0
Construction	100	88.8	11.2	19.3	88.86	11.14	100.00	80.74	88.8	11.2	100.0
Services	100	52.9	47.1	45.7	51.46	48.54	100.00	54.27	54.1	45.9	100.0
Trading services	100	37.4	62.6	45.1	37.71	62.29	100.00	54.88	37.1	62.9	100.0
Transport services	100	91.2	8.8	35.4	87.83	12.17	100.00	64.65	93.0	7.0	100.0
Hotel	100	36.4	63.6	44.8	34.83	65.17	100.00	55.19	37.7	62.3	100.0
Communication	100	64.8	35.2	71.3	59.64	40.36	100.00	28.73	77.6	22.4	100.0
Financial services	100	53.7	46.3	73.7	47.85	52.15	100.00	26.27	70.1	29.9	100.0
Business services	100	40.9	59.1	96.7	38.90	61.10	100.00	3.34	100.0	0.0	100.0
Public administration	100	89.5	10.5	55.5	87.83	12.17	100.00	44.52	91.6	8.4	100.0
Education	100	51.5	48.5	43.7	47.44	52.56	100.00	56.33	54.7	45.3	100.0
Health	100	59.3	40.7	51.7	64.83	35.17	100.00	48.27	53.3	46.7	100.0
Other services	100	50.8	49.2	43.5	47.99	52.01	100.00	56.47	52.9	47.1	100.0

Source: ESM 2014

- More than 75 percent of the total work force is employed in the rural activities. The contribution of urban activities in employment generation is thus 25 percent. Agriculture is predominantly a rural activity and hence it draws 97 percent of workers from rural locations. Industry also draws majority of their workers (i.e. 81 percent of industrial workers) from rural locations. Services draw workers from both locations in similar proportions. Almost 46 percent of service workers are from urban locations.
- In Cambodia, almost 53 percent of total workers are male while rest 47 percent are female. These patters between male and female workers also hold for urban and rural locations.

06 ASSESSING ECONOMIC RETURN OF CASSAVA AND COMPETING SECTORS: SAM MODEL APPROACH

6.1. SIMULATION DESIGN

The note on '*Proposed Investment in Cassava Value Chain'* has estimated that $ 296 million public investment is needed in the cassava sector. To assess the economic return of this investment, following four simulations have been carried out.

Business as Usual (BAU): A business as usual scenario is generated assuming that there is no additional public investment or intervention (i.e. in addition to trend increases in public investment) into the Cambodian economy. The exogenous account of the SAM model is set up in such a way (it reflects what is needed to change in all the three elements of the exogenous accounts – the government expenditure, investment and exports) to exactly match the nominal GDP values projected for 2019 in Cambodia's "Macro-economic" framework (i.e. covering 2009 to 2022). The BAU scenario also simulates projected employment situation which is consistent with the GDP outcomes of the BAU scenario. Generating the BAU to exactly match the projected GDP values of 2019 is important since it sets the benchmark to examine the impact of various simulations described below.

Primary and Processed Cassava: It is further argued that potential of cassava in Cambodia would be achieved if the sectoral production activities move higher in the cassava value-added chain. In this context, the '*Proposed Investments in Cassava Value Chain*', suggests investing $ 74 million on improving the production system $ 222 million on promoting higher valued processing activities. To implement this simulation, a cassava processing activity has been incorporated in 2014 SAM by separating the food processing activity into food and cassava processing activities. Since, this is a processing activity, the cassava processing sector's technology structure resembles that of the food processing activity.

Similar Alternative Investments: With other things remaining the same, additional public investment would likely have positive impacts on any economy including Cambodia. Increase in investment into the cassava sector would thus have positive socio-economic impacts. An assessment based only on cassava sector in isolation may not be sufficient to justify public sector investment in this sector. Thus, a meaningful approach is to compare outcomes under cassava sector investment with similar investments in other competing sectors. In this context, impacts of similar public investment injections in two alternative simulations have been considered. The sectors considered for simulation are randomly picked among the 31 SAM sectors.

Rice Sector: Additional public investment of $ 296 million has been considered for the rice sector in this simulation.

Livestock and Processed Food Sector (LPF): Additional public investment of $ 74 million in Livestock has been combined with additional investment of $ 222 million in the processed food sector in this simulation.

Tourism Sector (Tourism): Additional tourism investment of $ 296 million has been considered in this simulation.

Table 15: SAM Model Simulation Set Up

	Cassava	Rice	Livestock and Food	Tourism
Additional Public Investments (Million $)	*296*	*296*	*296*	*296*
Primary and processed Cassava (Million $)	*74+222*	*0.0*	*0.0*	*0.0*
Rice (Million $)	*0.0*	*296*	*0.0*	*0.0*
Livestock and Processed Food (Million $)	*0.0*	*0.0*	*74 + 222*	*0.0*
Tourism (Million $)	*0.0*	*0.0*	*0.0*	*296*

6.2. SIMULATION RESULTS

Business as Usual Scenario:

Using the SAM model, the business as usual (BAU) scenario was generated using the sectoral GDP information for 2019 projected in the Macro-economic framework. As mentioned above, an important feature is that sectoral GDP estimated under the BAU scenario exactly matches the sectoral GDP reported in the macro-economic framework. The sectoral GDP, gross domestic output, and employment are estimated under the BAU scenario. The BAU outcomes are presented in table below.

Table 16: BAU Scenario

SAM Activity Classification	Macro-Framework	Model Simulation		
	Value added* (Mil $)	Value added (Mil $)	Output (Mil $)	Employment** (Person)
Crop-Agriculture	3,406	2,757	3,882	1,923,947
Cassava		649	1,039	
Livestock and poultry	638	638	1,127	
Forestry	390	390	509	
Fishing	1,259	1,259	2,412	
Mining and Quarrying	521	521	812	52,559
Manufacture of Food Products, Beverages, and Tobacco	603	603	1,625	
Manufacture of Textiles, Wearing Apparel, and Footwear	2,705	2,705	8,821	670,355
Manufacturing of Wood, Wood Products, Paper, and Paper Products	130	130	309	
Manufacture of Rubber and Plastic Products	143	143	585	
Manufacture of Basic Metals		69	204	
Manufacture of Fabricated Metal Products; and Office and Computing Machinery		10	31	
Manufacture of Motor Vehicles & Other Transport Equipment		112	342	
Other Manufacturing	811	620	2,930	864,036
Electricity, Gas, and Water Supply	143	143	1,298	50,966
Construction	4,035	4,035	7,117	936,686
Wholesale &Retail Trade Services	2,571	2,571	2,977	1,403,935
Hotels and Restaurants	1,188	1,188	3,656	443,398
Transportation services	2,259	1,492	2,229	308,119
Post and Telecommunications		767	938	26,076
Financial Intermediation and Insurance	516	516	867	53,424
Real Estate, Renting, and Business Services	1,902	1,902	3,091	27,231
Public Administration and Defense	365	365	950	310,185
Education		386	601	182,874

SAM Activity Classification	Macro-Framework	Model Simulation		
	Value added* (Mil $)	Value added (Mil $)	Output (Mil $)	Employment** (Person)
Health and Social Work		742	1,377	69,753
Other Community Service Activities	2,014	886	1,268	398,825
Total	**25,599**	**25,599**	**50,998**	**7,722,370**

*Note: *As expected and required to test model validation, simulated sectoral GDP or value added in the BAU scenario reproduces the GDP or value added reported in the macro-economic framework.*

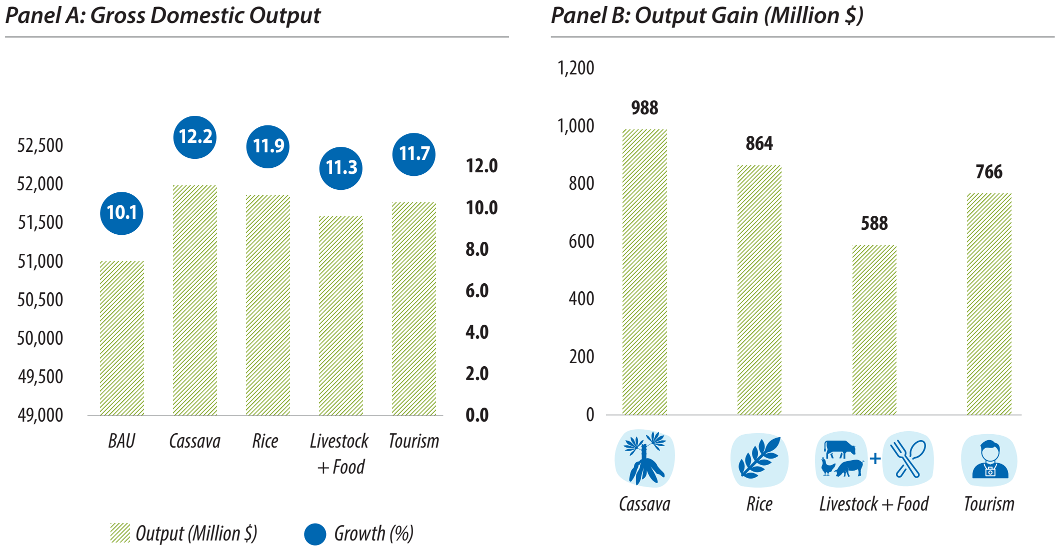
*** Simulated employment figures have been reported against the 16 sector or activity classifications adopted in LFS (2012). Employment outcome shows an unemployment rate of 2.7 percent.*

Investment Scenarios

As mentioned above, four investment potential simulations have been carried out. The impacts of the export potential simulations on the economy have been assessed by tracking the movements of the following indicators such as: (i) gross domestic output; (ii) nominal and real gross domestic product (GDP or income); (iii) employment; and (iv) the poverty situation.

Gross Domestic Output: Gross domestic output combines factors of production (i.e. labour and capital) with raw materials (i.e. domestic as well imported) to produce output. Gross domestic output is a comprehensive indicator to assess health of an economy. Impacts on domestic output under the four scenarios are presented in figure below.

Figure 6: Total Impact on Gross Domestic Output (over the 10-year period)



Source: SAM Model

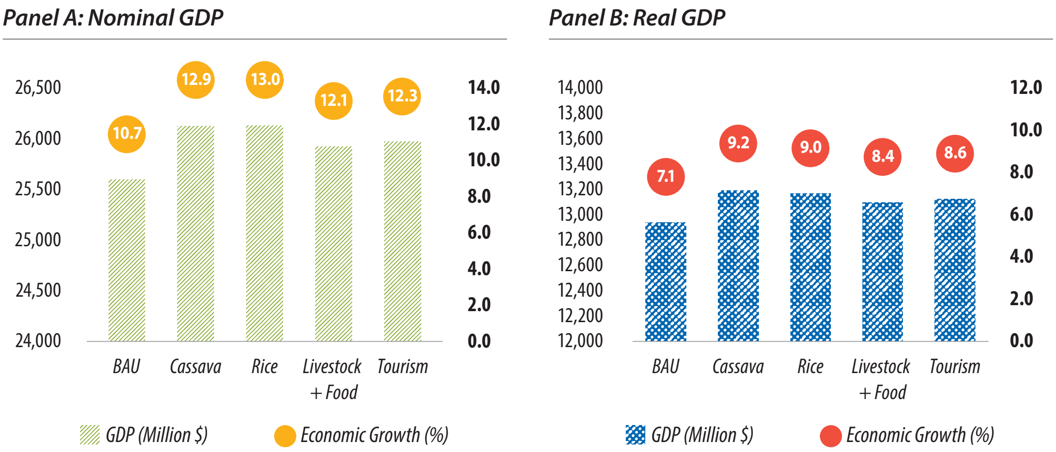
Total value of domestic output under the BAU scenario has been projected to be $ 50,998 million in 2019 envisaging a growth rate of 10.1 %. Higher by public investment are likely to exert positive impact on the domestic output. As a result of additional cassava sector investment of $ 296 million, total output will increase to $ 988 million or 12.2 percent of GDP over a 10-year period. The highest output increase has been noted for additional cassava sector investment of $ 296 million. While output increases under the three alternative simulations are also high, they are smaller than the output increase found under cassava investment simulation. For instance, additional pubic investment of $ 296 million in the rice activity is estimated to lead to extra output increase of $ 864 million, implying a period growth rate of 11.9 percent. Furthermore, additional pubic investment of $ 296 in the livestock and processed food activity leads to an output increase of $ 588 million implying a period growth rate of 11.3 percent. Lastly, the total output increase is $ 766 million under the tourism simulation.

Scenarios	Annualized	
	Output gains (Million $)	Output growth (%)
Cassava	98.8	0.21
Rice	86.4	0.19
Livestock and Food	58.8	0.13
Tourism	76.6	0.51

Total output increases are converted to annualized values considering a 10-year implementation period. The annualized output gains and growth rates are shown in the adjacent table. Highest annualized output gains and growth rates have been found for the Cassava simulation.

Gross Domestic Product (GDP): The most widely used and accepted indicator to measure economic well-being is GDP. It is the sum of values of all goods and services produced in an economy in a particular time period (e.g. usually a quarter or a year). There are two valuations of GDP – nominal and real. Nominal GDP includes the current prices of the goods and services, while real GDP excludes the price factor. The simulated impacts on GDP are presented below.

Figure 7: Total Impact on Gross Domestic Output (over the 10-year period)



Source: SAM Model

Simulated nominal GDP[19] in 2019 under the BAU scenario has been projected at $ 25,599 million. This implies a growth rate of nominal GDP of 10.7 %. Total nominal GDP under the cassava simulation has been estimated to be $ 26,126 million, generating highest growth rate of 12.9 %. The nominal GDP increase under the rice simulation is almost equal to the economic expansion found under the cassava simulation. Nominal GDP increases under the other two alternative simulations are high but smaller than the GDP increase found under the cassava simulation.

Activity level (Cambodian economy is represented by 26 activities) nominal GDP values are deflated using activity level GDP deflators for 2019 as reported in the Macro-economic framework to arrive at activity level real GDP values for 2019. Real GDP under the BAU scenario has been simulated at $ 12,940 million. This implies a real economic growth rate of 7.1 percent in 2019. The largest increase in real GDP is found in the cassava simulation. In this scenario, real GDP value is likely to increase to $ 13,191 million or register a 9.2 % growth rate. Real GDP value may likely increase to $ 13,168 million, implying a slightly lower economic growth rate of 9.0 % under the rice simulation as compared to the cassava simulation. Similar to the pattern observed in the case of gross output and nominal GDP, the real GDP increase under the two alternative simulations are high but fall short of the GDP increase and growth rates found under the cassava simulation.

[19] *We consider factor price GDP in the SAM framework. Factor price GDP only exclude two items – product taxes and subsidies and finance service charges.*

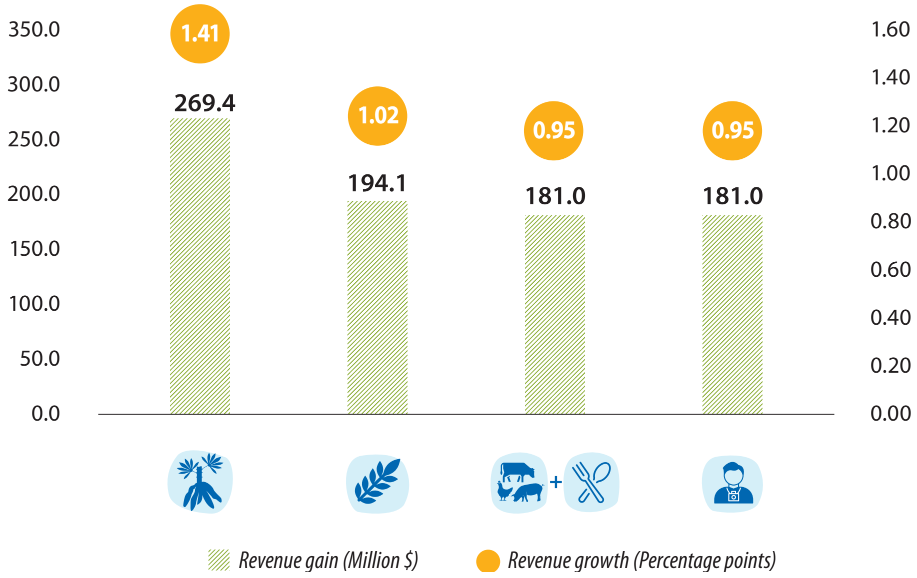
	Cassava	*Rice*	*Livestock and Food*	*Tourism*
Nominal GDP				
Gains (Million $)	*52.9*	*53.3*	*32.6*	*37.5*
Growth (%)	*0.23*	*0.23*	*0.14*	*0.16*
Real GDP[20]				
Gains (Million $)	*25.1*	*22.8*	*15.7*	*18.4*
Growth (%)	*0.19*	*0.18*	*0.12*	*0.14*

The annualized increase in value added and GDP growth rates are shown in the adjacent table. Similar to observation found for output increase, the highest annualized GDP increase and growth rates have been found for the cassava simulation.

Impacts on revenue have also been simulated. Revenue gains under the four-export potential scenarios are shown below. These have been compared with BAU revenues.

Both tax rates and tax net have remained unchanged. However, as a result of economic expansion, revenue has increased under all of the four simulations, albeit to different extents. Since economic expansion is highest in the cassava simulation, the largest revenue gain is also found for this scenario with gains over the 10-year period being as high as $ 269 million. Revenue gains under the rice, livestock and food, and tourism's scenarios are respectively $ 194 million, $ 181 million and $ 181 million.

Figure 8: Total Impact on Revenue (over the 10-year period)



An important aspect of revenue gain is that, total revenue gains have been found to be less than the required investment amount. This analysis of revenue gains and public investment envisages that public investment would thus ultimately need small amounts of financing from other sources.

Employment: An important indicator for socio-economic impact assessment is employment. Creating jobs, especially decent jobs is a key priority in most economies. Cambodia is no exception and hence attaches importance to employment generation. According to the LFS (2012), almost 72% of the total population belong to the working age group. Out of these, 69% participate in the labour market – or actively search for a job. The projected population of Cambodia in 2019 is 16 million. Assuming that the key employment parameters (as reported for 2012) still hold for 2019, the total working age population in 2019 is 11.5 million

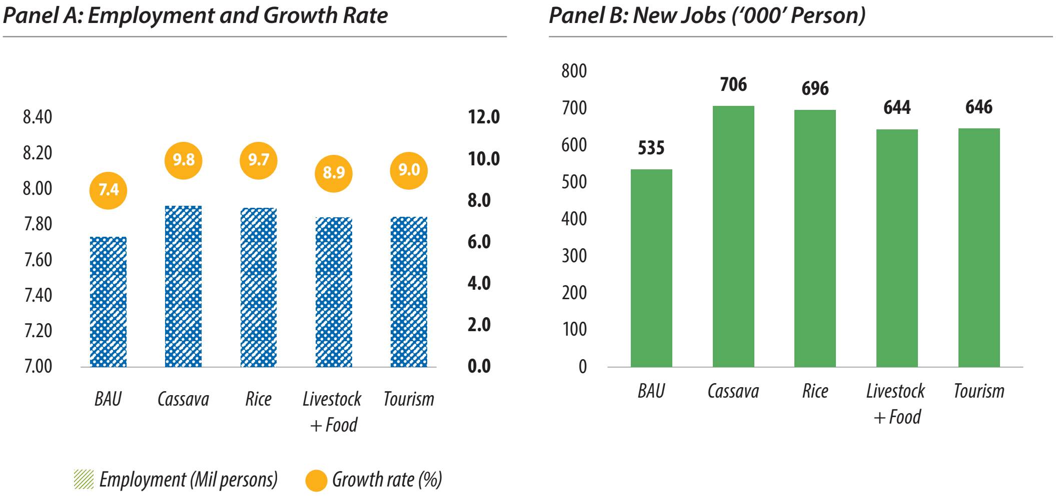
[20] *Variations in nominal and real GDP values between cassava and rice is due to differences in their GDP deflators.*

persons, making the number of persons actively looking for jobs 7.95 million. The simulated total number of jobs under the BAU is 7,722,370 persons or 7.72 million persons. This suggests a very low unemployment rate of 2.7 percent.

Although employment generation depends on the level of economic activities (i.e. usually measured by the gross domestic output), deeper insight of on factor intensities suggest that a surge of relatively higher labour-intensive activity would likely enhance employment generation compared to a surge in a low labour intensive activity. Analysis of factor intensities across 26 activities suggests that agricultural activities have high labour intensity. On the other hand, capital intensities are higher in processed manufacturing activities such as food processing. Thus, other things remaining same, increases in agricultural output are likely to have a substantial salutary impact on the employment situation in Cambodia. On the other hand, other things remaining same, increases in processed manufacturing output are likely to benefit capital factors more than the labour factors in Cambodia.

Activity level outputs simulated under the four simulations are linked to activity level employment coefficients to derive the employment effects. The simulated impacts on employment are presented below.

Figure 9: Total Impact on Employment (over the 10-year period)



Source: ESAM and SAM Model

The new job creation growth rate is 7.4 percent under BAU. Under the cassava simulation, the number of new jobs increases to 171,710 persons, resulting in a growth rate of 9.8 percent. The number of persons with new jobs under the rice simulation is slightly less than the cassava simulation at 160,998, implying a growth rate of 9.7 percent. Under the livestock and food simulation, the estimated number of persons with new jobs is less than the previous scenarios at 109,087. This suggests a growth rate of 8.9 percent. In the case of the tourism simulation, the estimated number of new jobs is 111,067, resulting an employment growth rate is 9.0 percent.

Employment effects are also assessed from location and gender perspectives. The assessment focused on (i) the number of employed persons; (ii) number of new jobs; and (iii) employment growth rate. These are presented in table below.

Table 17: Employment Impact by Location and Gender

	BAU		Cassava		Rice		Livestock and Food		Tourism	
	Urban	**Rural**	**Urban**	**Rural**	**Urban**	**Rural**	**Urban**	**Rural**	**Urban**	**Rural**
Employed Persons	2,022,527	5,709,415	2,048,262	5,855,390	2,043,468	5,849,472	2,039,089	5,801,940	2,050,830	5,792,169
New Employment Persons	238,882	295,649	264,617	441,624	259,823	435,706	255,444	388,174	267,185	378,403
growth rate (%)	13.39	5.46	14.84	8.16	14.57	8.05	14.32	7.17	14.98	6.99
Increase (percentage points)			1.44	2.70	1.17	2.59	0.93	1.71	1.59	1.53
	Male	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Employed Persons	4,218,809	3,513,133	4,309,684	3,593,968	4,304,369	3,588,572	4,276,029	3,565,000	4,272,891	3,570,108
New Employment Persons	439,903	94,628	530,778	175,462	525,463	170,066	497,123	146,495	493,985	151,602
growth rate (%)	11.64	2.77	14.05	5.13	13.91	4.97	13.16	4.29	13.07	4.43
Increase (percentage points)			2.40	2.36	2.26	2.21	1.51	1.52	1.43	1.67

Source: SAM Model and ESAM

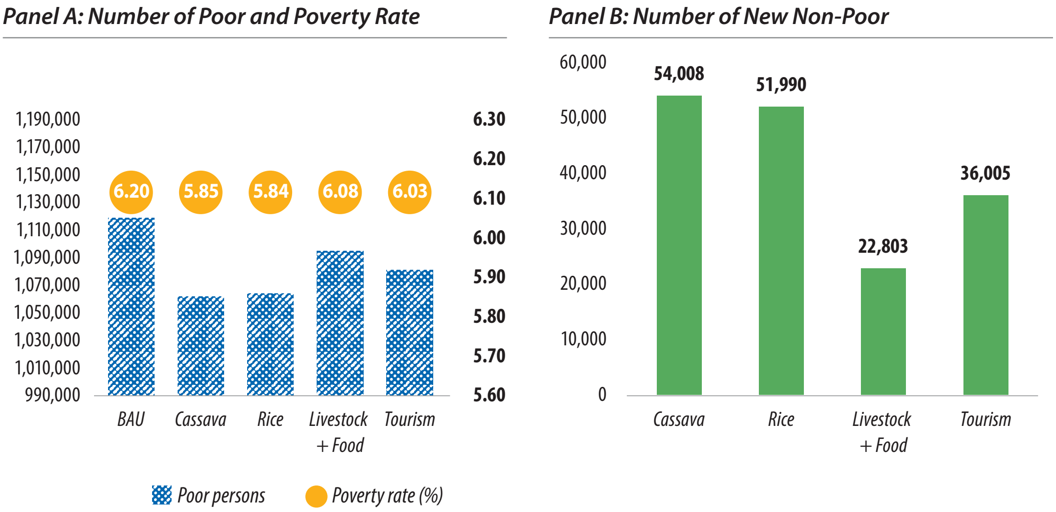
Employment by location and gender provides some important insights:

- Rural employment benefits more in the cassava, rice and livestock and processed food simulations;
- Benefits are higher for urban employment in the tourism scenario compared to the cassava scenario;
- Male employment dominates in the cassava and rice simulations and;
- Female employment is higher in the alternative investment simulations (i.e. livestock and food; tourism).

Poverty: This is the single most important indicator for welfare assessment. Reduction of poverty and eradication of extreme poverty are key objectives in many economies, especially in a developing economy like Cambodia. Based on the country's impressive progress on the poverty front, it may be argued that Cambodia is winning the fight against poverty. The head count poverty rate which was 47.8 % in 2007 declined to 13.5 % in 2014 (World Bank, 2017). A combination of three factors is key to the success of poverty reduction – high economic growth, job creation and higher windfalls from agricultural commodity prices. However, World Bank (2015) cautioned that '*Cambodia's gains in poverty reduction remain highly precarious, as most households that escaped poverty did so by only a small margin*". World Bank further argued using an estimation in 2012 that a small negative income (or consumption) shock of $ 0.30 per day may increase the head count poverty rate to 40 %, or approximately six million people may slip back to poverty. This observation is highly relevant for the current exercise, suggesting that expansion of economic activity or income and rise in new jobs may lead to further reduction of poverty in Cambodia.

One of the endogenous accounts of the SAM model is household and it captures the impact on household consumption or income. The changes in household income levels under the four scenarios are linked to the poverty model (based on CSES 2014 information) to assess poverty impacts of export potential. The simulated poverty impacts are presented below.

Figure 10: Poverty Impact (over the 10-year period)



Source: Poverty Model and SAM Model

Note: Non-poor refers to poor persons under the BAU simulation have shifted out of poverty under the policy simulations according the poverty thresholds.

Head count poverty is projected to drop to 6.2% in 2029 under the BAU scenario. However, economic expansion due to investment increase may likely lead to further decrease in poverty level in Cambodia. As many as 54,008 persons may escape poverty under the Cassava simulation implying a head count poverty rate of 5.85 %. The poverty outcome is similar under the rice simulation at 5.84% and a result as many as 51,900 persons may be lifted out of poverty. Poverty rates may drop to 6.08 % under the livestock and processed food sector scenario, which means that compared to the BAU scenario, the number of new non-poor persons are 22,803 under this scenario.
Head count poverty has been simulated at 6.03 % in the tourism scenario compared to the BAU poverty rate of 6.2 %t. This implies 36,005 new non-poor persons.

Benefit-Cost Ratio:

The benefit-cost ratio (BCR) contrasts the estimated present value of all benefits against present value of all cost to assess feasibility of a project from both financial and economic perspective. A project is feasible if the BCR is greater than one. Thus, BCR requires present value of all cost and benefits discounted using a discount rate.

BCR = (Present value of benefits) / (Present value of costs); Project viable if BCR > 1

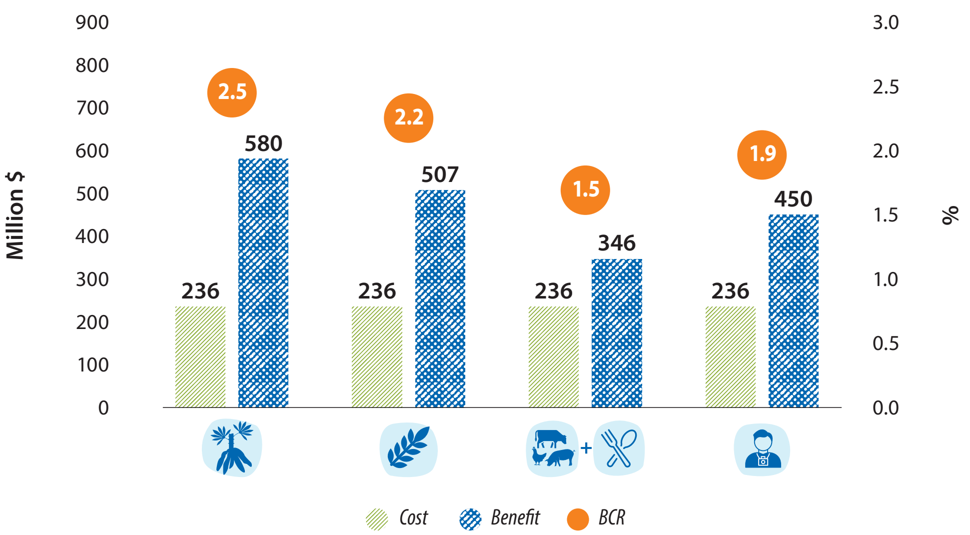
Table 18: Discounted benefit and cost under the four export potential scenarios

	Cassava			Rice			Livestock and Food			Tourism		
Period	**Cost**	**Benefit**	**B-C**	**Cost**	**Benefit**	**B-C**	**Cost**	**Benefit**	**B-C**	**Cost**	**Benefit**	**B-C**
1	29.7	0.0	-29.7	29.7	0.0	-29.7	29.7	0.0	-29.7	29.7	0.0	-29.7
2	44.6	0.0	-44.6	44.6	0.0	-44.6	44.6	0.0	-44.6	44.6	0.0	-44.6
2	59.4	98.8	39.4	59.4	86.4	27.0	59.4	58.8	-0.6	59.4	76.6	17.2
3	74.3	98.8	24.5	74.3	86.4	12.1	74.3	58.8	-15.4	74.3	76.6	2.4
5	89.1	118.5	29.4	89.1	103.6	14.5	89.1	70.6	-18.5	89.1	91.9	2.8
6	0.0	118.5	118.5	0.0	103.6	103.6	0.0	70.6	70.6	0.0	91.9	91.9
7	0.0	128.4	128.4	0.0	112.3	112.3	0.0	76.5	76.5	0.0	99.6	99.6
8	0.0	128.4	128.4	0.0	112.3	112.3	0.0	76.5	76.5	0.0	99.6	99.6
9	0.0	138.3	138.3	0.0	120.9	120.9	0.0	82.3	82.3	0.0	107.3	107.3
10	0.0	158.0	158.0	0.0	138	138.2	0.0	94.1	94.1	0.0	122.6	122.6
Undiscounted	297.0	987.6	690.6	297.0	863.5	566.5	297.0	588.1	291.1	297.0	766.2	469.2
Discounted	**236**	**580**	**344**	**236**	**507**	**271**	**236**	**346**	**110**	**236**	**450**	**214**

As mentioned above, a 10-year project for cassava has been considered in this analysis. It is further assumed that project investments (or costs) are implemented within a 3 to 5-year period. Investments are also assumed to accelerate in later years of the 5-year period. On the other hand, benefits may be generated over a period of 10 years. We consider increased nominal GDP values as the economic benefit streams of the investment. A discount rate of 10% has been used[21]. Undiscounted and discounted benefits and costs under the four scenarios are provided in the above table. The discounted benefits and costs found for the four scenarios have been used to calculate BCR for the four interventions.

The BCR for the livestock and processed food sector is 1.5, while tourism scenario has a BCR of 1.9. The largest BCR value of 2.5 has been found under the cassava[22] simulation. The BCR for Rice is at 2.2 – slightly smaller than the cassava simulation. On the basis of the BCR values, it can be argued that the RGC consider investing $ 236 million (discounted or $ 296 undiscounted) public resources to harness the potential of the cassava activity in Cambodia.

Figure 11: BCR values by scenarios



[21] *The author could not find a recommended social discount rate in Cambodia. According to some reports, the discounted rate used by the central bank is 5.25%. On other hand. Asian Development Bank (ADB), employed a discount rate of 12 % while evaluating the BRC of education sector projects.*

[22] *Increase in nominal GDP values are as benefit streams. Nominal GDP values are slightly higher under rice than the cassava. Use of output or real GDP values would have marginally lowered the BCR estimates of rice.*

07 ASSESSING ECONOMIC RETURN: DCGE MODEL APPROACH

Numerical specification of a general equilibrium model to a macro consistent data set is the first but most important step in a CGE exercise. The Cambodian SAM 2014 is a general equilibrium data set, thus, the dynamic computable general equilibrium (DCGE)[23] model for Cambodia has been calibrated to SAM 2014. Results of the base run of the DCGE model satisfy the model validation properties – namely the reproduction of SAM 2014. Validation of the DCGE also suggests that the model is ready to conduct policy simulations.

7.1. SIMULATION DESIGN

Since SAM model is a fixed price demand driven model, all simulations have been conducted by injecting additional amounts as one-time investment demand shocks. In the CGE model (i.e. both static and dynamic), simulations are usually performed by modifying the parameters such as tax rates, subsidy rates, and import duty rates etc. Moreover, some of the prices which are exogenous to the system may be also be altered to conduct simulations. This includes world price of imports, world price of exports, and nominal interest rates etc. Furthermore, institutional transfers (also exogenous) and policy variables may also be modified to perform simulations. Some of them are composed of government transfer to households and corporations, remittances from the rest of the world to households, government expenditure and investment demand. Two types of simulations have been conducted: (i) a BAU simulation; and (ii) policy simulations.

BAU: Two key drivers – namely accumulation of capital and increase in labour supply have been specified to simulate the BAU scenario. The capital accumulation rate (ratio of investment to capital stock) is increasing with respect to the ratio of the rate of return to capital and its user cost. The latter is equal to the dual price of investment times the sum of the depreciation rate and the exogenous real interest rate. The elasticity of the accumulation rate with respect to the ratio of return to capital and its user cost is set equal to two. By introducing investment by destination, we respect the equality condition with total investment by origin in the SAM 2014. Besides this, investment by destination is used to calibrate the sectoral capital stock in base run. Total labour supply is an endogenous variable – it is assumed to simply increase at the exogenous population growth rate.

Investment Demand Increase[24]: Following the SAM 2014 classification, in DCGE model investments are specified by the origin sectors such as construction, machinery, and transport equipment sectors etc. Thus, it is not possible to directly carry out simulation by altering investment demands of these four sectors. Rather in DCGE model simulations have been performed indirectly by enhancing exports demands of these four sectors such that gross fixed capital formations by all these four sectors are equal to $ 296 million over the ten-year period. For instance, additional Cassava exports demand of $ 517.7 million would ensure additional investment (GFCF) of $ 296 million. In the case of Rice, the is additional Rice export of $ 555.4 million would ensure additional investment (GFCF) of $ 296 million. In the case of LPF it would require LPF exports demand of $ 548.0 million would ensure additional investment (GFCF) of $ 296 million. The additional Tourism export of $ 583.1 million would ensure additional investment (GFCF) of $ 296 million. Simulation set ups under the DCGE are shown below.

[23] *Cambodia DCGE model is a square matrix with 2,274 single equations and 2,274 single variables. Model solution summary report suggests normal completion to a feasible solution to a square system. It thus also suggests that there are no infeasibility and errors.*

[24] *More specifically, in the DCGE simulations, world prices of the export commodities in question are manipulated to increase export demand amounts to assess their impacts on key macro and sectoral variables.*

Table 19: DCGE Model Simulation Set Up

	BAU[25]	Cassava	Rice	Livestock and Food	Tourism
Additional Investments (Million $)	0.0	296.0	296.0	296.0	296.0
Cassava (Million $)	0.0	296.0	0.0	0.0	0.0
Underlying Additional Exports (Million $)	0.0	517.7	0.0	0.0	0.0
Rice (Million $)	0.0	0.0	296.0	0.0	0.0
Underlying Additional Exports (Million $)	0.0	0.0	555.4	0.0	0.0
Livestock and Food (Million $)	0.0	0.0	0.0	296	0.0
Underlying Additional Exports (Million $)	0.0	0.0	0.0	548.0	0.0
Tourism (Million $)	0.0	0.0	0.0	0.0	296
Underlying Additional Exports (Million $)	0.0	0.0	0.0	0.0	583.1

7.2. SIMULATION RESULTS

In conformity with the standard practice of DCGE models, all outcomes of the investment demand increase simulations are compared with the outcomes derived under the BAU simulation. Simulation using CGE models generate changes in large number of variables including supply side variables – value added (GDP), outputs, and imports; and the demand side – household or private consumption; and export demand etc. It also impacts sectoral as well as the general price level. Incomes of the institutions (i.e. household, and government) are also affected by simulations. However, the focus is on the impact on selected key variables such as GDP at market prices; impacts on government revenue gross, wages of workers and household income[26].

Impacts on GDP

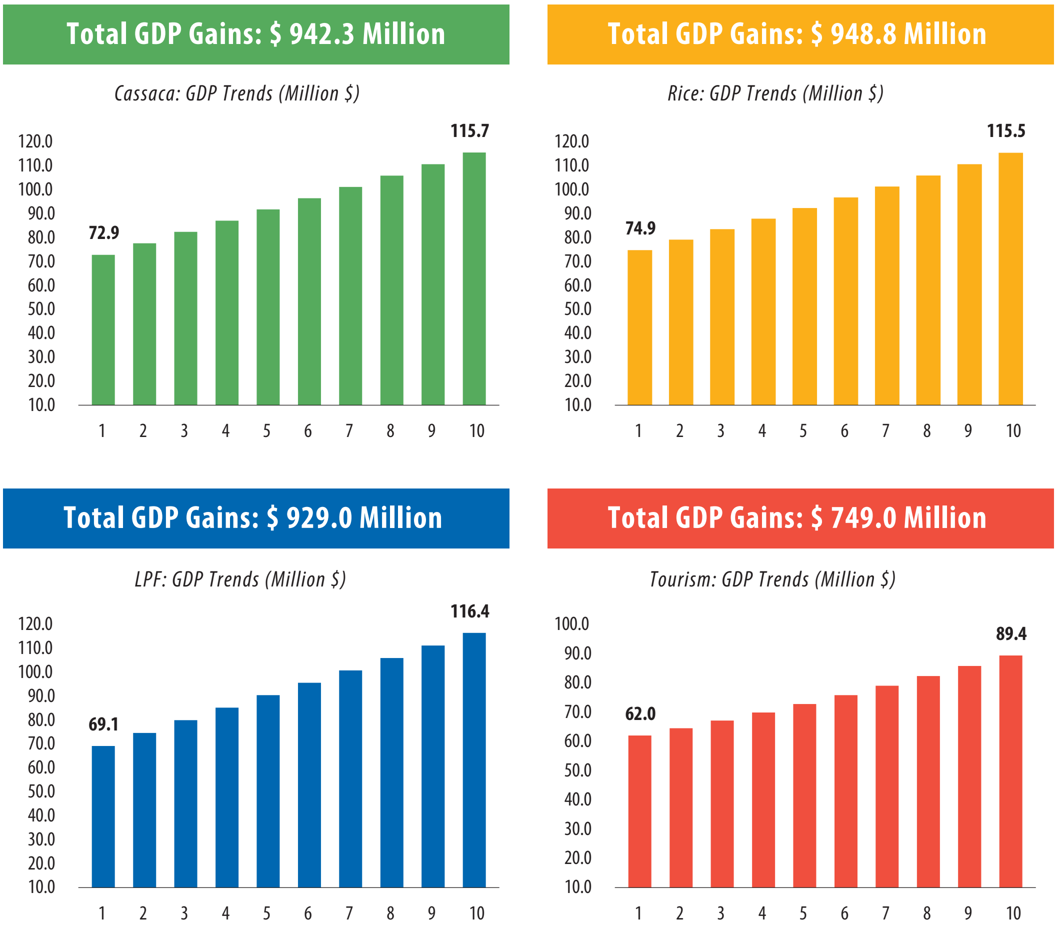
Additional investment demand of $ 296 million over the 10 period results in an increase in value added or GDP in each period of the 10-period time horizon. GDP trends over the ten-year period are shown in figure below.

In the case of the Cassava simulation, the period total GDP gain is $ 942.3 million. GDP gains suggest an increasing trend – with gain of $ 72.9 million in the first period which increases to $ 115.7 million in the last period. The total investment demand increases of $ 296 million over the 10-period in the Rice simulation lead to a total gain in value added or GDP equivalent to $ 948.8 million (i.e. $ 6.5 million higher than the amount found under the Cassava simulation). In this case, a GDP gain of $ 74.9 million in the first period rises to reach to $ 115.5 million in the last period. GDP gains in in the case of LPF simulation is less than GDP gains found for the Cassava and Rice simulations. The total gain in GDP equivalent to $ 929.0 million is less by $ 13.3 million compared to the Cassava simulation. While in comparison to the Rice simulation GDP gains is less by $ 19.8 million. However, GDP gains suggest an increasing trend – with gain of $ 69.1 million in the first period which increases to $ 116.4 million in the last period. The lowest GDP gains are found for the tourism simulation. In this case, the period total GDP gain is $ 749.0 million. GDP gains however suggest an increasing trend – with a gain of $ 62.0 million in the first period which increases to $ 89.4 million in the last period.

25 *BAU in DCGE model refers to a steady state (SS) situation where tendency of the dynamic variables is to return to the SS situation once a shock is injected into the system. The BAU scenario under DCGE is thus different the BAU scenario of the SAM model.*

26 *Since model invoked neoclassical full employment assumption in each period, there would be re-allocation of labour factors across activities but not additional gains in employment.*

Figure 12: DCGE simulation impacts on GDP (changes over BAU GDP values)

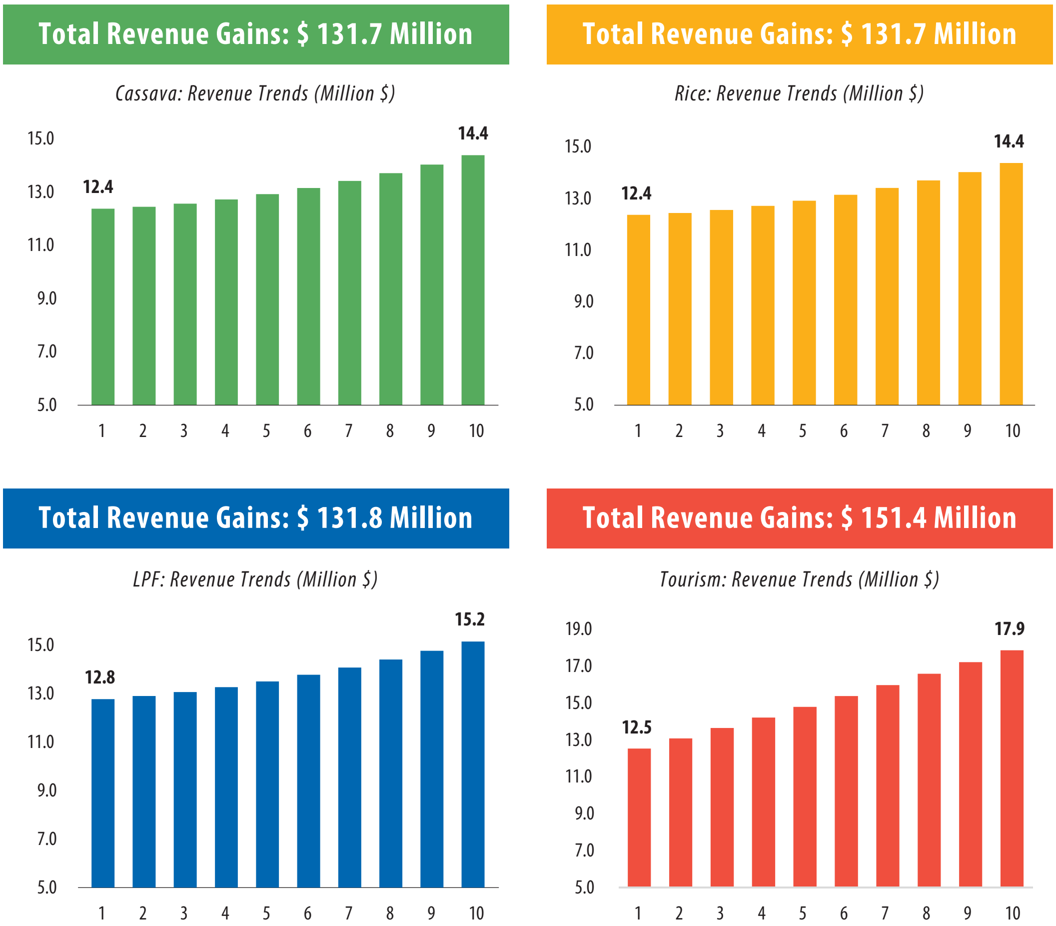


Source: Cambodian DCGE Model

Impacts on Revenue

Cassava is a low tax sector in Cambodia. Despite this phenomenon, expansion of the tax base (i.e. due to GDP expansion) government revenue shows an increasing revenue trend. The periods' total revenue gain is $ 131.7 million implying additional revenue efforts of 14 percent (i.e. the ratio of total additional revenue to total additional GDP ratio). Revenue gains in Rice and LPF simulations are close to revenue gains found for the Cassava simulation. The periods' total revenue gain is $ 131.7 million in the case of Rice simulation implying additional revenue efforts of 13.8 percent. In the case of the LPF simulation, the periods' total revenue gain is $ 131.8 million. The largest revenue gains were for the Tourism simulation. In this case, the periods' total revenue gain is $ 151.4 million suggesting additional revenue efforts of 20.0 percent.

Figure 13: DCGE simulation impacts on Revenue (changes over BAU Revenue values)



Source: Cambodian DCGE Model

Benefit-Cost Ratio

The BCR contrasts the estimated present value of all benefits against present value of all cost to assess feasibility of a project from both financial and economic perspectives. A project is feasible if the BCR is greater than one. Thus, BCR requires present value of all cost and benefits discounted using a discount rate.

Table 20: Discounted benefit and cost under the export demand scenarios

	Cassava			Rice			LPF			Tourism		
Period	***Cost***	***Benefit***	***B-C***	***Cost***	***Benefit***	***B-C***	***Cost***	***Benefit***	***B-C***	***Cost***	***Benefit***	***B-C***
1	27.4	72.9	45.5	27.8	74.9	47.0	26.6	69.1	42.6	25.3	62.0	36.7
2	27.7	77.7	50.0	28.0	79.2	51.2	27.1	74.6	47.5	26.2	64.5	38.3
3	28.1	82.5	54.4	28.3	83.6	55.3	27.7	79.9	52.2	27.1	67.1	40.0
4	28.6	87.2	58.6	28.6	88.0	59.4	28.4	85.2	56.8	28.0	69.9	41.9
5	29.1	91.9	62.7	29.1	92.4	63.4	29.1	90.4	61.3	29.0	72.8	43.8
6	29.3	96.5	67.2	29.4	96.9	67.5	29.3	95.6	66.3	30.3	75.8	45.5
7	30.0	101.2	71.3	30.1	101.4	71.3	30.7	100.7	70.1	30.9	79.0	48.1
8	31.1	106.0	74.9	30.8	106.1	75.3	31.5	105.9	74.4	32.0	82.3	50.3
9	31.9	110.8	78.9	31.5	110.8	79.2	32.4	111.1	78.8	33.0	85.8	52.7
10	32.7	115.7	83.0	32.3	115.5	83.3	33.3	116.4	83.1	34.1	89.4	55.2
Undiscounted	296	942	646	296	949	653	296	929	633	296	748	452
Discounted	197	612	415	197	618	420	196	601	404	195	490	295

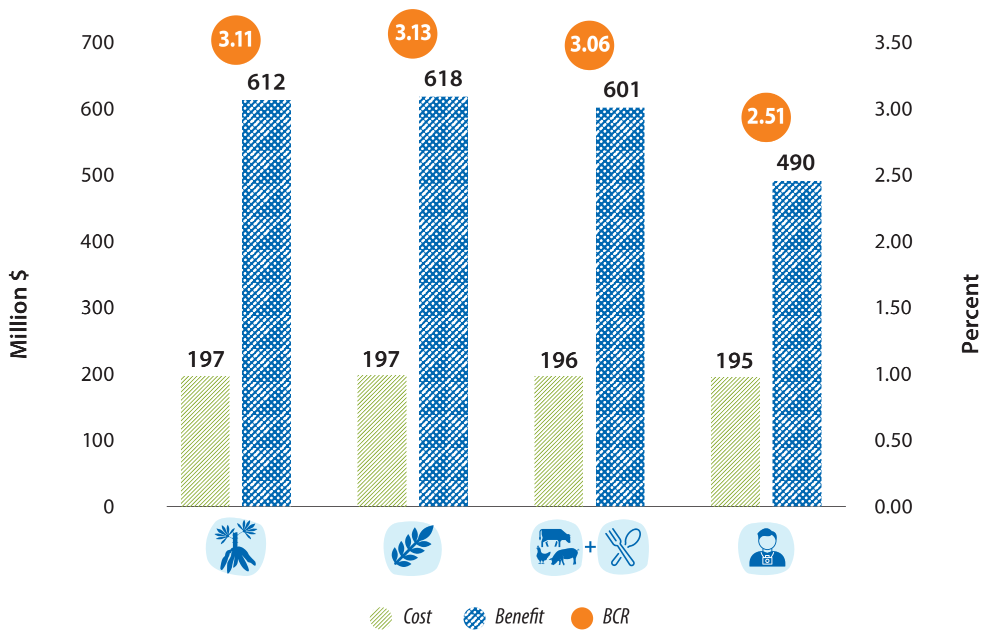
Note: Discounted investment (cost) values differ across simulations due to sequencing of investments over the ten-year period.

We consider increased GDP values for each year as the economic benefit streams of the investment. Investment demand increases in each period are considered interventions or costs. Again, a discount rate of 10% has been used (as in the case of the SAM approach). Undiscounted and discounted benefits and costs under the four simulations are provided in the above table. The discounted benefits and costs found for the four simulations have been used to calculate BCR for the interventions.

The BCR for the rice simulation is at 3.13. The BCR for the LPF simulation is 3.06, while the tourism scenario has a BCR of 2.51. While the BCR value of 3.11 found for the Cassava simulation is higher than LPF and Tourism simulations but slightly lower than has been found under the Rice simulation. Following observations are worth mention:

i. all estimated BCR values are higher than one envisaging all feasible projects;
ii. there are hardly any significant differences the BCR values of the Cassava and Rice sector – envisaging that they both are deserving candidates for the public sector investment;
iii. as expected estimated BCR values are different than the BCR values found under the SAM simulation;
iv. conclusions of SAM approach and DCGE approach are the same, on the basis of the BCR values – there is a strong case for investment of required amounts of public resources by RGC to harness the potential of the Cassava Sector in Cambodia.

Figure 14: BCR values by scenarios



Worker's Wages

The labour market according to Cambodia's SAM and DCGE has been represented by three skill categories – low skill; medium skill and high skill. Given the assumption of full-employment, gains in GDP in the four simulations suggest increase in workers' wages. The table below captures gains in wages by the three skill worker categories.

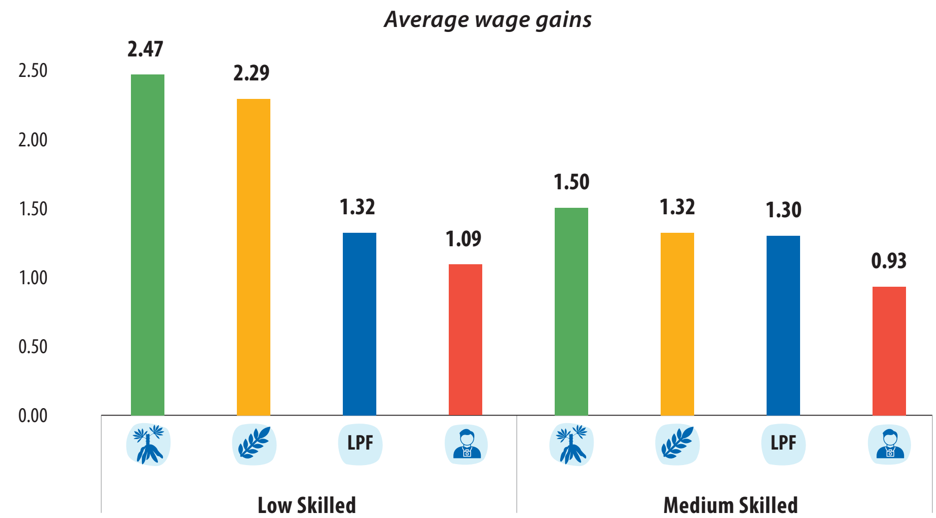
Table 21: Worker's wage increases trends (% change over BAU values)

	Cassava			Rice			LPF			Tourism		
Period	**LSK**	**MSK**	**HSL**	**LSK**	**MSK**	**HSL**	**LSK**	**MSK**	**HSL**	**LSK**	**MSK**	**HSL**
1	1.660	0.994	0.640	1.684	0.948	0.700	1.185	0.900	0.668	0.898	0.772	0.857
2	1.618	0.974	0.633	1.622	0.919	0.683	1.172	0.894	0.671	0.896	0.768	0.843
3	1.581	0.956	0.627	1.567	0.894	0.668	1.160	0.888	0.673	0.894	0.764	0.831
4	1.549	0.940	0.621	1.520	0.872	0.656	1.149	0.883	0.674	0.891	0.760	0.820
5	1.521	0.926	0.616	1.479	0.853	0.645	1.139	0.877	0.675	0.888	0.757	0.810
6	1.496	0.914	0.612	1.443	0.837	0.636	1.129	0.873	0.676	0.885	0.753	0.801
7	1.474	0.904	0.608	1.411	0.822	0.628	1.120	0.868	0.676	0.881	0.749	0.794
8	1.454	0.895	0.605	1.384	0.809	0.621	1.112	0.864	0.676	0.877	0.745	0.787
9	1.437	0.886	0.602	1.360	0.798	0.615	1.105	0.860	0.676	0.873	0.742	0.781
10	1.421	0.879	0.599	1.338	0.788	0.609	1.098	0.856	0.676	0.869	0.738	0.775
Average	**1.521**	**0.927**	**0.616**	**1.481**	**0.854**	**0.646**	**1.137**	**0.876**	**0.674**	**0.885**	**0.755**	**0.810**
WII	**2.47**	**1.50**	**1.00**	**2.29**	**1.32**	**1.00**	**1.69**	**1.30**	**1.00**	**1.09**	**0.93**	**1.00**

Note: WII refers to wage increase of other two skill classes (i.e. low and medium skilled) indexed to average wage of the high skilled workers.

Figure below captures the progressivity of the wage gains. To assess the progressivity of wage gains, period average (i.e. average of 10 periods) wage increases of low and medium skilled workers have been indexed to average wage gains of high skilled workers.

Figure 15: Wage gains for low and medium skilled workers across simulation



Some interesting and important observations include:

i. In line with the larger GDP gains, wage gains across the low and medium skilled worker categories are highest under the cassava simulations, while for the high skill category, the wage gain is lowest in the cassava simulation.

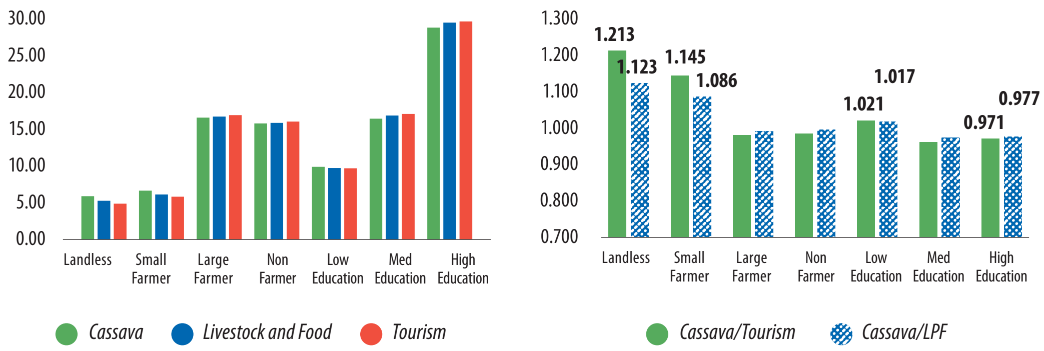
ii. The period average wage increase is most progressive in the cassava simulation with the period average wage increase for low skilled workers being 2.47 times higher than the wage increase of high skilled workers. It is 2.29 times higher under the rice simulation, and dropped to 1.68 in the case of the livestock and food simulation. The wage increase is least progressive in the case of tourism simulation with the period average wage increase for low skilled workers at only 1.09 times higher than the wage increase of high skilled workers. Medium skilled workers' wage gain is lower than the average wage gain of high skilled workers.

Household Income

Household income gains are analysed to measure welfare and distributional impacts of the three export demand simulations[27]. The figure below captures period total income gains by the representative households.

Figure 16: Distribution of income gains over BAU values by households and simulations (%)

Panel A: Period total income gains by households ***Panel B: Comparative income gains in Cassava***



Source: Cambodian DCGE Model

Panel A shows the period total income gains by the representative households under the three export demand simulations. Based on the income size, three less well-off households in Cambodia are landless, small farmers, and low educated households. Well-off households include large farmers, non-farm households, and medium educated households. High educated households are the most affluent group. It is clear that income gains for the landless and small farmers are higher under the cassava simulation than the other two competing simulations considered out of three simulations (wage impacts in the case of the Rice simulation is almost same than that of the Cassava and hence are not included). Income gains are also higher the low educated households under the cassava simulation compared to the other simulations.

On the other hand, according to Panel B, income gains of the well-off households (i.e. large farmer, non-farm, medium educated, and high educated) are less in the cassava simulation compared to gains found for the other two simulations. *These trends tend to suggest a pro-poor (or pro less well-off) income distribution under the cassava simulation compared to the other two simulations.* To obtain a better understanding of income gains, income gains by households are contrasted against income gains under the tourism simulation and livestock and processed food simulation (LPF). A value greater than one suggests a favourable income gain and anything less than one envisages an unfavourable income gain. These results are shown in Panel B. *The ratios are greater than one for all three less well-off households under the cassava simulation implying progressive income gains under the cassava simulation.*

[27] *Impacts are similar between Cassava and Rice and hence are not repeated.*

08 CONCLUDING OBSERVATIONS

Cassava is the second largest agricultural crop in Cambodia. It is also an important export item and an input to several industrial processes. Its development offers both short-term and long-term structural benefits to the Cambodian economy. Its potential role in promoting higher value-added and greater productivity has gained special attention from the RGC under its Industrial Development Policy 2015-2025.

However, its potential is under-realized, with much of sector focused on growing and exporting raw product, and in-country processing remains underutilized or non-existent. Realization of its potential needs public sector interventions in terms of investing resources and implementing capacity-building projects. In order to do this, RGC policy makers intend to understand the economic (or socio-economic) returns to investment in the cassava sector. This study is an attempt to assess the economic returns of public investment to the sector versus to other competing sectors.

Both SAM model and DCGE model have been used to assess economic returns to cassava investment. Since the previous Cambodian SAM which was prepared for 2011 does not have a cassava sector, a new cassava inclusive SAM has been developed for 2014. More specifically, a SAM multiplier model based on SAM 2014 has been used to examine the economic return of public sector investment on cassava.

A DCGE model calibrated to SAM 2014 has also been developed for this exercise. Simulations have also been carried out with DCGE model to assess the economic returns to cassava and the competing sectors under stricter conditions of supply side constraints.

SAM Approach

Economic returns to Cassava have been assessed by looking into the impacts on the income generation (i.e. nominal GDP values). A benefit cost ratio is also applied to examine the BCRs of the public investments on Cassava and competing sectors. This may also help select interventions on the basis of BCR values. In addition to the economic return analysis, socio-economic impacts have been assessed by examining the following key and relevant indicators such as: (i) real income (i.e. real GDP); (ii) revenue; (iii) employment; and (iv) poverty.

The economic and socio-economic return outcomes have been considered for a 10-year period (i.e. between 2019 and 2029). Four simulations have been carried out to examine the economic return as well as socio-economic impacts of public sector investment. The BAU scenario has no additional intervention. Additional investment of $ 296 million into the cassava sector has been considered in the cassava simulation. Three alternative scenarios are also considered. In the first one, additional public investment of $ 296 million to the rice sector has been considered. In another simulation $ 296 million additional investment has been injected into the livestock and processed food sectors. An additional investment of $ 296 million into the tourism sector has been considered in the last simulation.

Two measures have been used to assess economic returns to public investment on cassava and competing sectors. These are: (i) total income gains over the 10-year project period; and (ii) BCRs of these alternative investments. The income gain measure (or nominal GDP) suggests that *maximum income expansion occurs under the cassava scenario* compared to other scenarios. The Socio-economic impact has been examined by two widely used indicators such as changes in employment and poverty situation.

Economic returns are high for cassava investment. The benefit-cost ratio (BCR) contrasts the estimated present value of all benefits against present value of all cost to assess feasibility of a project from both financial and economic perspectives. A project is feasible if the BCR is greater than one. A 10-year project for cassava has been considered. The BCRs for the livestock and processed food sectors and tourism are respectively 1.5 and 1.9, while the rice scenario has a BCR of 2.2. The largest BCR value of 2.5 has been found under the cassava simulation. On the basis of the BCR values, it is concluded that RGC should invest $ 296 million public resources to harness the potential of the cassava activity in Cambodia.

Revenue gains under the investment simulations have been compared to revenue gains under BAU scenario. Both tax rates and tax nets have remained unchanged. But as a result of economic expansion, revenue has increased under the four simulations, albeit to different extents. Notably, the largest revenue gain is found for the cassava scenario. Revenue gains over the 10-year period may be as high as $ 269 million. Thus, the revenue gain ($ 269 million) is marginally less than the investment requirement ($ 296 million). This implies that a small amount of deficit financing is needed from other sources. Similarly, revenue gains in the alternative scenarios, although positive, fall short of matching up to the required public investment. Thus, the analysis of revenue gains and public investment envisages that financing from other sources may be needed to cover the required public investment in the Cassava sector.

Socio-economic impacts have been examined by two widely used indicators - changes in employment and the poverty situation. Here too *employment and poverty have found better outcomes under the cassava scenario compared to the other scenarios*.

DCGE Approach

Impacts on GDP; revenue and BCR have been used to assess the economic returns of cassava investment. Two types of simulations have been conducted: (i) a BAU simulation; and (ii) policy simulations. Accumulation of capital and increase in labour supply have been specified to simulate the BAU scenario. As mentioned above, following the SAM 2014 classification, in DCGE model investments are specified by the origin sectors such as construction, machinery, and transport equipment sectors etc. Thus, it is not possible to directly carry out simulation by altering investment demands of these four sectors. Rather in DCGE model simulations have been performed indirectly by enhancing exports demands of these four sectors such that GFCFs by all these four sectors are equal to $ 296 million over the ten-year period.

Two measures have been used to assess economic returns in cassava and competing sectors. These are: (i) total income or GDP gains; and (ii) estimated BCRs.

The highest total GDP gain of $ 948.8 million has been found under the rice simulation, followed closely by $ 942.3 million under the cassava simulation. GDP gains under the livestock and processed food simulation, and the tourism simulation have been $ 929.0 million and $ 749.0 million respectively. The income gain measure (or nominal GDP) suggests *income expansion under the rice and cassava simulations* are more or less similar.

We consider increased GDP values for each year as the economic benefit streams of the investment or intervention. Again, a discount rate of 10% has been used (as in the case of SAM approach). The BCR values for the cassava simulation was 3.11, for the livestock and processed food simulation 3.06 and 2.53 for the tourism simulation. However, contrary to SAM model result, the largest BCR value of 3.13 has been found under the rice simulation.

An important finding is that, period average wage increase is most progressive in the cassava simulation with wage increase for low skilled workers being 2.47 times higher than that of high skilled workers. This is 2.29 times higher under the rice simulation and dropped to 1.68 in the case of the LPF simulation. The wage increase is least progressive in the case of the Tourism simulation.

On the basis of estimated economic returns measured by income gains; benefit-cost ratio; and revenue gains, a public sector investment of $ 296 million in the cassava sector in Cambodia is justified. The positive and favourable impacts on employment generation, progressivity in wage increase and poverty reduction under the cassava simulation also vindicate the economic returns of the Cassava sector. However, it is important to note that, full investment amount of $ 296 million should be allocated for cassava to realize the full potential of this sector.

REFERENCES:

Abbink, G. A., M. C. Braber, and S. I. Cohen. 1995. "A SAM-CGE Demonstration Model for Indonesia: A Static and Dynamic Specifications and Experiments." International Economic Journal 9 (3): 15–33.

Afreen, N. and M. S. Haque (2014), "Cost benefit analysis of cassava production in Sherpur district of Bangladesh." Journal of Bangladesh Agricultural University, 12(1): 119–126, 2014

Bourguignon, F., W. H. Branson, and J. de Melo. 1989. "Macroeconomic Adjustment and Income Distribution: A Macro-Micro Simulation Model." OECD Technical Paper 1. Paris.

Jung, H. S., and E. Thorbecke. 2003. "The Impact of Public Education Expenditure on Human Capital, Growth, and Poverty in Tanzania and Zambia: A General Equilibrium Approach." Journal of Policy Modeling 25: 701–25.

Kuy, M.S (2014, "Social Protection Policy in Cambodia", Working paper, Australian National University. July 2014.

NIS (2015). Cambodia Socio-Economic Survey 2014, National Institute of Statistics Ministry of Planning Phnom Penh, October 2015.

Philippines Statistical Authority (2006). 2006 Input-output Accounts of the Philippines. Philippines Statistical Authority, Manila, September, 2014.

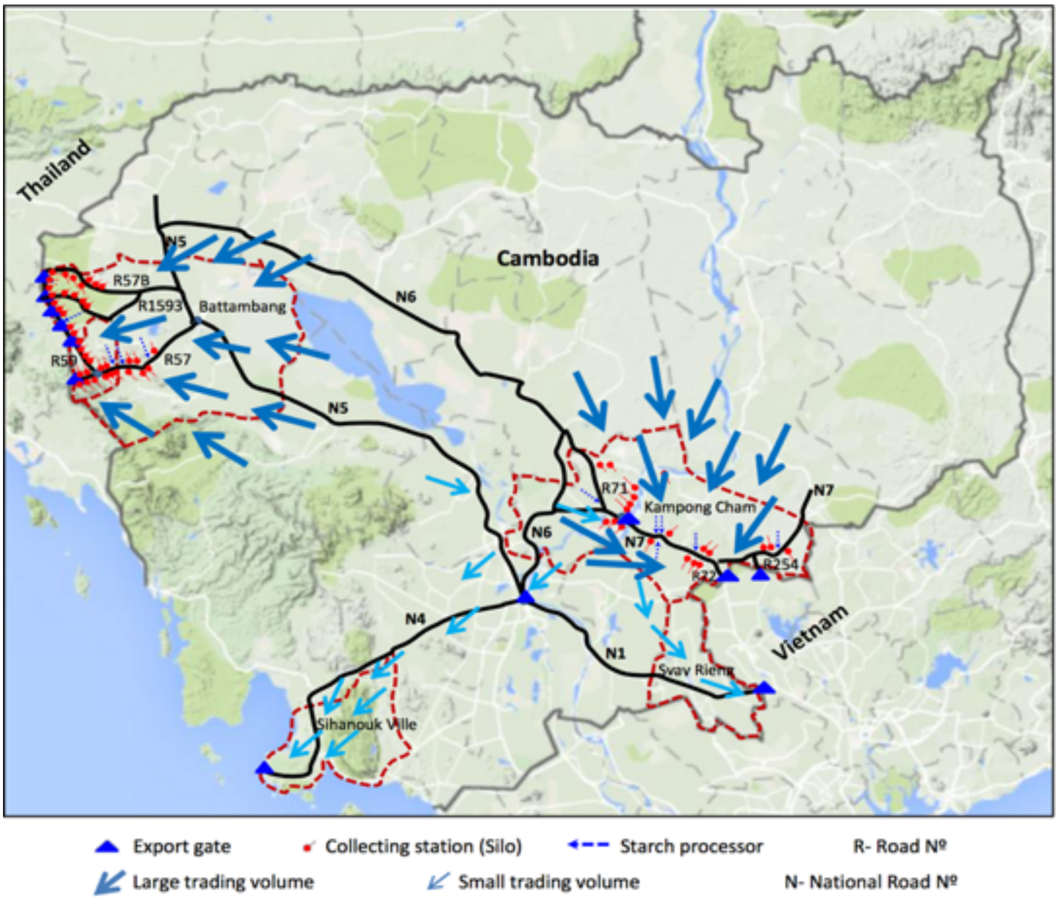
Pradesh, A. and J. Thurlow, (2017), "2014 Social Accounting Matrix for Myanmar". IFPRI, Washington DC, USA.

UBOS (2019), "Uganda Social Accounting Matrix – Preliminary Results", Uganda Bureau of Statistics, May, 2019, Kampala.

UN (1993b), "Handbook of National Accounting: Integrated Environmental and Economic Accounting. Studies in Method (Series F, No. 61)," Department for Economic and Social Information and Policy Analysis, Statistical Division, United Nations, New York.

ANNEX 1: CASSAVA PRODUCTION AND VALUE CHAIN

The flows of cassava to the main border crossings



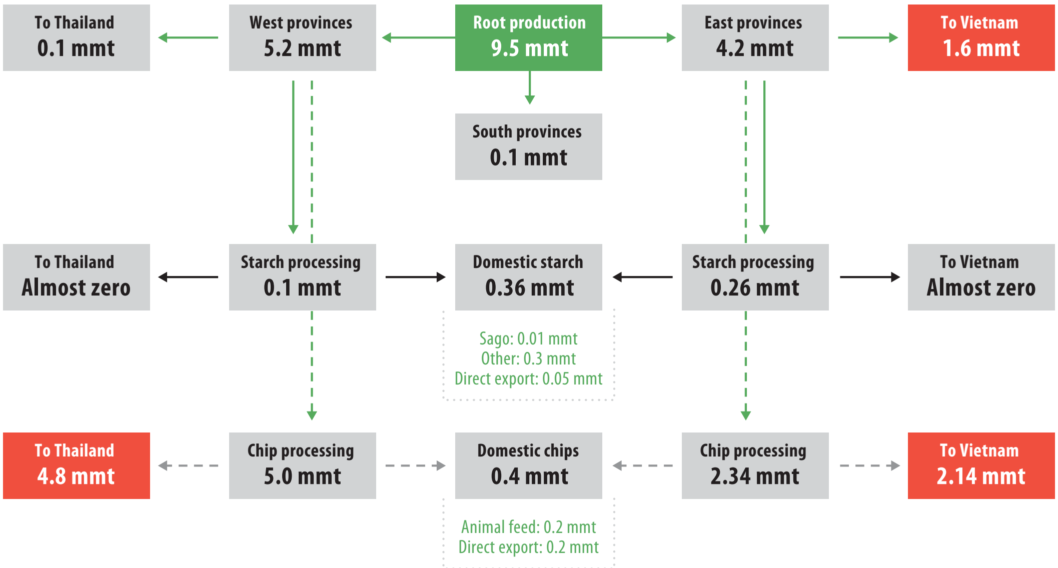
Source: Commoditia, "A Study of the Value Chains for Cassava in Cambodia", 2016

Cassava production area: Cambodia

Source: Commoditia, "A Study of the Value Chains for Cassava in Cambodia", 2016

Analysis of Value Chain (Should show entire value chain of Cassava in Cambodia)[28]

I16: The value chains for cassava in Cambodia 2014/15 (million tonnes of roots)



SL No	Investment project description	budget
1	Creation of a R & D center	2
2	Breeding new cassava varieties and research activities	2
3	Dissemination of agronomic practices, extension services and on-farm support	2.5
4	Cassava seedling and multiplication (private owned)	0.5
5	Soil analysis, zoning, soil management, climate smart agriculture etc.	1
6	Improving agricultural farming system, including quality of input supplies, agricultural machineries and productivity of labour force	1
7	Climate change adoption, small scale irrigation, and farming facilities	4
8	Building farmer entrepreneurship/commercial farming	1
9	Build road for access to farm and effective land use	5
10	Build on-farm facilities such as storage, seed bank	5
11	Special budget to intervene during supply glut, temporary border closing or market sluggish	50
12	Year-round production (crop rotation, calendar plan and technical supports on production)	2
13	Supply chain management/contract farming	1
14	Capacity building and institutional support of farmer organizations	1
15	Market research and analysis of global trend for strategic guidance and the government's intervention	0.2
16	Investment attraction strategy and activities	0.2
17	Access to technologies and innovation for better factories	0.2
18	Creating a functional national cassava association with support on institutional development and capacity building	0.5
19	Business networking and marketing activities to promote Cambodia cassava	0.2
20	Product standards/development	0.1
21	Building skill labours suiting to needs of the private sector	0.3
22	Trade negotiation and facilitation for market access and penetration, mainly removing barriers to trade etc.	0.3
23	Product development and innovation center	3
24	Support on SMEs to trial and produce products from cassava for local markets and export	1
25	Improve trade facilitation services (one window service or on-line app)	1
26	Address issues/export bottlenecks (informal fee,	0.3
27	Trade finance and loan to private sector	50
28	Short cut roads from processing factories to ports	150
29	Logistic facilities at ports or key border check points as well as linking from processing zones to transportation means (rail or waterways)	10
30	Research on ethanol blending, cassava special processing zone, animal value chain etc.	0.15
31	Improving business environment including laws, regulations, and other support	0.2
32	Operation of the cassava working group	0.5
33	M & E and update the cassava policy	0.3
	Total (Million $)	**296.45**

[28] *Ibid.*

ANNEX 2: DERIVATION OF MICRO-SAM ACCOUNTS

Activity and Commodity Accounts

Activity and commodity accounts deal with the supply and demand components of the economy. Derivation of activity-commodity accounts thus implies generation of each element of supply and demand by the representative activity-commodity classification. In the context of the current exercise, it entails derivation of supply and demand components by 26 representative activities and 31 representative commodities.

Supply Component

Value Added: According to the National Accounts of Cambodia, estimates of value added are provided for activities (this is referred to as 'NA sector'). Value added data by the 26 NA sectors has been provided by NIS. This information has been used directly to define the value-added vector of the 26 activities. Among others, NIS also provides value added data for cassava, forestry, and livestock and poultry activities. The value-added account may be symbolized as: VA_j^{14} , where j represents the 26 activities.

Intermediate Input Use: An updated inter-industry transaction matrix for 2014 is not available from which input use by the 26 activities can be obtained. Activity level input usages to value added shares (i.e.∂) as observed in 2011 IOT are used with the activity level value added for 2014 to derive the initial input use values by the 26 activities.

$$IU_j^{14} = \partial_j^{12} \text{ x } VA_j^{14}$$

Outputs or Domestic Supply: Input use and value added together define gross output (Q_j^{14}) by 26 activities for 2014.

$$Q_j^{14} = IU_j^{14} \text{ x } VA_j^{14}$$

The next step is to convert the value added by 26 activities to 31 commodities through a mapping between the 26-activity and 31 commodity classification. Higher numbers of commodities than activities suggest that some activities produce more than one commodity. Except one for activity, one to one correspondence between activity and commodity level has been found for remaining 25 activities and commodities. This implies that each of these 25 activities produce one single commodity. The remaining manufacturing activity produces four commodities. Supplies of two commodities (i.e. chemical and petroleum products) are entirely from imports.

Indirect Tax: Information of indirect tax mobilized from the domestic bases for 2014 is obtained from the General Director of Taxation (GDT). The sector classification used by GDT is different from the 31-commodity classification. Hence a mapping scheme relating the GDT classification to the SAM commodity classification is defined. Thus, using both the GDT information and mapping scheme the indirect tax vector for 2014 (IT_j^{14}) has been derived.

BOX 3: CASSAVA SECTOR DATA

Data needed to represent a cassava activity are not readily available in Cambodia. Following data are needed to design cassava activity - value added; input use; technology vector; consumption of cassava; and exports of cassava. Cassava value added data for 2014 has been provided by NIS.

Input use in cassava is based on patterns observed in Bangladesh study (2014), Philippines SAM 2006 and Myanmar SAM for 2014. Following these data sets, input-output ratio for cassava has been set around 20 percent, that is one-unit cassava production needs 0.2 units of inputs other products. Again, the technology structure of the cassava activity is based on the input structures found for Bangladesh, Philippines SAM and Myanmar SAMs. Out of 31 commodities, cassava activity purchases 20 products for cassava production in Cambodia. Cassava export data has been obtained from ITC data set. On the other hand, private consumption of cassava has been obtained from CSES 2014.

Imports of Goods and Services: Information on imports of goods for 2014 ($mocM_m^{14}$) was acquired from the Ministry of Commerce (MOC) as well as from ITC trade data. Again, the commodity classification (denoted as m) used by MOC and ITC varies from the SAM commodity classifications (i.e. g). The SAM account classification denotes that out of 31 sectors – 21 are goods and the remaining 10 are services. Hence a mapping scheme linking the MOC classification to 21 SAM goods classification is used to derive imports by SAM commodities for 2014 ($M_g^{14} = mocM_m^{14}$). Service receipts data provided in the macro-economic framework have been used to generate service imports for the year 2014 (M_s^{14}). The total imports for 2014 are thus composed of estimated goods and services imports.

$$M_j^{14} = M_g^{14} + M_s^{14}$$

Revenue from import bases (dM_g^{14}) for 2014 is based on information from customs agency.

Total Supply: The main components of the supply side of an economy are domestically produced goods and services or outputs (Q_j^{14}) and imports of goods and services (M_j^{14}). Total supply of goods and services (SS_j^{14}) by 31 SAM commodities is generated by adding outputs to imports. Total supply is given as:

$$SS_j^{14} = Q_j^{14} + IT_j^{14} + M_j^{14} + dM_g^{14}$$

Use or Demand Component

Private or Household Consumption: The vector of private or household consumption has been obtained from the information on 'final consumption expenditure by basic heading of more than 100 commodities at current price, reported in CSES 2014. Commodity classification of CSES is different from the SAM commodity classification. Hence in the first step, CSES consumption estimates by 100 commodities $_{CES}pC_j^{14}$ are mapped to 31 SAM commodities classification (pC_j^{14}). Derivation of private consumption vector for 2014 is shown below.

$$pC_j^{14} = {}_{CES}pC_j^{14}$$

Government Consumption: Government consumption is usually confined to three sectors such as public administration, education, and health. The rationale is that different purchases (e.g. agriculture, commodities and services) by government are included under the sector public administration data. Information on government expenditure for 2014 ($_{NA}gC^{14}$) is thus used to derive government consumption by SAM commodities for 2014 ($gC_j^{14} = {}_{NA}gC^{14}$).

Exports of Goods and Services: Information on exports of goods for 2014 ($mocE_E^{14}$) is obtained from export of commodities by 4-digit level, provided by the MOC and ITC trade data. Again, the sector classification of the MOC is different from the 21 SAM-goods classification. Hence a mapping scheme linking the MOC classification to SAM goods classification is used to derive exports by 21 SAM goods for 2014 ($E_g^{14} = mocE_E^{14}$). Service payment data provided in macro-economic framework have been used to generate service exports for the year 2014 (E_s^{14}). The total exports for 2014 are thus composed of estimated goods and services exports.

$$E_j^{14} = E_g^{14} + E_s^{14}$$

Investment: National account with experts and SAM builders are conversant the special treatment of goods and services with respect to capital formation and stock changes. It is well known that only goods can be stored. On the other hand, services must be consumed instantaneously, implying that it cannot be stored and hence can not last for a longer time duration to be able to form capital. Furthermore, only some specific goods can generate investment or form capital which assists further production. Therefore, in SAM 2014, stocks and capital formations are recorded only against goods and not against services. Investment for 2014 (I_j^{14}) has been generated using this information

Final Demand: The above estimates of consumption, exports and investment have been added together to derive final demand vector for the 31 SAM commodities (FD_j^{14}). This is specified as:

$$FD_j^{14} = pC_j^{14} + gC_j^{14} + E_j^{14} + I_j^{14}$$

Intermediate Input Demand: Final demand (FD_j^{14}) has been deducted from total supply (SS_j^{14}) to derive initial intermediate input demand by 31 SAM commodities ($ID_j^{14} = SS_j^{14} - FD_j^{14}$). Using the information of final demand and intermediate demand, a vector of initial total demand (DD_j^{14}) for 31 SAM commodities has been derived.

The resulting demand in the first instance does not match or balance supply and demand vectors. In other words, these discrepancies may be denoted as *errors*. Hence an iterative balancing technique has been used to re-estimate some of the initial values of the supply and demand components to ensure equality between sectoral supply and demand. An accepted practice for IOT or SAM balancing is that errors are absorbed in larger accounts or values of accounts which are not firm. The larger accounts are input demand, input use, private consumption, and value added. The value added vector is not usually adjusted since it is estimated more accurately than the other three accounts mentioned above. Following this principle, specific elements of the input demand vector and input use vector have been adjusted in the first step of this error correction procedure. In the last step, only few elements of the consumption vector have been modified ensuring consumption control total specified in Macro PA. The two-step error correction process not only ensures supply-demand matching but also restricts significant deviation of the technical coefficients from the observed realities. In order to verify the degree of deviation of the technical coefficients, the estimated backward linkages are reported below. The final estimates of the intermediate input demand; input use and private consumption are inserted in place of the initial estimates to ensure demand and supply balance for all the sectors.

Factor Accounts

Factors of production (FP) play an important role in the process of producing and distributing the fruits of growth and development, i.e. by providing factor services to production activities and in return factors receive value-added in the form of wages and salaries, profits and rents. The level of distribution is in accordance to the level and kind of endowments; hence, the income subsequently transferred to household groups (i.e. as owners of labour and capital) will be heavily influenced by their endowments, which typify household behaviour.

The FP can be classified into three main categories of factor ownership (a) labour, (b) fixed assets and (c) capital services. Unlike the first, the last two are not straightforward. It must be considered that only households provide labour services, whereas fixed assets, land and capital services are provided both by households and other institutions (i.e. corporations and government). Classifications of labour types should aim at grouping individuals into homogeneous groups of income earners. For the grouping, differences regarding average factor incomes and gender within or between labour groups must be considered. Among others, the most important could be labour skills reflecting different occupational categories or different income groups of earners using gender as an additional criterion. More concretely, for most production activities factor labour can be distinguished according to highly skilled professionals, managers, traders, government employees, personal services employees, blue-collar labourers or street vendors. For agricultural activities these could be agricultural farm owners, farm administrators and land workers of distinct labour types: landless farmers, subsistence farmers, etc. It should be clear that all or most could be classified according to gender.

Information from developing countries as well as Cambodia appears to be the same, inevitably showing a high incidence of self-employed or family-based activities, hence, differences according to the ownership of fixed assets and capital incomes generated by unincorporated and corporate sectors should be considered. Incomes from unincorporated capital (mainly family enterprises) can additionally distinguish the imputed wage for self-employed workers and the remaining capital income. A desirable classification of factors of production is presented below.

Table 22: A Desirable Factor Classification

Labour	Capitalist and Others
1. Self-employed Labour	1. Unincorporated or mixed income
2. High Skilled Professionals and Managers	2. Corporate
3. Medium Skilled Professionals and Technicians	3. Rentiers
4. Government and non-Government Office Clerks (employees)	
5. Workers (Transport Workers, Mechanics and Other Industrial Workers)	
6. Artisans and Handicraftsmen	
7. Informal (Street-vendors and non-economic services N.E.C.)	
8. Agricultural Owners/Administrators	
9. Agricultural Workers	
10. Agriculture Subsistence farmers	

Even though the above classification of factors appears to be desirable, it was not possible at this point to derive a desirable classification of factors as stated above. In the present version of the SAM 2014, factors are classified into three types of labour and one type of capital. The factor classifications are based on the information derived from CSES 2014 and Cambodia SAM for 2011.

Factor Income by Activities: Detailed information on sectoral employment for the different factor categories has been extracted from the 2011 SAM for Cambodia and employment matrix 2012. The information of the two above sources are added together to define a factor-sector share matrix ($shyF_{Fj}$). Derived value-added vector by 26 SAM activities for 2014 (VA_j^{14}) is distributed among 4 factor types[29] using the factor-activity share matrix ($shyF_{Fj}$) to update the factorial income matrix by activity for 2014 (yF_{Fj}^{14}). The derivation is shown below.

$$yF_{Fj}^{14}=shyF_{Fj} \cdot VA_j^{14}$$

Institutional Accounts

Current account transactions are captured by 3 institutional agents: households and unincorporated capital; government; and the rest of the world. Household account includes 7 representative groups (4 rural and 3 urban). One consolidated capital account is also defined to capture the flows of savings and investment by institutions and the rest of the world, respectively.

Household Accounts

Households (HHs) should be conceptualized as consumption units, different from income earning agents (e.g. labourers, renters and capitalists), which receive 'transfers' from the factors of production which they own and 'sell' to production activities. This distinction is important because the income sources of earning agents can be diverse (as many as the activities which use the factor(s) owned by the agents), while 'income' to households (viewed as a group of income earning agents) may come from the different factor endowments which the members of the household possess and may simultaneously come from several factor endowments.

Generally, in specifying household classifications the following criteria are considered:

1) Regional differences, i.e. urban and rural households;
2) Education levels of the heads of the households;
3) Gender of the heads of the households; and
4) Access to productive forms of material wealth, particularly agricultural land and land rights.

The above criteria can be justified on the grounds that:

a) Urban-rural income differentials are usually large. The average per capita disposable income of urban households is considerably higher than that of rural households. And often female headed households are more vulnerable;

[29] *SAM 2014 factor account includes three types of labour based on their level of skills. Workers with no education or skill training have been classified as low skilled. Workers with education between class 5 and 12 or with some skill trainings have been classified as medium skilled. High skill category includes persons who have completed 12 class and more.*

b) Among the factors that can help to generate homogeneity, the most relevant appear to be classifications according to homogeneity in consumption expenditure or savings patterns;

c) In urban areas differences in household income levels and consumption patterns are closely related to the educational level of the household head, while for rural households the size of farm landholdings appears to be the most significant determinant; and

d) Significant differences in consumption pattern and in income generating capacity are found between those rural households primarily engaged in agricultural activities and those whose main income is derived from non-agricultural activities.

The 2014 SAM distinguishes between seven household types, classified according to location, land ownership and education of the household's head. Household classifications contained in SAM 2014 are based on CSES classifications (CSES, 2014). The details are provided in the table below.

Table 23: Household Types and Their Definition

SAM HH Classification	CSES Classification
Landless Farmer	Landless Farmer: owning less than 4999 sqm
Marginal Farmer	Marginal Farmer: 5000 sqm<S.F.<39,999 sqm
Large Farmer	Large Farmer: owning more than 40000 sqm
Non-Farm Poor	Non-Farm[30]
Low Education	Low Education: If no class completed
Medium Education	Medium Education: Class 5<Education<Class 10
High Education	High Education: 10 Class and above

Main sources of household income are factor returns and various transfers from domestic and external institutions. Generation of household income from these sources is discussed below.

Household Income from Factors: Direct factor income (i.e. wages and mixed income) constitutes the major source of household income. Compensation to employees or labour factor payments is paid entirely to household groups, as they are the only suppliers of labour factor. Control totals for labour incomes by the 3 factor types are already estimated above which must be distributed among the 7 representative households according to their factor endowments. Factor endowment information ($shfY_{FH}$) is contained in CSES 2014. Control totals for factor income (yF_{FK}^{14}) are applied on the factor endowment shares to generate household's income from factors (fY_{FH}^{14}=$shfY_{FH} \cdot \sum_K yF_{FK}^{14}$). This procedure ensures that the observed factor endowment structure (i.e. reflecting the factor income distribution) of 2014 as well as the factor control totals for 2014 are preserved.

Household Receipts from Other Sources: Besides labour and mixed incomes, households also receive income from other sources, namely remittances or factor incomes from abroad, and government transfers. Information on foreign remittances for 2014 ($rowR^{14}$) is obtained from balance payment data. Remittance share information by household groups ($shfR_H$) is contained in CSES 2014. Control totals for remittance ($rowR^{14}$) are applied on the remittance shares to generate household income from remittance ($rowR_H^{14}$= $shfR_H \cdot_{row} R^{14}$). This procedure ensures that the observed remittance structures of 2014 as well as the remittance control totals are preserved.

There is no readily available data on social protection in Cambodia. Hence it is not easy to ascertain the social protection transfer amount. However, a paper by Kuy (2014) provides some light on the size of the social protection transfer amount. He argued that "*the government has increased fund constantly for social protection, cash transfers, and public work program, for example, it rose from 1.5 per cent to 1.7 percent of GDP or between USD 159 million to USD 176 in 2009*

[30] *Used Section 5A, question 2: "Does anyone in your household own or operate any land that is used/could be used for vegetable gardening, agri-culture or farming-activities (crop cultivation, livestock raising or private forestry)?" If the answer to this question is NO then the household is considered as a "non-farm" household.*

(source, Kuy 2014; page 4)." We used the 1.7 percent value to determine the size of social protection transfer amounts for 2014. Similar procedures are also applied to distribute institutional transfers by representative household groups. Again, institutional transfers (i.e. by government) share information by the representative household groups are obtained from CSES 2014. Control totals for the institutional transfers are applied on these shares to generate households' income from government transfers ($gTr_H^{14}=shgTr_H \cdot {}_{CR}\, gTr^{14}$). Total receipts by household groups are derived from all the above sources and this is defined as:

$$R_H^{14}=\sum_F fY_{FH}^{14}+ rowR_H^{14}+ gTr_H^{14}$$

Household Expenditure Pattern: Consumption expenditure constitutes the major component of their (i.e. household) outlays. Consumption expenditures by the 7 representative household groups on the 31 SAM commodities are estimated by using the expenditure structures contained in CSES 2014. This provides a detailed breakdown of expenditures by 7 household groups and products. In particular, the product classifications adopted in the CSES which are different are mapped to the 31 SAM commodity groups. Household consumption by 31 SAM commodities (pC_j^{14}) has already been derived using the private consumption control total and the private consumption structure for the 31 SAM commodities. The derived consumption vector is then distributed among the 7 household groups using their derived expenditure structures ($shpC_{HK}$). The procedure generates a consumption matrix for 2014 by 7 representative household groups and 31 SAM commodities ($pC_{HK}^{14}=shpC_{HK} \cdot pC_K^{14}$).

Household Outlays: Other notable expenditures incurred by household groups are income tax payments. Income tax payment shares contained in CES 2014 ($shdT_H$) and NA income tax payment control total (${}_{NA}dT^{14}$) are used to derive income tax payments by household groups ($dT_H^{14}=shdT_H \cdot {}_{NA}\, dT^{14}$).

Total outlays by household groups are defined as:

$$P_H^{14}=\sum_K pC_{HK}^{14}+ dT_H^{14}$$

Household savings are determined by deducting household payments from household income in such a way that savings close the account as well as reflect the savings pattern observed in the CSES.

Other Institutions' Accounts

Receipts and outlays of other three current institutions are discussed below.

Government Account: Sources of government income include tax revenues. The main sources of tax revenue are (i) indirect taxes on imports and domestic production and (ii) direct taxes in the form of corporate and personal (household) income taxes. Amounts for all of the four elements of tax revenues (i.e. IT_j^{14}, dM_j^{14} , and dT_H^{14}) are already defined in the supply-demand section. Total government receipts (gR^{14}) is thus defined as:

$$gR^{14}=\sum_j IT_j^{14}+\sum_j dM_j^{14}+ \sum_H dT_H^{14}$$

Government spends most of its income on purchase of goods and services (gC_K^{14}) and transfer programmes (gTr_H^{14}). Rest of the income constitutes government savings. Government savings (gS^{14}) act as the balancing factor between its receipts and outlays. The balancing condition envisages that receipt must equate the outlay. This is specified as:

$$gR^{14}-\sum_j gC_j^{14}+\sum_H gTr_H^{14} + gS^{14}=0$$

Rest of the World Account: Rest of the world account records inflows and outflows of foreign resources in a country in a fiscal year. The major sources of inflows are: imports of goods (M_j^{14}) and services and foreign assistance (i.e. $rowS^{14}$ also known as foreign savings). Major form of outflow includes exports of goods and services (E_j^{14}), and net current transfer (remittances). Amounts for all of these four elements which are defined above are assembled in this account to complete the account as well as to verify its balance. The balancing condition envisages that sum of inflows must equate the sum of outflows. This is specified as:

$$\sum_j M_j^{14}+ rowS^{14}-\sum_j E_j^{14}+ \sum_{FK} yF_{Fk}^{14} +\sum_H rowR_H^{14}=0$$

Sectoral values of production account; factor account and institutional account are put together in the SAM matrix format to produce the SAM for 2014.

ANNEX 3: INPUT-OUTPUT MATRIX AND SOCIAL ACCOUNTING MATRIX

A social accounting matrix (SAM) is an extension (or generalization) of the input-output matrix by incorporating other parts of the economy – namely primary and secondary income distribution and institutions of an economy. More specifically, input-output analysis involves constructing a table in which each horizontal row describes how one industry's total product is divided among various production processes and final consumption. Each vertical column denotes the combination of productive resources used within one industry. A table of this type (Figure 3) illustrates the dependence of each industry on the products of other industries: for example, an increase in manufacturing output is also seen to require an increase in the production of power.

Figure 17: Input-output table

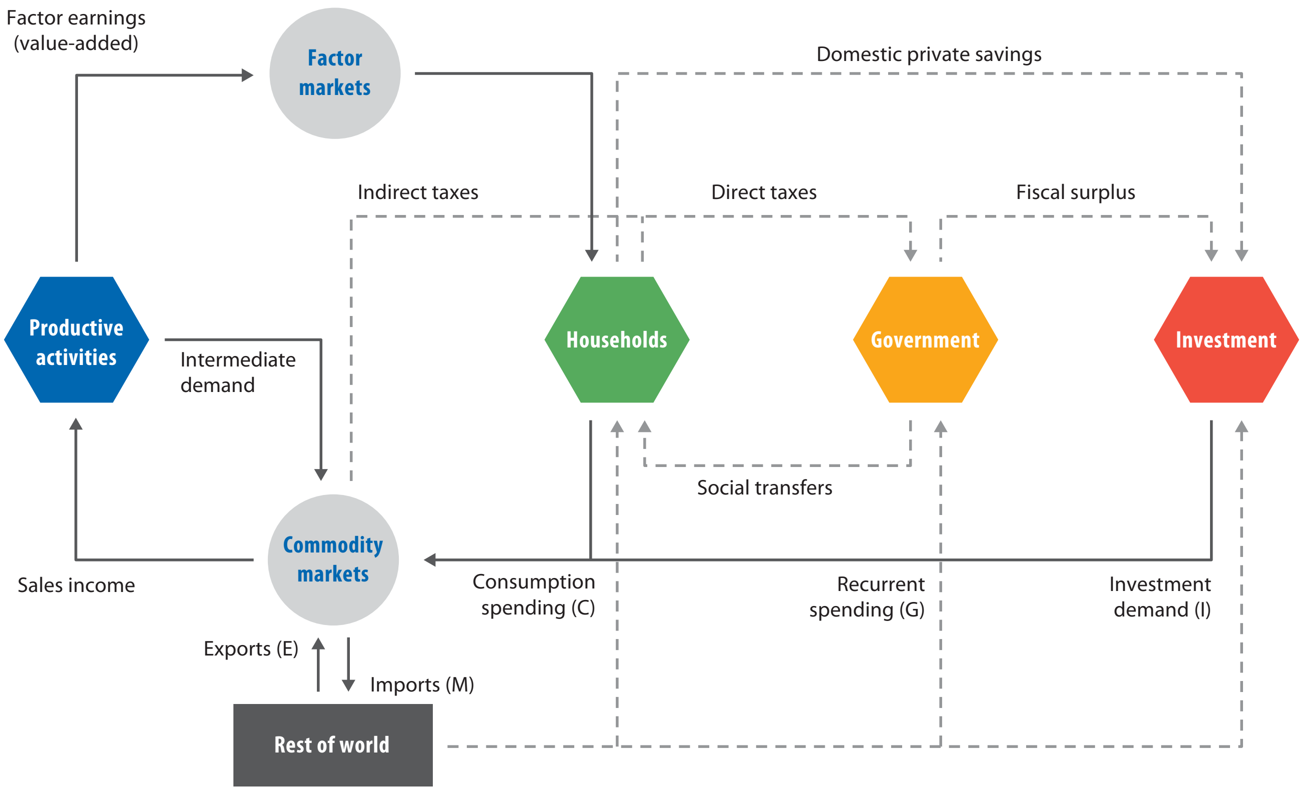
<table>
<tr><td></td><td></td><td colspan="5">Activity</td><td colspan="4">Final Demand</td><td rowspan="2">Total Use</td></tr>
<tr><td></td><td></td><td>A1</td><td>…</td><td>…</td><td>…</td><td>A26</td><td>C_p</td><td>C_g</td><td>I</td><td>Ex</td></tr>
<tr><td rowspan="5">Commodity</td><td>C1</td><td colspan="5" rowspan="5">Technology matrix (16 x 16)</td><td colspan="4" rowspan="5">Final Demand</td><td></td></tr>
<tr><td>..</td><td></td></tr>
<tr><td>..</td><td></td></tr>
<tr><td>..</td><td></td></tr>
<tr><td>C31</td><td></td></tr>
<tr><td rowspan="3">Value added</td><td>Compensation</td><td colspan="5" rowspan="3">GDP (Income Approach)</td><td colspan="4" rowspan="3">GDP (Expenditure Approach)</td><td></td></tr>
<tr><td>Operating Surplus</td><td></td></tr>
<tr><td>Indirect Taxes</td><td></td></tr>
<tr><td></td><td>Import</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>Total Supply</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

SAM is a square matrix which captures all the main circular flows (Figure 20) within an economy in a given period.

Figure 18: Basic Structure of a SAM

		Expenditure columns							
		Activities C1	Commodity C2	Factors C3	Households C4	Government C5	Investment C6	Rest of world C7	Total
Income rows	Activities R1		Domestic Supply						Activity income
	Commodities R2	Intermediate demand			Consumption spending (C)	Recurrent spending (G)	Investment demand (I)	Export earnings (E)	Total demand
	Factors R3	Value-added							Total factor income
	Households R4			Factor payments to households		Social transfers		Foreign remittances	Total household income
	Government R5		Sales taxes and import tariffs		Direct taxes			Foreign grants and loans	Government income
	Savings R6				Private savings	Fiscal surplus		Current account balance	Total savings
	Rest of world R7		Import payments (M)						Foreign exchange outflow
	Total	Gross output	Total supply	Total factor spending	Total household spending	Government expenditure	Total investment spending	Foreign exchange inflow	

Figure 19: Circular flow in an Economy



Source: Breisinger, et al (2009)

The input-output part of SAM captures production linkages between sectors that are determined by sectors' production technologies. These linkages can be differentiated into backward and forward linkages. Stronger forward and backward production linkages lead to larger multipliers.

Backward production linkages are the demand for additional inputs used by producers to supply additional goods or services. For example, when electricity production expands, it demands intermediate goods like fuel, machinery, and construction services. This demand then stimulates production in other sectors to supply these intermediate goods. The more input intensive a sector's production technology is, the stronger its backward linkages are.

Forward production linkages account for the increased supply of inputs to upstream industries. For example, when electricity production expands, it can supply more power to the economy, which stimulates production in all the sectors which use power. Thus, the more important a sector is for upstream industries, the stronger its forward linkages will be. Forward linkages are particularly important for the energy sector as it provides key input into the majority of other sectors in the economy.

Methodology – Description of social accounting matrix model

The move from a SAM data framework to a SAM model (also known as multiplier framework) requires decomposing the SAM accounts as 'exogenous' and 'endogenous'. Generally, accounts intended to be used as policy instruments (for example, government expenditure including social protection, investment and exports) are made exogenous and accounts specified as objectives or targets must be made endogenous (for example, output, commodity demand, factor return, and household income or expenditure). For any given injection into the exogenous accounts of the SAM, influence is transmitted through the interdependent SAM system among the endogenous accounts. The interwoven nature of the system implies that the incomes of factors, households and production are all derived from exogenous injections into the economy via a multiplier process. The multiplier process is developed here on the assumption that when an endogenous income account receives an exogenous expenditure injection, it spends it in the same proportions as shown in the matrix of average propensities to spend (APS). The elements of the APS matrix are calculated by dividing each cell by the sum total of its corresponding column.

The economy-wide impacts of the investment have been examined by changing the total exogenous injection vector, especially government. More specifically, the total exogenous account is manipulated to estimate their effects on output (through an output multiplier), value-added or GDP (through the GDP multiplier), and household income (through household income multiplier) and commodity demand (via commodity multipliers).

Table 24: Description of the endogenous and exogenous accounts and multiplier effects

Endogenous (y)	*Exogenous (x)*
The activity (gross output multipliers), indicates the total effect on the sectoral gross output of a unit-income increase in a given account, i in the SAM, and is obtained via the association with the commodity production activity account i.	
The consumption commodity multipliers, which indicates the total effect on the sectoral commodity output of a unit-income increase in a given account i in the SAM, is obtained by adding the associated commodity elements in the matrix along the column for account i.	Intervention into through activities (x = i + g + e), where i= GFC + ST (GFCF) Exports (e) Government Expenditure (g) Investment Demand (i) Inventory Demand (i)
The value-added, or GDP multiplier, giving the total increase in GDP resulting from the same unit-income injection, is derived by summing up the factor-payment elements along account i's column.	
Household income multiplier shows the total effect on household and enterprise income, and is obtained by adding the elements for the household groups along the account i column.	*Intervention via Households (x = r + gt + ct), where* *Remittance (r)* *Government Transfers (gt)* *Corporation Transfers (ct)*

The shift from a 'data' SAM structure to a SAM multiplier module requires the introduction of assumptions and the separation of the SAM accounts into 'exogenous' and 'endogenous' components.[31]

Table 25: General SAM modular structure

		1a-PA	1b-CM	2-FP	3a-HH-OI	4-KHH-OI	5-ROW	TDD
1a	PA		$T_{1a, 1b}$		0			Y_{1a}
1b	CM	$T_{1b, 1a}$			$T_{1b, 3}$	$T_{1b, 4}$	$T_{1b, 5}$	Y_{1b}
2	FP	$T_{2, 1a}$					$T_{2, 5}$	Y_2
3	HH-IO	$T_{3, 1a}$	$T_{3, 1b}$	$T_{3, 2}$	$T_{3, 3}$		$T_{3, 5}$	Y_3
4	KHH-OI	$T_{4, 1a}$			$T_{4, 3a}$		$T_{4, 5}$	Y_4
5	ROW		$T_{5, 1b}$	$T_{5 2}$	$T_{5, 3}$	0	0	Y_5
	TSS	E_{1a}	E_{1b}	E_2	E_3	E_4	E_5	

Where: by definition $Y_i = E_j$ and 1 Production (1a PA = Production Activities and 1b CM = Commodities); 2 FP = Factors of Production; 3 HH-IO = Households and Other Institutions (incl. Government); 4 KHH-OI = Capital Account Households and Other Institutions (including government); 5 ROW = Rest of the World (current and capital account). Blank entries indicate that there are no transactions by definition.

The separation is needed to enter the system, allowing some variables within the SAM structure to be manipulated exogenously (via injection instruments) to assess the subsequent impacts on the endogenous accounts as well as on the exogenous accounts.

Generally, accounts intended to be used as policy instruments are classified as exogenous and accounts specified *a priory* as objectives (or targets) are classified as endogenous. Three accounts are designated as endogenous accounts: 1) Production (production activities and commodities) account, 2) Factors of Production account, 3a) Households and Other Institutions (excluding the Government).

The exogenous accounts comprise: 3a) Government (expenditure, transfer, remittances); 4) Capital account of institutions

[31] *This methodology follows Pyatt G and Round J.I., "Social Accounting Matrices for Development Planning", Review of Income and Wealth, Series 23, No.4, 1977; Pyatt G and Round JI, "Accounting and Fixed Price Multipliers in a SAM Framework", Economic Journal, No. 89, 1979 and Pyatt, G. and Roe, A. (1987) (eds), while the layout follows Alarcon JV et al, La Matriz de Insumo-Producto Adaptada-para la Planificación de lasnecesidadesbásicas, Ecuador*

(savings and demand for houses, investment demand, infrastructure and machinery and equipment); and 5 ROW transfers, remittances, export demand and capital. The SAM flows and the categorization into endogenous and exogenous accounts are shown below.

Table 26: Endogenous and Exogenous Accounts

		1a-PA	1b-CM	2-FP	3a-HH-OI	3b-Gov	4-KHH-OI	5-ROW	TDD
1a	PA		$T_{1a, 1b}$		0				Y_{1a}
1b	CM	$T_{1b, 1a}$			$T_{1b, 3a}$	$T_{1b, 3b}$	$T_{1b, 4}$	$T_{1b,5}$	Y_{1b}
2	FP	$T_{2, 1a}$						$T_{2, 5}$	Y_{2}
3a	HH-OI			$T_{3a, 2}$	$T_{3a, 3a}$	$T_{3a, 3b}$		$T_{2, 5}$	Y_{3}
3b	Gov	$T_{3b, 1a}$	$T_{3b, 1b}$		$T_{3b, 3a}$	$T_{3b, 3b}$		$T_{3a, 5}$	
4	KHH-OI	$T_{4, 1a}$			$T_{4, 3}$			$T_{4, 5}$	Y_{4}
5	ROW		$T_{5, 1b}$	$T_{5, 2}$	$T_{5, 3a}$	$T_{5, 3b}$	$T_{5, 4}$	0	Y_{5}
	TSS	E_{1a}	E_{1b}	E_{2}	E_{3a}	E_{3b}	E_{4}	E_{5}	

Where Endogenous: 1 Production (1a PA = Production Activities and 1b CM = Commodities); 2 FP = Factors of Production; 3a HH = Households and Other Institutions (excluding Government); Where Exogenous: 3b Government; 4 KHH-OI = Capital Account of Households and of Other Institutions (incl. government); 5 ROW = Rest of the World (current and capital account). Blank entries indicate that there are no transactions by definition.

Table 27: Endogenous and components of exogenous accounts

	PA	CM	FP	3a HH&OI	EXO	INCOME	Exogenous Accounts (EXO) used as injections Column Vectors
1a PA		$T_{1a\ 1b}$		0	X_{1a}	Y_{1a}	$X_{1a} = 0$
1b CM	$T_{1b\ 1a}$			$T_{1b\ 3a}$	X_{1b}	Y_{1b}	X_{1b} = Government Consumption Subsidies - Taxes + Exports + Gov. Investment (capital formation in infrastructure and machinery and equipment) + Gross Capital Stock formation
2 FP	$T_{2\ 1a}$				X_{2}	Y_{2}	X_{2} =Factor Remittances from ROW
3a HH&OI			$T_{3a\ 2}$	$T_{3a\ 3a}$	X_{3a}	Y_{3a}	X_{3a} = Transfers (OAA), remittance
3b-5 Leaks	L_{1a}	L_{1b}	L_{2}	L_{3a}	$L_{3b\text{-}5} = X_{3b\text{-}5}$	$Y_{3b\text{-}5}$	3b =Aid to Government from ROW
EXPN	E_{1a}	E_{1b}	E_{2}	E_{3a}	$E_{3b\text{-}5}$		Where $E_{i=}Y_{j}$
L_{1a} = Activity Tax					L_{3a} = Income Tax + Household Savings + Corporate Savings		
L_{1b} = Commodity Tax + Import Duty + Imports					$L_{3b\text{-}5}$ $X_{3b\text{-}5}$ and $Y_{3b\text{-}5\ \text{falls}}$ out of the model		
L_{2} = Factor Remittances to ROW				Blank entries indicate that there are no transactions by definition.			

Note on Injection: For any given injection into the exogenous accounts X_i (i.e., instruments) of the SAM, influence is transmitted through the interdependent SAM system among the endogenous accounts. The interwoven nature of the system implies that the incomes of factors, institutions and production are all derived from exogenous injections into the economy via a multiplier process. Multiplier models may also be built on the input-output frameworks. The main shortcoming of the IO model is that the feedback between factor income generation (value-added) and demand by private institutions (households) does not exist. In this case, the circular economic flow is truncated. The problem can be partly tackled by endogenising household consumption within the I-O framework; this is typically referred to as a 'closed I-O model'. In this case, the circular economic flow is only partially truncated. A better solution is to extend the I-O to a SAM framework, which captures the full circular economic flow derivation of SAM multipliers

1975 y 1980, Quito, ISSPREALC, 1984, and Alarcon JV et al, The Social Accounting Framework for Development, Avebury, Gower House, 1991.

SAM coefficients (A_{ij}) are derived from payments flows by endogenous accounts to themselves (T_{ij}) and other endogenous accounts as to the corresponding outlays ($E_i = Y_j$); similarly, the leak coefficients (B_{ij}) derived from flows reflecting payments from endogenous accounts to exogenous accounts. They are derived below.

Table 28: Coefficient Matrices and Vectors of the SAM Model

Account	1a – PA	1b – CM	2 – FP	3a - HH&OI	3b … 5 EXO	Income
1a – PA		$A_{1a,1b} = T_{1a,1b}/Y_{1b}$			X_{1a}	Y_{1a}
1b – CM	$A_{1b,1a} = T_{1b,1a}/Y_{1a}$			$A_{1b,3a} = T_{1b,3a}/Y_{3a}$	X_{1b}	Y_{1b}
2 – FP	$A_{2,1a} = T_{2,1a}/Y_{1a}$				X_2	Y_2
3a - HH&OI			$A_{3a,2} = T_{3a,2}/Y_2$	$A_{3a,3a} = T_{3a,3a}/Y_{3a}$	X_{3a}	Y_{3a}
3b … 5 Leaks	$B_{1a} = L_{1a}/Y_{1a}$	$B_{1b} = L_{1b}/Y_{1b}$	$B_2 = L_2/Y_2$	$B_{3a} = L_{3a}/Y_{3a}$		
Expenditure	$E_{1a} = Y_{1a}$	$E_{1b} = Y_{1b}$	$E_2 = Y_2$	$E_3 = Y_{3a}$		

The multiplier analysis using the SAM framework helps us to understand the linkages between the different sectors and the institutional agents at work within the economy. Accounting multipliers have been calculated according to the standard formula for accounting (impact) multipliers, as follows:

$$\mathbf{Y(t) = A\,Y\,(t) + X(t) = (I - A)^{-1}\,X(t) = M_a X(t)}$$

Where:
t is time
Y is a vector of incomes of endogenous variables
X is a vector of expenditures of exogenous variables
A is the matrix of average expenditure propensities for endogenous accounts
$M_a = (I - A)^{-1}$ is a matrix of aggregate accounting multipliers (generalized Leontief inverse).

From the above it logically follows that the SAM model mainly provides answers to ten basic issues:

1. It helps to assess the impacts on the endogenous and exogenous accounts in a clear and differentiated manner;
2. The technological structure of the sectors oriented towards the production of basic intermediate and final goods and services;
3. Expenditure structures of factors of production, institutions and demand for goods and services of domestic and foreign origin;
4. The identification of key sectors, commodities, factors of production, institutional accounts and basic needs in the economy and quantification of the main linkages (total and partial);
5. The dynamics of the production structure, factorial and institutional income formation;
6. Helps to assess the effects of incomes of institutions and their impact on production via their corresponding demand;
7. Helps to assess the intra, across or extra and inter-circular group effects, both in additive and multiplicative manner;
8. Matching labour and investment requirement can be calculated;
9. Assess price changes on endogenous accounts arising out of endogenous account price changes as well as exogenous account price changes;
10. Design simulations and alternative scenario and perform analysis; and
11. It serves as the basis for development of computable general equilibrium.

ANNEX 4: DESCRIPTION OF THE DYNAMIC CGE MODEL

Static Module of the DCGE Model

Production bloc

The equations of the production bloc are provided below. The description of the variables and parameters is provided below.

(1) $$XS_j = Min\left[\frac{CI_j}{io_j}, \frac{VA_j}{v_j}\right]$$

(2) $$VA_j = A_j^{KL}\left[\propto_i^{KL} LD_i^{-\rho_i^{kl}} + (1-\propto_i^{KL})KD_i^{-\rho_i^{kl}}\right]^{-1/\rho_i^{KL}}$$

(3) $$LD_i = A_i^{LL}\left[\propto_i^{LL} QL_i^{-\rho_i^{LL}} + (1-\propto_i^{LL})NQL_i^{-\rho_i^{LL}}\right]^{-1/\rho_i^{LL}}$$

(4) $$CI_j = io_j XS_j$$

(5) $$DI_{i,j} = aij_{i,j} CI_j$$

(6) $$LD_i = \left(\frac{\alpha_i^{KL}}{1-\alpha_i^{KL}}\right)^{\sigma_i^{KL}}\left(\frac{r_i}{w_i}\right)^{\sigma_i^{KL}} KD_i$$

(7) $$NQL_i = \left(\frac{\alpha_i^{LL}}{1-\alpha_i^{LL}}\right)^{\sigma_i^{LL}}\left(\frac{wq}{wnq}\right)^{\alpha_i^{LL}} QL_i$$

Income and demand bloc

The equations are provided below:

(9) $$YH_h = \lambda_h^{WQ}.wq\sum_j QL_j + \lambda_h^{WQN}.\sum_j NQL_j + \lambda_h^{R}\sum_{nag} r_{nag} KD_{nag} + \lambda_h^{L}.\sum_{ag} r_{ag} KD_{ag} + P_{index}TG_h + P_{index}TH_{h,hj} + P_{index}TWH_h + DIV_h \quad (8)$$

(10) $$YDH_h = YH_h - DTH_h$$

(11) $$SH_h = v.\psi_h.YDH_h$$

(12) $$YF = \lambda^{RF}\sum_i r_i KD_i + \lambda^{LF}.rl.LAND$$

(13) $$SF = YF - \sum_h DIV_h - e.DIV^{ROW} - DTF$$

(14) $YG = \sum_i TI_i + \sum_i TIE_i + \sum_i DTH_h + DTF$

(15) $SG = YG - G - PINDEX \sum_h TG_h$

(16) $TI_i = tx_i(P_i XS_i - PE_i EX_i) + tx_i(1 + tm_i). e. PWM_i M_i$

(17) $TIM_i = tm_i e. PWM_i M_i$

(18) $TIE_i = te_i PE_i EX_i$

(19) $DTH_h = tyh_h YH_h$

(20) $DTF = tyf.YF$

International Trade

The equations are provided below:

(21) $XS_i = B_i^E \left[\beta_i^E EX_i^{k_i^E} + (1 + \beta_i^E) D_i^{k_i^E}\right]^{\frac{1}{k_i^B}}$

(22) $EX_i = \left[\left(\frac{PE_i}{PL_i}\right)\left(\frac{1-\beta_i^E}{\beta_i^E}\right)\right]^{\tau_i^E} D_i$

(23) $EXD_i = EXD_i^o . \left(\frac{PWE_i}{PE\_FOB_i}\right)^{elast_i}$

(24) $Q_i = A_i^M \left[\alpha_i^M M_i^{-\rho_i^M} + (1 - \alpha_i^M) D_i^{-\rho_i^M}\right]^{\frac{-1}{\rho_i^M}}$

(25) $M_i = \left[\left(\frac{PD_i}{PM_i}\right)\left(\frac{\alpha_i^M}{1-\alpha_i^M}\right)\right]^{\sigma_i^M} D_i$

(26) $CAB = \sum_i PWM_i M_i + \lambda^{ROW} \sum_i r_i KD_i / _e + DIV^{ROW} - \sum_i PE_{FOB_i} EX_i$

Price blocs

The prices equations are provided below. The nominal exchange rate is the numéraire in each period.

(27) $PV_j = \frac{P_j XS_j - \sum_i PC_i DI_{i,j}}{VA_j}$

(28) $r_i = \frac{PV_i VA_i - w_i LD_i}{KD_i}$

(29) $w_i = \frac{wq.QL_i - wnq.NQL_i}{LD_i}$

(30) $PD_i = (1 + tx_i)PL_i$

(31) $PM_i = (1 + tx_i).(1 + tm_i).e.PWM_i$

(32) $PE_i = \frac{e.PE\_FOB_i}{1+te_i}$

(33) $PC_iQ_i = PD_iD_i + PM_iM_i$

(34) $P_iXS_i = PL_iD_i + PE_iEX_i$

(35) $P_{inv} = \prod_i \left(\frac{PC_i}{\mu_i}\right)^{\mu_i}$

(36) $P_{index} = \sum_i \delta_i PV_i$

Equilibrium Condition

The equations are provided below:

(37) $Q_i = DIT_i + \sum_h C_{i,h} + INV_i + Dstk_i$

(38) $EX_i = EXD_i$

(39) $LSQ = \sum_j QL_j$

(40) $LSNQ = \sum_j NQL_j$

(41) $IT + \sum_i PC_iDstk_i = \sum_h SH_h + SF + SG + e.CAB$

Dynamic Module of the DCGE Model

The equations of the dynamic bloc are provided below.

(42) $KD_{i,t+1} = (1 - \delta)KD_{i,t} + Ind_{i,t}$

(43) $LSQ_{t+1} = (1 + ng).LSQ_t$

(44) $LSNQ_q = (1 + ng).NQL_t$

(45) $C^{min}_{i,h,t+1} = (1 + ng)C^{min}_{i,h,t}$

(46) $\frac{Ind_{i,t}}{KD_{i,t}} = A^{IK}_i \left(\frac{R_{i,t}}{U_{i,t}}\right)^2$

(47) $U_{i,t} = Pinv_t(ir + \delta_i)$

(48) $IT_t = Pinv_t.\sum_i Ind_{i,t}$

(49) $SG_{t+1} = (1 + ng)SG_t$

(50) $CAB_{t+1} = (1 + ng)CAB_t$

(51) $TG_{t+1} = (1 + ng)TG_i$

(52) $CG_{t+1} = (1 + ng)CG_t$

(53) $Dstk_{t+1} = (1 + ng)Dstk_t$

(54) $DIV_{t+1} = (1 + ng)DIV_t$

(55) $DIV\_ROW_{t+1} = (1 + ng)DIV\_ROW_t$

(56) $TWH_{t+1} = (1 + ng)TWH_t$

(57) $TH_{h,hj,t+1} = (1 + ng)TH_{h,hj,t}$

(58) $EXD^o_{t+1} = (1 + ng)EXD^o_t$

Description of the Variables and Parameters of the Dynamic CGE Model

Endogenous variables

$C_{i,h}$	Household consumption of good i (volume)
CF	Composite agricultural capital-Labour factor (volume)
CI_j	Total intermediate consumption of activity j (volume)
CTH_h	Household h's total consumption (value)
D_i	Demand for domestic good i (volume)
$DI_{i,j}$	Intermediate consumption of good i in activity j (volume)
DIT_i	Intermediate demand for good i (volume)
DTF	Receipts from direct taxation on firms' income
DTH_h	Receipts from direct taxation on household h's income
EX_i	Exports in good i (volume)
G	Public expenditures
INV_i	Investment demand for good i (volume)
IT	Total investment
LD_j	Activity j demand for Labour (volume)
M_i	Imports in good i (volume)
P_i	Producer price of good i
PC_i	Consumer price of composite good i
PD_i	Domestic price of good i including taxes
PE_i	Domestic price of exported good i

$Pindex$	GDP deflator
$Pinv$	Price index of investment
PL_i	Domestic price of good i (excluding taxes)
PM_i	Domestic price of imported good i
PV_i	Value added price for activity j
Q_i	Demand for composite good i (volume)
r_i	Rate of return to capital in activity i
rl	Rate of return to agricultural land
rc	Rate of return to composite factor
SF	Firms' savings
SG	Government's savings
SH_i	Household h's savings
TI_i	Receipts from indirect tax on i
TIE_i	Receipts from tax on export i
TIM_i	Receipts from import duties i
VA_j	Value added for activity j (volume)
w	Wage rate
XS_i	Output of activity i (volume)
YDH_h	Household h's disposable income
YF	Firms' income
YG	Government's income
YH_h	Household h's income
LS	Total Labour supply (volume)
KD_i	Demand for capital in activity i (volume)
CAB	Current account balance
$Ind_{i,t}$	Demand for capital in activity i (volume)
U_t	Capital user cost
$C_{i,h}^{min}$	Minimum consumption of good i by household h

Endogenous variables

PWE_i	World price of export i
PWM_i	World price of import I
e	Nominal Exchange rate (numéraire)

Parameters

Production functions

A_i	Scale coefficient (Cobb-Douglas production function)
$aij_{i,j}$	Input-output coefficient
α_j	Elasticity (Cobb-Douglas production function)
io_j	Technical coefficient (Leontief production function)
v_j	Technical coefficient (Leontief production function)

CES function between capital and Labour

A_i^{KL}	Scale coefficient
α_i^{KL}	Share parameter
ρ_i^{KL}	Substitution parameter
σ_i^{KL}	Substitution elasticity

CES function between skilled and unskilled Labour

A_i^{LL}	Scale coefficient
α_i^{LL}	Share parameter
ρ_i^{LL}	Substitution parameter
σ_i^{LL}	Substitution elasticity

CES function between imports and domestic production

A_i^{M}	Scale coefficient
α_i^{M}	Share parameter
ρ_i^{M}	Substitution parameter
σ_i^{M}	Substitution elasticity

CET function between domestic production and exports

B_i^{E}	Scale coefficient
β_i^{E}	Share parameter
κ_i^{E}	Transformation parameter
τ_i^{E}	Transformation elasticity

LES consumption function

$\gamma_{i,h}$	Marginal share of good i

Tax rates

te_i	Tax on exports *i*
tm_i	Import duties on good *i*
tx_i	Tax rate on good *i*
tyh_h	Direct tax rate on household *h*'s income
tyf	Direct tax rate on firms' income

Other parameters

δ_j	Share of activity *j* in total value added
λ_h^L	Share of land income received by household *h*
λ^{LF}	Share of land income received by firms
λ^{LROW}	Share of land income received by foreigners
λ_h^R	Share of capital income received by household *h*
λ^{RF}	Share of capital income received by firms
λ^{ROW}	Share of capital income received by foreigners
λ_h^W	Share of labour income received by household *h*
ψ_h	Propensity to save
μ_i	Share of the value of good *i* in total investment
ng	Population growth rate
δ	Capital depreciation rate
γ_{1i}	Parameter in the investment demand function
γ_{2i}	Parameter in the investment demand function
ir	Real interest rate

#53, Pasteur Street, Boeung Keng Kang I
P.O. Box 877, Phnom Penh, Cambodia
Tel: +855 23 216 167 / 214 371
Fax: +855 23 216 257 / 721 042
E-mail (General): registry.kh@undp.org
Website: www.kh.undp.org